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

Volume I

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

September 2009 **Draft Report**

Prepared for :

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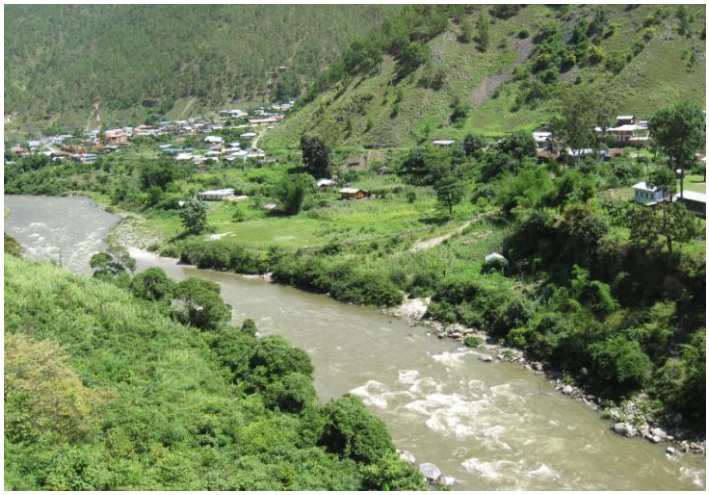

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AUSTRALIA | ASIA | MIDDLE EAST | AFRICA | PACIFIC

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ABBREVIATED FORM	FULL FORM
APP	Aggregate Processing Plant
BOOT	Built-Own-Operate-Transfer
CAT	Catchment Area Treatment
CEA	Central Electricity Authority
CIFRI	Central Inland Fisheries Research Institute
CPCB	Central Pollution Control Board
DEM	Digital Elevation Model
DoEF	Department of Environment and Forest
DPR	Detailed Project Report
E&M	Electro Mechanical
EAC	Environment Appraisal Committee
EAC	Extra Additional Commissioner
EIA	Environmental Impact Assessment
EL	Elevation
EMP	Environment Management Plan
ERDAS	Earth Resources Data Analysis System
FCC	False Colour Composite
FERC	Federal Energy Regulatory Commission
G&D	Gauge And Discharge
GoI	Government of India
HEC-RAS	Hydraulic Engineering Centre-River Analysis System
HEP	Hydro Electric Project
HRT	Head Race Tunnel
IMD	Indian Meteorological Department
IPP	Independent Power Producer
IRS	Indian Remote Sensing
LISS-III	Linear Imaging Self-Scanning Sensor
MoEF	Ministry of Environment and Forest
MW	Mega Watt
NBSS&LUP	National Bureau of Soil Survey and Land Use Pattern
NEEPCO	North Eastern Electricity and Power Corporation
NEFA	North Eastern Frontier Agency
NER	North Eastern Region
NRSA	National Remote Sensing Agency

ABBREVIATED FORM	FULL FORM
NWS	National Weather Service
PFR	Preliminary Feasibility Report
PHC	Primary Health Centre
PMF	Probable Maximum Flood
PSS	Pumped Storage Scheme
RSPM	Respirable Suspended Particulate Matter
SFRI	State Forest Research Institute
SOI	Survey of India
SPCB	State Pollution Control Board
SPF	Solid Project Flood
SPF	Standard Project Flood
SPM	Suspended Particulate Matter
TPM	Tonnes Per Minute
TRT	Tail Race Tunnel
USBR	United States Bureau of Reclamation
USF	Unclassified State Forest
UTPCC	Union Territory Pollution Control Committee
VEC	Valued Environment Component
WLPA	Wild Life Protection Act
ZSI	Zoological Survey of India

Chapter 1

INTRODUCTION

1 INTRODUCTION

1.1 HYDROPOWER POTENTIAL IN NORTH-EAST INDIA

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. To provide availability of over 1000 units of per capita electricity by year 2012 it is estimated that need based capacity addition of more than 1,00,000 MW would be required during the period 2002-12. At present[1], most of the electricity generated (64.6%) is through thermal power plants. Hydro power constitutes 24.7%, Nuclear Power 2.9%, and Renewable Energy Sources[2] (RES) produce 7.7% of the total power generated.

Hydroelectricity is a clean and renewable source of energy. Hence, maximum emphasis would be laid on development of feasible hydro potential in the country. The '50,000 MW hydro initiative' has been launched and is being vigorously pursued. Harnessing hydro potential speedily will also facilitate economic development of States, particularly North-Eastern States, Sikkim, Uttaranchal, Himachal Pradesh and J&K, since a large proportion of our hydro power potential is located in these States. The States with hydro potential need to focus on the full development of these potentials at the earliest.

The North-East Region (NER) has a hydropower potential of 58,971 MW, but only a small portion of this potential (2.04%) has been harnessed so far. The status of hydro electricity potential in NER states is provided in **Table 1.1** below.

Table 1:1 Status of Hydro Electric Potential Development in North-Eastern Region (NER)[3]

State	Identified Capacity	Capacity Developed	Capacity under Construction	Capacity yet to be developed
	(MW)	(MW)	(MW)	(MW)
Meghalaya	2394	185.2	124.0	2084.8
Tripura	15	15.0	0.0	0.0
Manipur	1784	105.0	0.0	1679.0
Assam	680	375.0	0.0	305.0
Nagaland	1574	99.0	0.0	1475.0
Arunachal Pradesh	50328	423.5	2600.0	47304.5
Mizoram	2196	0.0	0.0	2196.0
Total (NER)	**58971**	**1202.7**	**2724.0**	**55044.3**
All India	**148701**	**33222.5**	**12855.0**	**102623.5**

Source : *http://www.cea.nic.in* ***(In terms of installed capacity as on 31.03.2009)***

[1] Information obtained from Ministry of Power web site http://www.powermin.nic.in/JSP_SERVLETS/internal.jsp

[2] Renewable Engergy Sources or RES includes Small Hydro Project, Biomass Gasfier, Biomass Power, Urban & Industrial Water Power, and Wind Energy.

[3] Note 1 In addition to above 4809.6 MW PSS is under operation

Note 2 The above Table does not include schemes below 3 MW up to March'2003 and thereafter up to 25MW under construction.

1.2 POWER POTENTIAL IN ARUNACHAL PRADESH

Arunachal Pradesh not only in NER, even at the national level, Arunachal Pradesh shares more than one-third of total hydropower potential. The state is blessed with significant hydropower potential, which is available in eight river basins. The map showing all the river basins of Arunachal Pradesh and Kameng Basin are provided in **Figure 1.1** and **1.3** respectively. Details of basin wise hydropower potential of Arunachal Pradesh are given in **Table 1.2.** The existing Hydel stations of West Kameng district is presented in **Table 1.3**.

Under the 57,000 MW Hydro electric initiatives, Preliminary Feasibility Reports (PFRs) of the 162 hydroelectric projects having an aggregate installed capacity of 47,930 MW are completed. Out of these 162 identified projects, PFR of 42 projects with aggregate installed capacity of 27,293 MW are in Arunachal Pradesh. The Hydro Power projects of Arunachal Pradesh are shown in **Figure 1.2**. It shows that Government of Arunachal Pradesh has been playing a proactive role in achieving the objectives stated in the National Electricity Policy. Government of Arunachal Pradesh has achieved this target through both public sector undertakings and as well as through private sector participation. In order to encourage the private sector it has prepared Small Hydro Power Project Policy-2007. This policy comprehensively addresses the private participation in development of small hydro power projects and provides some attractive incentives. A number of private developers have taken this opportunity and participating in this unique initiative in Arunachal Pradesh.

Table 1:2 Hydro-power potential in various river basins of Arunachal Pradesh

Sl. No.	River Basin	District	Hydro Power Potential (in MW)
1.	Tawang	Tawang	2057.00
2.	Kameng	West & East Kameng	6183.00
3.	Subansiri	Upper & Lower Subansiri and Kurung Kumey	12248.00
4.	Dikrong	Papum Pare	410.00
5.	Siang	West , East & Upper Siang	17308.00
6.	Dibang	Dibang Valley & Lower Dibang Valley	10977.00
7.	Lohit	Anjaw & Lohit	7679.50
8.	Tirap	Changlang & Tirap	140.00
		Total	**57002.50**

(***Source**: http://www.arunachalhydro.org.in*)

Table 1:3 Existing Hydro-power Stations in West Kameng District

Sl. No	Name of Station	Unit in K W	Installed Capacity (in KW)	Year of Commissioning
1.	Rahung	3 x 250	750	1972 – 73
2.	Dirang	4 x 500	2000	1977 – 78
3.	Sessa	3 x 500	1500	1992 – 93
4.	Khelong	1 x 10	10	1995 – 96
5.	Rupa	2 x 100	200	1997 – 98
6.	Dokumpani	1 x 30	30	2000 - 01

(***Source:** http://www.arunachalhydro.org.in*)

Moreover, the entire landscape of Arunachal Pradesh is crisscrossed by streams having tremendous potential even for Mini/ Micro Hydel Projects. If these are properly utilized, it will fulfill the growing demand of power generation and reduce the quantum of diesel used. Moreover such projects will be suitable, effective and economical for the electrification in rural and far-flung areas.

1.3 NAFRA HYDRO ELECTRIC PROJECT

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 envisaged as 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. Being a run-of-river scheme, it merits consideration for earning of carbon credit.[4]

The project involves simple civil works to be completed in 36 months. The project with a proposed installation of 96 MW (2 x 48 MW) will afford 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. The power would be evacuated to the nearest pooling station / sub-station. The estimated cost of the project is Rs. 692.85 crores including escalation during construction and IDC at April 2009 price level.[5]

1.4 PROJECT PROPONENT

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.

[4] The carbon credits are earned in accordance to Clean Development Mechanism (CDM). CDM is a component of the Kyoto Protocol, an international treaty designed to facilitate a global reduction in greenhouse gas emissions. The Kyoto Protocol provides for quantified emission limitations and reduction commitments for the developed countries and mechanisms to facilitate compliance with these targets, reporting and review and it lists six greenhouse gases- Carbon dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6). The project activity is expected to generate significant amount of Certified Emission Reductions that can be sold into international carbon markets, improving the IRR financial viability of the project.

[5] Estimated cost as per Detailed Project Report.

Figure 1:1 River Basin Map of Arunachal Pradesh

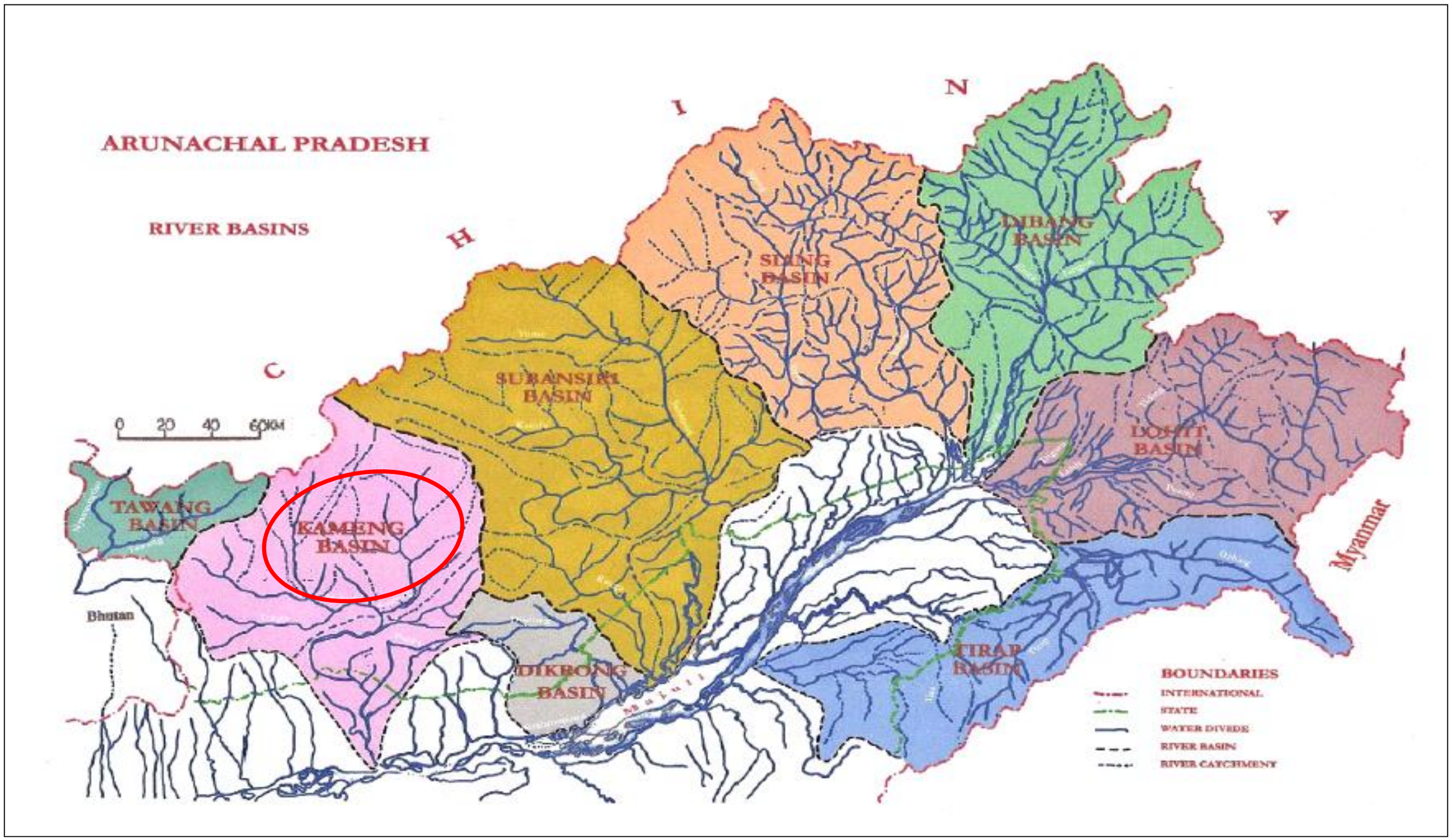


Figure 1:2 Hydro Power Projects in Arunachal Pradesh

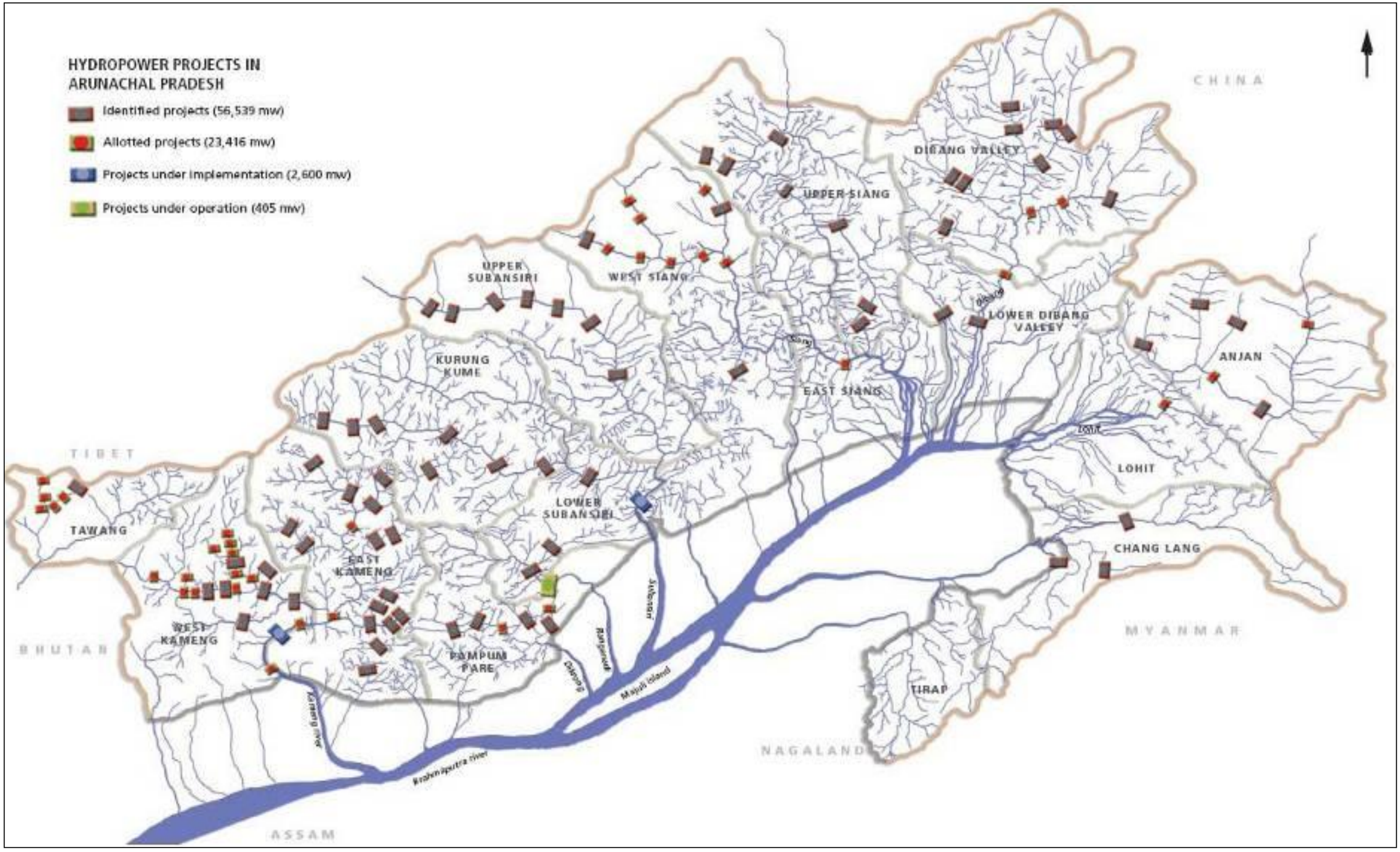
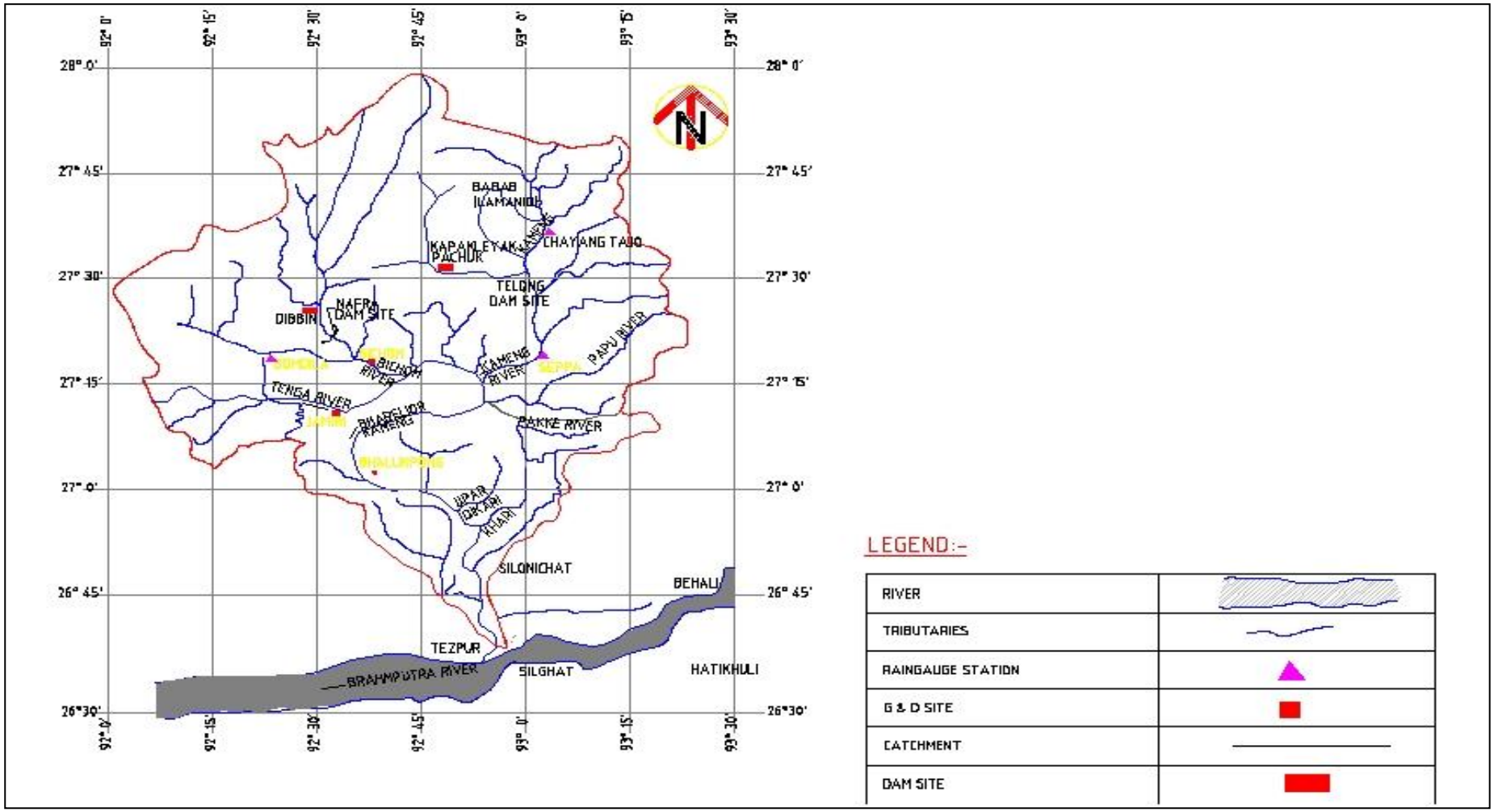


Figure 1:3 Kameng River Basin Map



1.5 ENVIRONMENT IMPACT ASSESSMENT (EIA) STUDY

This EIA study is conducted for Nafra Hydro Electric Project by SMEC India Pvt. Ltd as per the ToR issued by MoEF during the prior-environment clearance. The brief description of purpose and scope and methodology of the study and the study area is provided in the sections below.

1.5.1 PURPOSE OF THE STUDY

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. This Environmental Impact Assessment (EIA) study has been conducted to identify possible environmental impacts and to suggest ways for mitigating or minimizing them. The EIA also identifies the possible benefits and adverse impacts on the environment as a result of construction and operation of the project. The Environment Management Plan (EMP) provides a plan which, upon implementation, will reduce impacts of the project and minimize environmental degradation. This minimization may be a result of implementation of a project alternative or project modifications or environmental protection measures which simply reduces the severity or magnitude of impacts.

1.5.2 SCOPE OF THE STUDY

The scope of this EIA study is as follows:

- Assessment of the existing condition of physico-chemical, ecological and socio-economic aspects of environment;
- Identification of potential impacts on various environmental components due to activities envisaged during construction and operational phases of the proposed hydro-electric project.
- Prediction of significant impacts on major environmental components;
- Delineation of Environmental Management Plan (EMP) outlining measures to minimize adverse impacts during construction and operational phases of the proposed project. This includes components like Catchment Area Treatment Plan (CAT)[6] , Green Belt Development Plan, Fisheries development, conservation/management plan, Muck Disposal Plan, Dam Break Analysis etc;
- Formulation of Rehabilitation and Resettlement Plan as per National R&R Policy 2007;
- Formulation of environmental monitoring programme for construction and operation phases;
- Estimation of Cost for implementation of Environmental Management Plan, Resettlement & Rehabilitation Plan, Catchment Area Treatment Plan and Environmental Monitoring Programme.

[6] "M/s. KSK Energy Group, project authority of Dibbin HEP on Bichom River has been directed by Expert Appraisal Committee to undertake a basin study for Bichom Basin. Cost of the study to be shared by all the project authorities of HEPs in Bichom Basin on prorate basis per MW" – as per approved TOR of EAC, MoEF, Ref. No. J-12011/ 42/ 2008- IA.I dated 24.10.2008.

EAC, MoEF has commissioned Bichom River Basin Study (Ref. No.J-12011/93/2007-IA.I) at the cost of Rs.65.00 lakhs in the twenty-third (23rd) meeting of Expert Appraisal Committee for River Valley and Hydroelectric Projects constituted under the provisions of EIA notification 2006, held on 16th & 17th February, 2009 in New Delhi.

1.5.3 METHODOLOGY OF THE STUDY

The EIA study is based on relevant data collected from primary and secondary sources on environmental parameters. Pre-project environmental baseline conditions including physical, biological and socio-economic parameters, resource base and infrastructure has been covered in this EIA study. The environmental data collection included all attributes as stipulated in EIA Manual and EIA notification of MoEF.

A scoping matrix has been formulated to identify various issues likely to result of the proposed project. The scoping matrix adopted for the EIA study is given in **Table 1.4.**

Based on the assessment of impacts likely to accrue during the proposed project, various aspects to be covered in the EIA study were identified. The other issues outlined in the Scoping matrix were then discarded. Thus, planning of baseline survey commenced with the shortlisting of impacts and identification of parameters for which the data was required to be collected.

Table 1:4 Scoping Matrix for EIA study for the proposed Nafra Hydro Electric Project

Aspect of Environment	Likely Impacts
A. Land Environment	
Construction phase	▪ Increase in soil erosion ▪ Pollution caused by construction spoils ▪ Use of land for labour colonies ▪ Solid waste from labour colonies and muck disposal ▪ Hazardous waste disposal ▪ Acquisition of land for various project appurtenances
Operation phase	▪ Diversion of forest land for non-forest purpose ▪ Solid waste from project colonies
B. Water resources and water quality	
Construction phase	▪ Increase in turbidity of nearby receiving water bodies ▪ Degradation of water quality due to disposal of wastes from labour colony and construction sites
Operation phase	▪ Disruption of hydraulic regime ▪ Sedimentation and siltation risks ▪ Impacts on downstream water users due to decreased flow ▪ Deterioration of water quality in river due to diversion of flow resulting in decrease in the assimilative capacity of the river.
C. Aquatic Ecology	
Construction phase	▪ Increased pressure on aquatic ecology as a result of indiscriminate fishing. ▪ Reduced productivity due to increase in turbidity
Operation phase	▪ Impacts on migratory fish species ▪ Impacts on spawning and breeding grounds due to diversion of water for hydropower generation. ▪ Degradation of riverine ecology
D. Terrestrial Ecology	
Construction phase	▪ Loss of forest

Aspect of Environment	Likely Impacts
	▪ Impacts on rare/ endangered species, if any ▪ Impacts on medicinally and economically important plant species, if any ▪ Increased pressure on nearby forests due to labour force to meet their fuel wood and timber requirements ▪ Adverse impacts due to migration of labour population
Operation phase	▪ Impacts on nature reserves due to various project appurtenances ▪ Impacts on wildlife habitats ▪ Impacts on wildlife movement
E. Socio-Economic	
Construction phase	▪ Acquisition of land and private properties ▪ Social disruption in standard of living of Project Affected Families. ▪ Impacts on archaeological and cultural monuments ▪ Impacts on mineral reserves ▪ Improved employment potential during project construction phase ▪ Development of allied sectors leading to greater employment ▪ Pressure on existing infrastructure facilities
Operation phase	▪ Impetus on industrialization and urbanization due to increased power generation ▪ Uncontrolled migration of people into the areas due to increased employment potential as a result of project implementation.
F. Air Pollution	
Construction Phase	▪ Impacts due to emissions generated by crushers and other equipment. ▪ Impacts due to increased vehicular movement ▪ Fugitive emissions from various sources.
G. Noise Pollution	
Construction Phase	▪ Noise due to operation of various equipment ▪ Noise due to increased vehicular movement ▪ Increased noise and vibrations due to blasting.
H. Public Health	
Construction Phase	▪ Increased incidence of water-related diseases ▪ Transmission of diseases by immigrant labour population including water borne and other communicable diseases.
Operation phase	▪ Increased incidence of vector-borne diseases

1.5.4 STUDY AREA

Study area has been taken as 10 Kms radius of Nafra HEP site as per MoEF guideline and approved ToR by the EAC, MoEF. The environmental and ecological parameters as defined in ToR were studied in the 10 Kms radius of Nafra HEP. The study area is shown on Topographic sheet No. 83A/11 (**Figure 1.4**).

Figure 1:4 Study Area

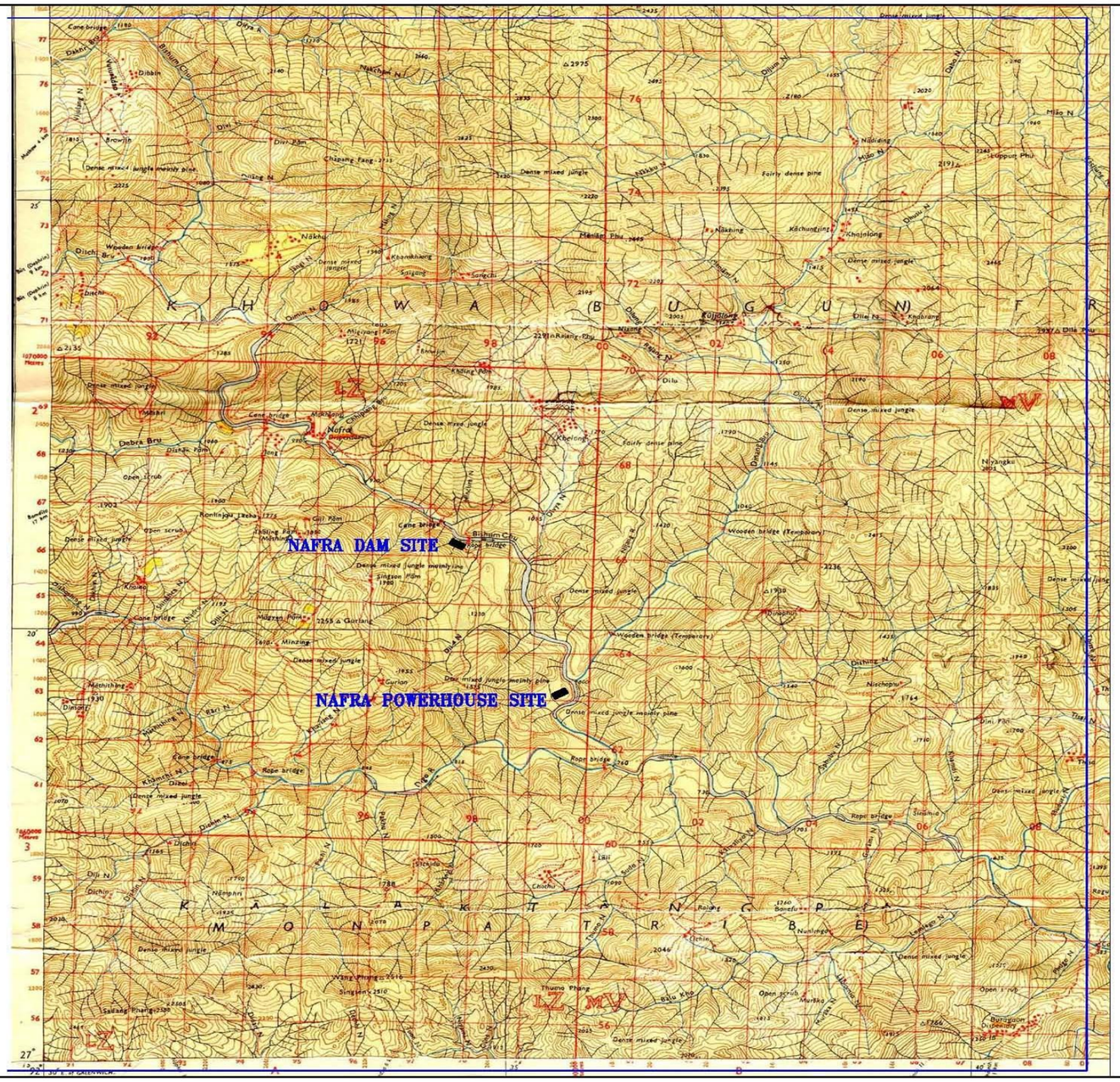


FIGURE NO. 1.4 : STUDY AREA

TOPOGRAPHIC SHEET NO. 83 A/11

1.6 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

1.6.1 Environmental Clearance

The principal Environmental Regulatory Agency in India is the Ministry of Environment and Forests (MoEF). MoEF formulates environmental policies and accords environmental clearance for the projects. The State Pollution Control Board (SPCB) accords Public hearing, Consent for Establishment and Operation for the project activity and the State Forest Department accords Forest Clearance.

The project would need the following environmental clearances:

- Site clearance from various departments at state level;
- Prior Environmental Clearance from the MoEF, GoI;
- Forest Clearance from the Arunachal Pradesh State Forest Department;
- Proceedings of public hearing as per EIA notification 2006 (and addendum thereafter) and Consent from the Arunachal Pradesh State Pollution Control Board;
- Clearance from the Department of Environment & Forests (DoEF), Govt. of Arunachal Pradesh or Arunachal Pradesh State Pollution Control Board under the Air Act, the Water Act and the Cess Act, (if required) as stipulated by the DoEF;
- Environmental Clearance from the MoEF, GoI before start of any construction activity.

1.6.2 Environmental Clearance from MoEF, GoI

As per MoEF EIA Notification, dated 14th September 2006 (and amendments thereafter), under Activity 1(c) - River Valley projects; if, the capacity of power generation for any HEP will more than 50 MW, the project falls under Category A. Comprehensive EIA study needs to be undertaken and environmental clearance to be obtained from MoEF before start of any construction activity. The process of environmental assessment and clearance procedures is shown in Annexure I.

The Nafra HE project falls under category "A" listed for Environment Clearance by MoEF as the proposed hydroelectric power generation capacity is 96 MW (2 x 48 MW), which is more than the threshold limit of MoEF EIA notification for category 'A' project..

Therefore, Form 1 including Terms of Reference (TOR) for the EIA study along with Preliminary Feasibility Report (PFR) in prescribed format was submitted to MoEF to get it approved by Environmental Appraisal Committee under the category of River Valley Projects of MoEF, GoI. ***Environmental Clearance for pre-construction activities*** along with approved TOR was issued by the said committee vide their letter no. J-12011/42/2008-IA.I dated 24.10.2008. (Copy of the same is enclosed as ***Annexure II***.)

The final EIA report, prepared as per the approved TOR, is hereby submitted to the concerned regulatory authority i.e. MoEF for appraisal and subsequent grant of Final Environment Clearance.

1.6.3 Forest Clearances from State Forest Department

The proposed project will require Unclassified State Forest (USF) for the purpose of construction of various project components. Hence, it requires the clearance form State Forest Department. In December 1996, a Supreme Court Judgment provided further guidelines for the process of

protecting forest. Depending on the size of the forest tract to be cleared, the levels of the Government that would give clearance is defined.

- If the forest land exceeds 20 hectare then prior permission of Central Government is required;
- If the forest land is between 5 to 20 hectare, then permission from the Regional Office of Chief Conservator is required;
- If the forest land is below or equal to 5 hectare the State Government can give permission;
- If the construction area is more than 40% forest, permission to undertake any work is needed from the Central Government, irrespective of the size of the area.

As per Rule 6 of the Forest (Conservation) Rules, 2003, every user agency, who wants to use any forest land for non-forest purposes, shall make his proposal in Forms appended to it. **Form 'A'** has to be submitted for proposals seeking first time approval under the Act. Form 'B' is required for proposals seeking renewal of leases where approval of the Central Government under the Act had already been obtained earlier.

1.6.4 Consent and clearance from State Pollution Control Board (SPCB)

For Nafra Hydro Electric Project, consent to establish and operate is required from Arunachal Pradesh State Pollution Control Board (SPCB). SPCB will provide clearance under Water (Prevention and Control of Pollution) Act of 1974, and Air (Prevention and Control of Pollution) Act of 1981.

The concerns of local affected persons and others who have plausible stake in the environmental impacts of the project or activity will be ascertained by SPCB through conducting a Public Hearing. Their views will be taken into account all the material concerns in the project design and implementation activities as appropriate. The Public hearing shall have two components as follows :

(a) A public hearing at the site or in its close proximity- district wise, to be carried out in the manner prescribed in **Appendix IV** of public hearing procedures (attached as ***Annexure III***), for ascertaining concerns of local affected persons;

(b) Obtain responses in writing from other concerned persons having a plausible stake in the environmental aspects of the project or activity.

1.6.5 Other Environment Laws and Regulations

The key environmental laws and regulations and their applicability to the project have been explained below:

The Environment (Protection) Act, 1986: This Act was introduced as an umbrella legislation that provides a holistic framework for the protection and improvement to the environment. In terms of responsibilities, the Act and the associated Rules requires for obtaining environmental clearances for specific types of new / expansion projects (addressed under Environmental Impact Assessment Notification, 1994) and for submission of an environmental statement to the State Pollution Control Board annually.

Wild Life Protection Act, 1972: According to this Act, "wildlife" includes any animal, bees, butterflies, crustaceans, fish and moths; and aquatic or land vegetation which forms part of any

habitat. In accordance with Wildlife (Protection) Amendment Act, 2002 "no alternation of boundaries /National Park/Sanctuary shall be made by the State Govt. except on recommendation of the National Board for Wildlife (NBWL)". The study area does not involve any notified National Park or Wild life Sanctuary or biosphere reserve located within 10 Km radius; hence this Act is not applicable.

Water (Prevention and Control of Pollution) Act, 1974: This Act makes provision for the establishment of the Central and State level Pollution Control Boards, whose responsibly includes managing of water quality and effluent standards, as well as monitoring water quality, prosecuting offenders and issuing licenses for construction and operation of any facility. This project will include generation of liquid effluent during construction of the dam and other civil engineering activities. This Act will be applicable during construction of project for establishment and operation of crushing plant, batching plant and DG set.

Air (Prevention and Control of Pollution) Act, 1981: This Act empowers Central and State Pollution Control Boards for managing air quality and emission standards, as well as monitoring air quality, prosecuting offenders and issuing licenses for construction and operation of any facility. National ambient air quality standard for different regions e.g. industrial, residential and sensitive is notified under this Act. Air quality during construction and operation phases, particularly for obtaining consent for establishment & operation of crushing plant, batching plant etc will be done under this Act.

India Explosive Act 1984: Use and storage of explosive for quarry blasting work

Manufacture storage and Import of Hazardous Chemical Rules 1989: Storage of fuel oil, lubricants, diesel etc. at construction camp.

State Minor Mineral Concession Rules, The Mines Act of 1952: Quarry operation

Contract Labour (Regulation & Abolition) Act, 1970: Engagement of labour and basic facility to be provided and labour licence to be obtained.

Child Labour (Prohibition and Regulation) Act, 2000: Whereas it is expedient to prohibit engagement of child in factory, mining and similar other risky work and to make necessary provision for health. Child's safety and services and facilities while engaging them in other work.

Ancient Monuments and Archaeological sites and Remains Act, 1958: Conservation of cultural and historical remains found in India

The Indian Fisheries Act, 1897: The Indian Fisheries Act, 1897 contains seven sections. Section 5 of the Act prohibits destruction of fish by poisoning waters.

1.7 OUTLINE OF THE REPORT

The content of the study are organized as follows:

Chapter 1 : Introduction & Overview

This Chapter gives an overview covering purpose of the project, its importance, project background, project proponent and scope of the Consultant, the policy, legal and administrative framework for environmental clearance.

Chapter 2 : Project Overview

This chapter describes the project including location, salient features, and project components.

Chapter 3 : Description of Baseline 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 categoris of determining the baseline environmental conditions are physico-chemical, biological and socio-economic parameters. A range of parameters in each of these categories are discussed in this chapter.

Chapter 4 : Anticipated Environmental Impacts and Mitigation Measures

This Chapter describes anticipated adverse impacts on Valued Environmental Components (VECs) as a result of the construction and operation of the proposed hydro-power project. The impacts are broadly categorised as impact due to project location, impact due to project construction, impact due to project operation. After reviewing the baseline environmental condition and anticipated impacts on VECs, a set of mitigation measures are proposed in this chapter.

Chapter 5 : Environment Management and Monitoring Plan

Based on the impact assessments made and mitigation measure, a more specific environment management plan is developed and discussed in this chapter. Environmental Management Plan (EMP) includes mitigation measures to avoid or minimise the impacts identified in Chapter 4 and also enhancement measures to improve the surrounding environmental condition. As part of the EMP a detailed monitoring plan for various environmental category has been discussed. Budget for implementing the EM&MP has also been estimated and provided at the end of this chapter.

Chapter 6 : Additional Studies

Additional Studies discussed in this chapter include Stakeholder Consultations, Risk Assessment (covering Dam Break Analysis and Disaster Management Plan) and Social Impact Assessment.

Chapter 7 : Summary Project Benefits and Conclusion

The chapter provides an overview of benefits in terms of improvement of physical infrastructure, social infrastructure and employment generation in the reigon due to the proposed project.

Chapter 8 : Disclosure of Consultants Engaged

The summary of team of consultants engaged in this EIA & EMP study is provided in this chapter along with their brief resume.

Chapter 2

PROJECT OVERVIEW

2 PROJECT OVERVIEW

2.1 GENERAL

The proposed Nafra Hydro Electric Project is a run-off-the-river scheme on the Bichom river of Kameng Basin in Arunachal Pradesh. The project construction includes a 40m high Composite Dam' located at Latitude 27^0 21' 15.71" N; Longitude 92^0 33' 56.66" E where the river bed level is at an elevation of 944m above mean sea level. The waters 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 27^0 19' 24.91" N; Longitude 92^0 35' 25.25" E where the natural ground elevation is 810m above mean sea level. Installed capacity planned for the power house is 96 MW (2 units of 48 MW each vertical Francis type Turbine designed for a net head of 173.31m).

2.2 PROJECT LOCATION and ACCESSIBILITY

The project site is located at Nafra village of West Kameng District in the state of Arunachal Pradesh. The site is accessible by road from Guwahati via Tezpur, Bhalukpong and Bomdila. Its distances from major places are as follows:

From	To	Distance (Km)
Guwahati	Tezpur	180
Tezpur	Bhalukpong	60
Bhalukpong	Bomdila	101
Bomdila	Nafra	58
Nafra	Dam Site	8
Nafra	Power House Site	14

Tezpur is the nearest rail head and the nearest air port is located about 215 km from the project site. The project location maps are provided in **Figures 2.1** and **2.2.**

2.3 SALIENT FEATURES OF THE PROJECT

LOCATION	
State	Arunachal Pradesh
District	West Kameng
River	Bichom
River basin	Kameng
Nearest Railway Station	Bhalukpung
Nearest Airport	Tezpur
HYDROLOGY	
Catchment area upto Dam Site	776 km^2
Average annual rainfall	3188 mm
Probable max. flood	5988 m^3 / sec
90% available discharge	38.43 m^3 / sec
Annual Inflow	1219.29 MCM
DAM	
Type	Composite
Max. height above river bed level	40 m

River bed level (masl)	944.0 m
Elevation of top of Dam (masl)	984.0 m
Length of Dam at top	241 m
Freeboard	3.0 m to FRL
Width at top	10.0 m
SPILLWAY	
Type	Sluice Spillway
No. and size of gates (Radial)	4 Nos x 10m wide x 12m high
Discharge capacity	5978 m^3 / sec
No. of bays	4 Nos.
Length of spillway	58.0 m
Bay width	10.0 m
Crest elevation (masl)	952.0 m
RESERVOIR and SUBMERGENCE	
Full Reservoir Level FRL (masl)	981.0 m
Maximum Water Level (masl)	982.0 m
Minimum Draw Down Level (masl)	972.0 m
Gross capacity	5.267 MCM
Live capacity	2.413 MCM
Dead storage capacity	2.854 MCM
Submergence area at FRL	32.67 ha
No. of villages affected	NIL
HEAD RACE TUNNEL	
Length	3.68 km
Diameter	5.0 m
Shape	Modified Horse Shoe
Design discharge	61.38 m^3 / sec
Design velocity	3.02 m^3 / sec
Invert level of intake (masl)	961.50 m
SURGE SHAFT	
Type	Restricted orifice type Surge Shaft
Surge Shaft Diameter	10.50 m
Orifice Diameter	2.35 m
Height	57.00 m
Top elevation (masl)	1002.0 m
Bottom elevation (masl)	945.0 m
Gates for Penstock	2 Nos
PENSTOCK	
Type	Subsurface penstock
Number of Pressure shaft / penstock	2 nos
Maximum discharge through Pressure shaft / penstock	30.69 m^3 / sec
Diameter of each Pressure shaft / penstock	3.0 m
Maximum velocity	4.34 m / sec
Length of Subsurface Pressure shaft	100.0 m
Length of penstock	486.00 m
POWER HOUSE	
Type	Surface
Location	1.5 km upstream of Digo river confluence with Bichom

Number of units	2 nos
Rated unit capacity	48 MW
Installed Capacity	96 MW
Maximum Gross head	184.40 m
Design net head	173.31 m
Type of turbine	Vertical Francis
Maximum flow through each unit	30.69 m^3 / sec
Normal Tail Water Level	796.57 m (two units running at full load)
Minimum Tail Water Level	794.84 m (one unit running at full load)
Speed specific and synchronous	375 rpm
Type of Switchyard	Outdoor (53 x 42 m)
POWER BENEFITS	
Peaking Capacity	96 MW
Annual Energy (GWh/Yr) for 50% dependable year	491.60 MU
Load factor for operation (annual / lean period) for 50% dependable year	58.46 %, 30.72 %
Annual Energy (GWh/Yr) for 90% dependable year	423.95 MU
Load factor for operation (annual / lean period) for 90% dependable year	50.41 %, 22.76 %
ESTIMATED COST	
Civil Works (Including gates and hoists)	Rs. 379.44 Crore
E and M Works (Including costs of transmission line to pooling station)	Rs. 149.30 Crore
Total Basic Cost	Rs. 528.74 Crore
Total cost including monitoring as per MOA	Rs. 529.27 Crore
Escalation during Construction	Rs. 73.75 Crore
Interest during Construction	Rs. 80.90 Crore
Working capital margin	Rs. 6.78 Crore
Total (Generation Works)	Rs. 690.70 Crore
Cost per MW installed	Rs. 7.19 Crore
FINANCIAL ASPECTS	
Levelized Tariff for Design Energy at 90% Dependable Year	Rs. 3.53 / KWh
PIRR (Project Internal Rate of Return for 3-5 Years)	10.46 %
CONSTRUCTION PERIOD	36 months

Source: *Detailed Project Report (DPR)-Nafra Hydro Electricity Project*

Figure 2:1 Project Location within State and District

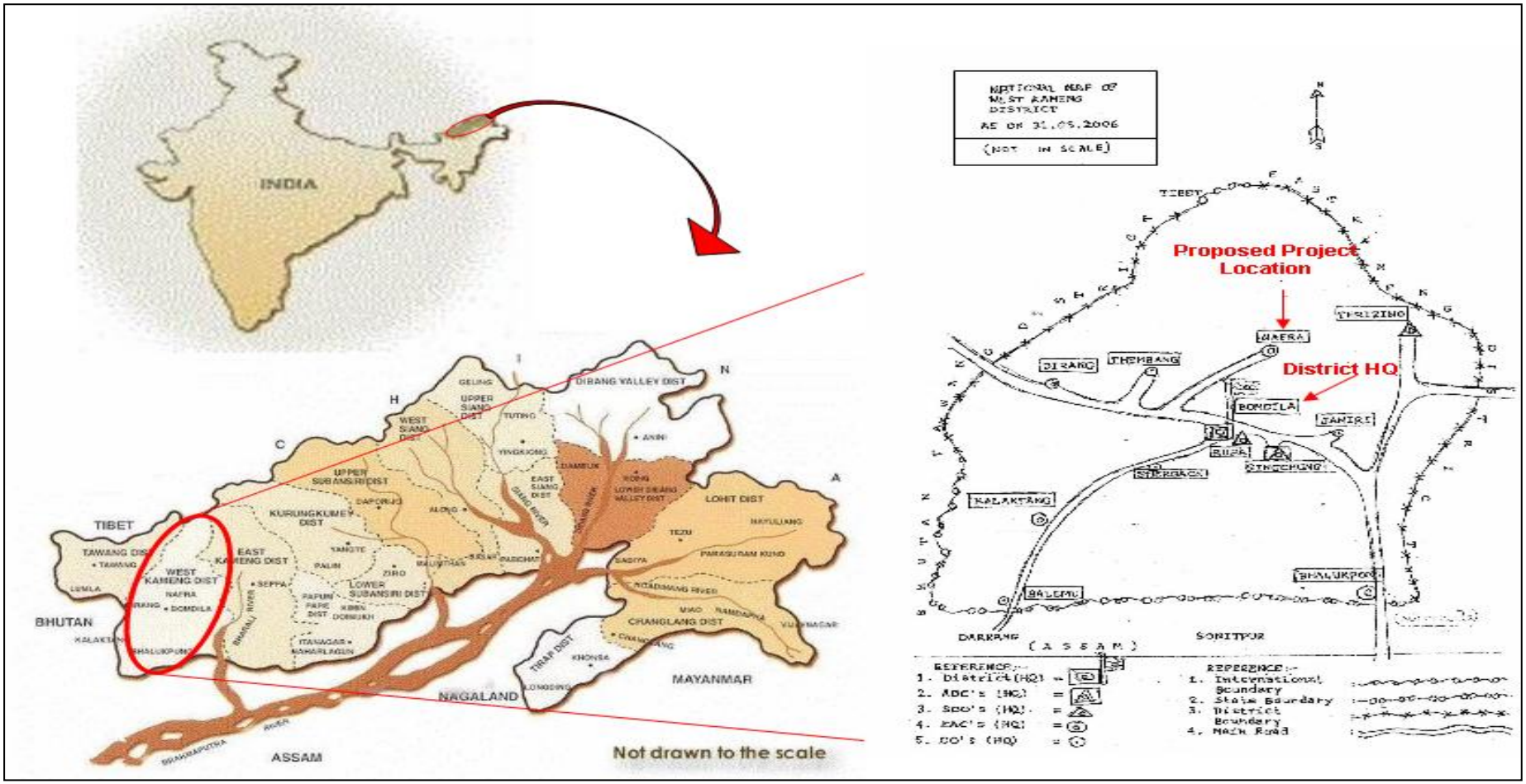


Figure 2:2 Satellite Image of Project Location

2.4 PROJECT COMPONENTS

The main components of the project are briefly described in the following paragraphs and are shown in project layout plan in **Figure 2.3**. and **2.4.**

Spillway

The construction of Spillway will be taken up after excavation and stabilization of side rock slopes above the Spillway which involves diversion of existing road. For slope stabilization measures, rock bolts and wire mesh reinforced shotcrete will be provided. The work of the Spillway is proposed to be taken up and completed in 26 months after completion of excavation. The excavation will be carried out using conventional drilling and blasting techniques. Muck handling will be carried out by combination of loaders, dumpers and dozers. Dry or wet shotcrete machines may be deployed for this.

An Aggregate Processing Plant (APP) of 50TPH capacity and a batch and mixing plant of 30 m^3/hr capacities will be provided for concreting operations. Spillway concreting will be carried out by using pumpcretes, transit mixers etc. Wherever necessitated, grouting will also be planned.

Diversion of River

After completion of Spillway, the river will be diverted through the channel provided in spillway by constructing a small rock dyke across the river in low flow season. Thereafter construction of coffer dams will be taken up. Excavation of the abutments will be completed simultaneously during excavation of the Spillway/ Intake area.

Composite Dam

The Nafra Dam location has been selected to take optimum advantage of the topographical and geological conditions of the site. Average river bed level at the dam site is EL. 944.0. The dam with its deepest assumed excavated level at EL 944.0m is 40 m high with its top at EL 984.0. It is about 40 m above the river bed level. The Rock fill dam comprises central clay core with shouldering of 200mm thick sand and gravel filters and thereafter the compacted rockfill. The u/s is protected by 1000mm thick rip rap material to safeguard against wave action/level variation. The dam with its u/s and d/s slopes of 2.5.1 and 2.1 has a top width of 10m and has been provided with 3m free board. The clay core trenches into the existing foundation clay. The top soil removal and clay stock piling work shall start immediately after mobilization and completed in a period of 10-11 months.

Intake Structure

The intake structure is located on right bank of the river. After establishing access to the intake structure, open excavation works will be taken up. Excavation of rock in 1:10 slope starting from top will be carried out in benches. Installation of rock bolts, shotcrete and provision of drainage holes will be carried out on the excavated slope before taking up the next benching to safeguard against disturbance in the cut slope. Excavation of Intake will take 4 months time. Concreting of the Intake structure will involve placing of substantial quantity of reinforcement and provision of grooves for trash rack, gate and hoist. The concreting will be done by deploying 30 m^3/hr capacity concrete pump and transportation of concrete will be through 4m^3 capacity transit mixers. The concreting will take 7 months and a period of 5 months after concreting will be required for installation of gate, hoist and trash rack.

Head Race Tunnel

The total length of the Nafra Hydro-Electric Project head race tunnel (HRT) is 3680m. The tunnel will be of modified horse shoe shape profile of 5.0 m finished diameter and excavated diameter of about 5.95m. The cycle time for tunnel excavation has been worked out based on drill and blast methodology, considering deployment of tyred equipment for mucking operations. Excavation of HRT will be over in 25 months. Concrete lining of the headrace tunnel will be taken up in the excavated section by using telescopic collapsible shutters, with pumpcrete. Grouting will be taken up in parallel with a gap of 3 months from the start of concreting and will be over after 2 months from completion of concreting.

Surge Shaft

The restricted orifice type surge shaft will be of 10.5m diameter and 60.0m in height with the orifice dia. of 2.35m. The surge shaft will also be open at the top.For carrying out construction of surge shaft, access road has been provided at the top of the shaft at EL 1005.0m. Further an adit of 100 m length has been provided at the bottom of the shaft at EL 940.0m. Excavation of surge shaft will involve drilling of 250mm dia pilot hole from top, reaming of the pilot hole to 1.8m dia from bottom to top using Raise borer and enlargement of the reamed hole from top to bottom in benches using jack hammers. The work of surge shaft construction will be completed in 14 month.

Pressure Shaft:

From the surge shaft bottom steel pressure tunnel of 3.0m dia. of about 100 m length up to valve chamber of size 16m x 8m has been provided. From valve chamber 2 surface penstocks of 3.0m dia take off and terminate into power house units. The steel liner and concreting in segments shall be done from surge shaft side proceeding towards valve chamber. Grouting will be carried out after full shrinkage of concrete, through the holes provided in liner, which after grouting, shall be plugged, welded and ground smooth.

Power House

The deep seated power house proposed on the right bank of Bichom River is located on a flat terrain on terrace deposit. Elevation of the river bed at this location is around EL 800m and power house terrace is at EL 810m. The powerhouse will be in a deep pit and sufficiently away from the river. Hence seepage is not expected to be major problem; however provision for drainage pumping should be kept. A protection bund of suitable height around the complex has been planned to safeguard against floods up to PMF. The deepest foundation level is at EL 781.70m. The excavation work will be completed in 6 months and concreting in 14 months excluding monsoon period.

Electro-Mechanical Works

23 months period is envisaged for erection of E&M works and 1 month for commissioning and synchronization.

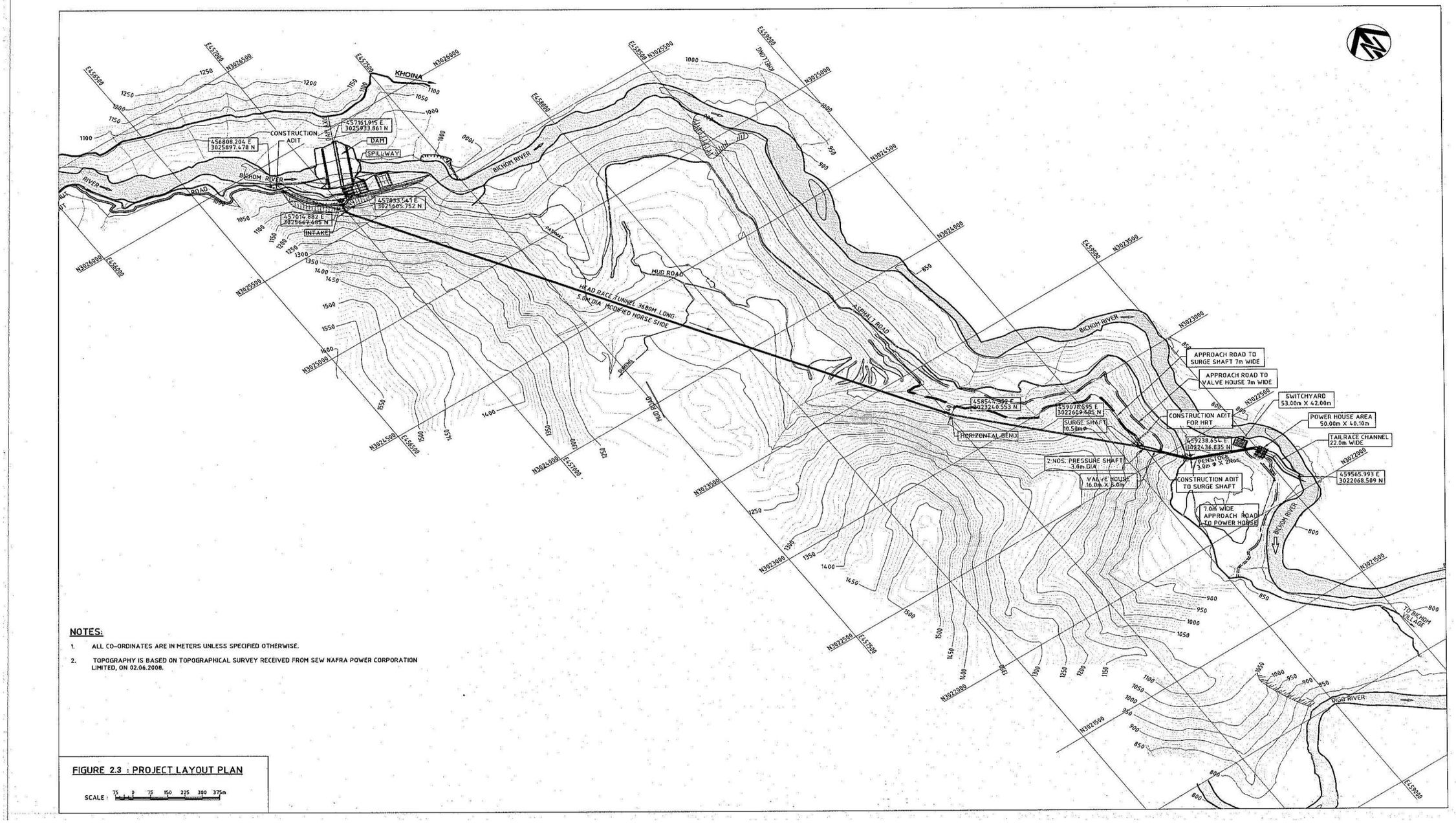
Tailrace Arrangement

The tail race channel of 165.0 m length has been provided from the Power house up to the Bichom River. The excavation work for the tail race channel will be taken up after the excavation work for Power house is completed. Excavation of tail race channel will be completed in 10 months time and 9 months time is required for stone pitching of the tail race channel.

Switch Yard

An outdoor 220KV switchyard (53m x 42m) has been planned on the platform near the power house at an elevation of 813m. Civil works will be completed in 8 months and equipment installation by another 3 months.

Figure 2:3: Project Layout Plan



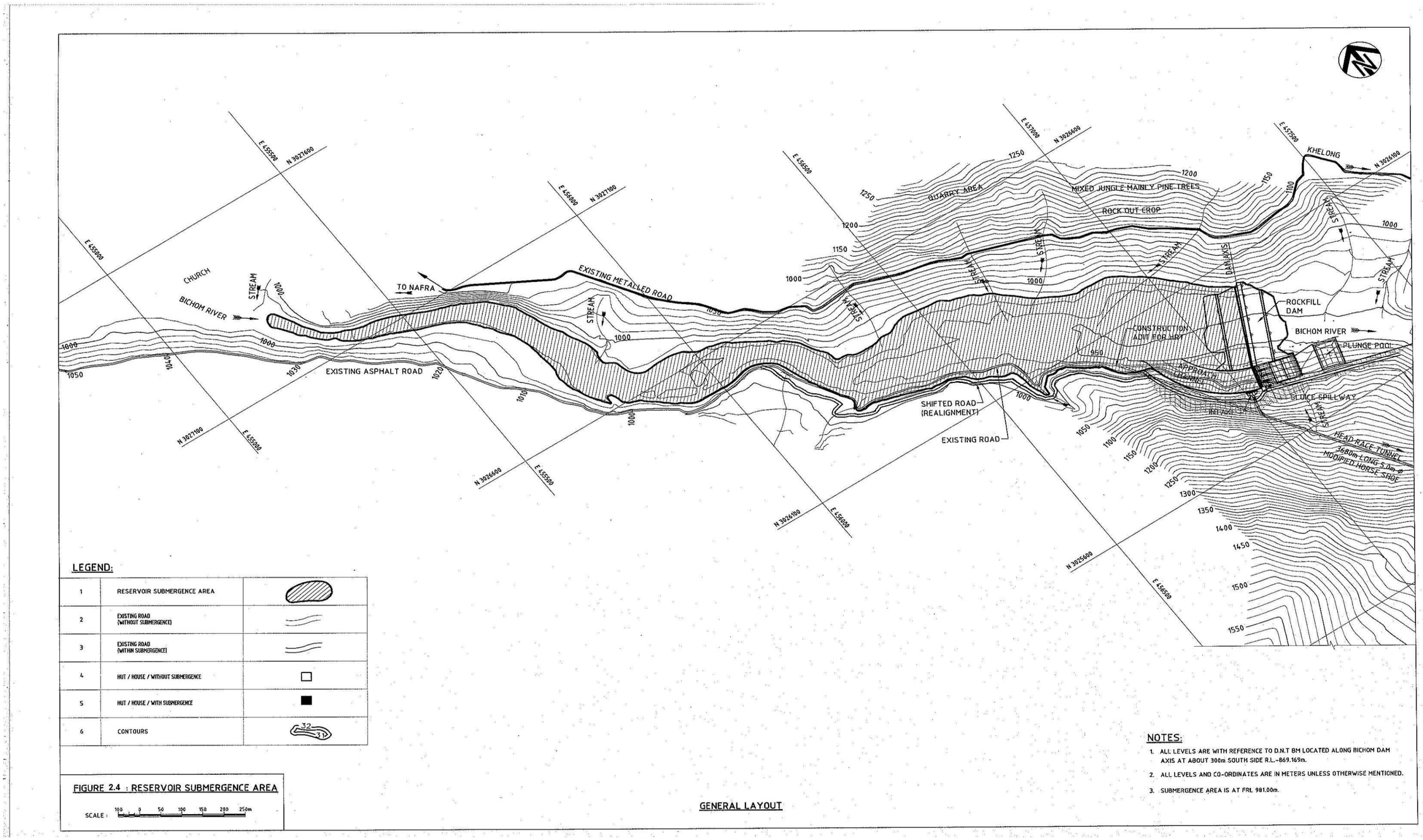
NOTES:

1. ALL CO-ORDINATES ARE IN METERS UNLESS SPECIFIED OTHERWISE.
2. TOPOGRAPHY IS BASED ON TOPOGRAPHICAL SURVEY RECEIVED FROM SEW NAFRA POWER CORPORATION LIMITED, ON 02.06.2008.

FIGURE 2.3 : PROJECT LAYOUT PLAN

SCALE : 75 0 75 150 225 300 375m

Figure 2:4 Layout Plan of Submergence Area



LEGEND:

1	RESERVOIR SUBMERGENCE AREA	
2	EXISTING ROAD (WITHOUT SUBMERGENCE)	
3	EXISTING ROAD (WITHIN SUBMERGENCE)	
4	HUT / HOUSE / WITHOUT SUBMERGENCE	
5	HUT / HOUSE / WITH SUBMERGENCE	
6	CONTOURS	

FIGURE 2.4 : RESERVOIR SUBMERGENCE AREA

SCALE : 100 0 50 100 150 200 250m

GENERAL LAYOUT

NOTES:

1. ALL LEVELS ARE WITH REFERENCE TO D.N.T BM LOCATED ALONG BICHOM DAM AXIS AT ABOUT 300m SOUTH SIDE R.L.-869.169m.
2. ALL LEVELS AND CO-ORDINATES ARE IN METERS UNLESS OTHERWISE MENTIONED.
3. SUBMERGENCE AREA IS AT FRL 981.00m.

Chapter 3

DESCRIPTION OF BASELINE ENVIRONMENT

3 DESCRIPTION OF BASELINE ENVIRONMENT

This chapter provides pre-project environmental baseline conditions including physical, biological and socio-economic parameters. The baseline data of appropriate environmental parameters is essential to measure the impact due to implementation of the project.

3.1 METHODOLOGY OF BASELINE DATA COLLECTION

The baseline information presented in this chapter has been collected through field studies, interaction with various government departments, interaction with local communities and collation of available literature with various institutions and organizations. The study was conducted by a team of experts belonging to an array of related disciplines. The on-site baseline environmental quality data collection and analysis has been done by M/s. Mitra S. K. Private Limited established in 1938. Their laboratory is accredited by NABL for ISO 17025 and West Bengal Pollution Control Board, Orissa Pollution Control Board. Their professional qualification and experience are provided in Annexure-XVII of this report.

Methodology for collection of baseline data for each category of environmental parameter is described in the sections below:

3.1.1 Land Environment

Following Information was collected to assess the baseline land environment of the study area:

- Digital Satellite data IRS 1D LISS-III from NRSA was used to study physiography, land use/ land cover, lithology, drainage pattern, slope characteristics, landslides/slips.
- SOI 1:50,000 scale toposheets (83 A/11) is used for the study.
- Field survey was carried out for study of soil characteristics of erosion prone areas and landslides in the catchment area.
- Soil quality has been monitored at three locations for three seasons (Monsoon, Post-monsoon and Winter).

3.1.2 Ambient Air Quality

In order to build data base on the existing air quality of the study area, ambient air monitoring at three locations at nearby villages viz. Nafra, Khellong and Lower Jung was undertaken. Instruments such as Respirable Dust Samplers APM-460 and APM-411 (Envirotech make) was used for monitoring Suspended Particulate Matter (SPM), Respirable fraction (<10 microns) and gaseous pollution like SO_2 and NOx. Following parameters were measured to prepare the baseline condition:

i) Suspended Particulate Matter (SPM)

ii) Respirable Suspended Particulate Matter (RSPM)

iii) Sulphur dioxide (SO_2)

iv) Nitrogen oxide (NO_x)

v) Carbon monoxide (CO)

3.1.3 Ambient Noise Level

Ambient noise level was measured using sound level meter SL- 4010 (Digital-Instrument LUTRON Make) at the same three locations selected for ambient air quality monitoring. Leq (Day), Leq (Night) and Mean noise level in dB (A) was measured to assess the baseline condition.

3.1.4 Water Environment

The baseline data for water quality has been generated based on following parameters:

- General survey of the river basin including proposed dam site.
- Physical, chemical and biological characteristics of surface water (River Bichom) quality have been monitored for three seasons (Monsoon, Post-monsoon and Winter)
- Seasonal (Monsoon, Post-monsoon and Winter) monitoring of drinking water (collected from tap) at Nafra Village.
- Importance of water quality on existing aquatic fauna in Mountain Rivers.

3.1.5 Terrestrial Ecology

Floral Study : The study involved an extensive field survey of the project area. The forest types, vegetation profile, number of tree species in the project area, community structure was studied during field study. During multiple visits to the site and with the help of local community economically important plants, including medicinal, timber and fuel wood were identified. A thorough search for endemic, endangered and threatened species was carried out by subject experts. Local forest offices were consulted to check the location of any Biosphere Reserve, National Park or Sanctuary in the vicinity of the project.

Faunal Study : Transects were undertaken along nearby villages to carry out faunal studies since the village trails are the best options to cover the entire area. The study included inventorisation of terrestrial wildlife along with schedule of species, zoogeographic distribution, endemic, threatened and endangered species.

- The field survey for the ecological studies was conducted for all the three seasons during the year 2008-09.
- Survey was carried out on both banks of the river Bichom, including the areas of inundation due to dam construction.
- Importance Value Index (IVI) of the tree species in the project area was also prepared.

3.1.6 Aquatic Ecology

Baseline study of the aquatic environment has been done based on the following methodology:

- The sample collection sites were randomly selected (a) between proposed Dam site and Power House Site, (b) downstream of proposed power house site.
- For enumeration of planktonic population, 100 litre composite water samples were collected from the river surface using the plankton net.
- The samples were preserved in 5% formalin solution and brought to laboratory for the identification of the plankton.

- Macro-biota was collected from the stones and boulders and kept in 5% formalin for identification.
- The identification has been done based on survey and spot collection in consultation with Department of Fishery, Arunachal Pradesh, Rajiv Gandhi University, Arunachal Pradesh; Department of Zoology, Guwahati University, Assam.

Evaluation of the parameters related to aquatic environment has been done based on the following:

- Biological characteristics of water of Bichom River.
- Selection of location for water sampling and collection of aquatic organisms
- Inventorization of benthos (phyto and zoo)
- Present status of riverine fish fauna: identification of obligate fish species, their migratory pattern, feeding and breeding grounds.
- Collection and identification of different resident fish species from River Bichom – their feeding habits, migratory pattern and cold water adaptations
- Presence, distribution and dominance of different fish species in different selected sampling location of the river.
- Identification of feeding and breeding grounds of some economically important fish species in River Bichom.
- Growth pattern of some fish species of commercial value of mountain rivers.
- Distribution and population density of macro-zoo benthos in River Bichom.
- Impact of reduced flow in river water

3.1.7 Land Use and Land Cover

Geo-referenced LISS-III Satellite data was used followed by signature collection. Standard supervised classification techniques were used to generate land use and land cover features of the area.

Data Set / Software Used for the Project

Survey of India (SoI) Topographic Sheet No	:	83A-11 (Scale: 1:50000)
Projection and Datum	:	UTM and WGS 84 North
Satellite Data	:	PAN LISS 3 and Multispectral Bands LISS 3 (Band2, 3, 4)

3.1.8 Socioeconomic Environment

To assess the baseline condition of socio-economic aspects of the study area, following primary and secondary data were collected:

- The data on socio-economic aspects has been collected in two stages. The first stage involved a rapid assessment of the study area in order to obtain an overall picture of the villages located in the project area.
- The second stage of data collection was done in the villages which are going to be directly affected by acquisition of land for project construction. A sampling strategy was adopted based on the observations made during the first phase. Socio-economic survey format was designed for conducting socio-economic survey which included questions on demographic, ethnographic, economic, literacy, development, agricultural, cultural and aesthetic site,

infrastructure facilities: education, health and hygiene, communication network, etc. A door to door survey was conducted later in this phase to collect information.

- Data collection from secondary sources was also made to validate some of the primary information.

The summary of data collected from various sources as a part of the EIA study is outlined in **Table 3.1**.

Table 3:1 Sources of data used for baseline profile

Aspect	Mode of Data collection	Parameters monitored	Frequency	Sources
Meteorology	Secondary	Temperature, Humidity, Rainfall	-	Indian Meteorological Department (IMD)
Hydrology/ Water Resources	Secondary	Flow, Design, hydrograph, and design flood hydrograph	-	Detailed Project Report (DPR)
Geology and seismology	Primary and Secondary	Regional Geology Tectonic and Earthquakes	-	Geological Survey of India, IMD and Detailed Project Report (DPR)
Land use	Primary and secondary	Land use pattern	-	Remote Sensing and GIS Studies
Ambient Air	Primary	SPM, RSPM, SO_2, NOx and CO	Seasonal	On-site monitoring and analysis
Surface Water	Primary	Physico-chemical and biological parameters	Seasonal	On-site monitoring and analysis
Drinking Water	Primary	Physico-chemical and biological parameters	Seasonal	On-site monitoring and analysis
Ambient Noise	Primary	Leq (Day), Leq (Night) and Mean noise level in dB (A)	Seasonal	On-site monitoring and analysis
Soil	Primary	Physico-chemical parameters	Seasonal	On-site monitoring and analysis
Terrestrial Ecology	Primary and secondary	Floral and faunal diversity, density and species composition	Seasonal	On-site data collection, Forest Department, State Forest Research Institute, Itanagar, Zoological Survey of India, Itanagar, Rajiv Gandhi University, Itanagar, Guwahati University, Assam and Literature review
Aquatic Ecology and Fisheries	Primary and secondary	Diversity, density and species composition of planktons and fishes	Seasonal	On-site data collection, Fishery Department, Itanagar, Guwahati University, Assam and Literature review
Socio-economic aspect	Primary and secondary	Demographic profile, Ethnographic profile, Economic structure, Literacy profile, Development profile, Agricultural practices, Cultural and aesthetic sites, Infrastructure facilities: education, health and hygiene, communication network, etc., Impact on socio-cultural and ethnographic aspects due to dam building activity	-	Field Survey, Directorate of Economics and Statistics, Got. of Arunachal Pradesh, Itanagar, District Statistical Office, Bomdila, West Kameng District, Arunachal Govt. Website, Revenue Department and Literature review

3.2 ENVIRONMENTAL BASELINE STATUS

The information on various aspects has been collected to understand the environmental setting of the proposed project site. The basic parameters on which data has been collected are discussed in the foregoing paragraphs.

The baseline status has been categorized into three major heads as follows:

- Physico-chemical Aspects
- Biological Aspects
- Socio-economic Aspects

3.2.1 Physico-chemical Aspects

3.2.1.1 Meteorology

The region has four distinct seasons ranging from severe winter from December to March followed by summer season lasting from April to June. The region receives rainfall (Monsoon) from July to mid-September followed by Post-monsoon season lasting up to November. The meteorological conditions of project area are summarized in **Table 3.2.**

Table 3:2 Meteorological conditions of the project area

Month	Temperature		Relative Humidity	Average Rainfall
	Max	Min		
January	23.6	9.8	79	11.4
February	26.4	11.5	64	12.8
March	30.2	15.5	57	57.7
April	31.5	20.0	65	142.3
May	31.0	22.5	75	248
June	31.4	24.7	82	350
July	31.8	25.5	83	353
August	32.1	25.5	83	270
September	31.7	24.6	83	166
October	30.1	21.8	83	79
November	27.4	16.4	83	19
December	24.6	11.5	84	5

(***Source :*** *Indian Meteorological Department Climatological Tables Index No. 42410 Page 291)*

Temperature: At higher altitude, the temperature in winter months drops below freezing point. The temperature rises gradually after February and between May and August. The temperature begins to drop in the Post-monsoon months. December is the coolest month of the year with a mean minimum temperature dropping up to -1.5^0 C.

Humidity: Relative humidity is above 90% during Monsoon months and in Winter months ranges from 70% to 80%.

Rainfall: The rainfall in the state is very high, amongst the heaviest in the country. A major portion of rainfall received under the influence of South-West Monsoon during the months from June to September. The mean annual average rainfall recorded at Bomdila IMD station is

1259.36mm. The range of mean annual rainfall in four other IMD stations in the district West Kameng varies from 2125.05mm to 4834.04mm.

Snow Cover: Limited information is available on the snow cover in Nafra catchment. Only 4% of the catchment area (approx 31.00 sq km) is permanently covered by snow, which is beyond the study area. The snow line occurs at an elevation of 5000m and snow fall generally occurs during December.

3.2.1.2 Geography and Physiography of Project Area

Arunachal Pradesh is the North-Eastern-most state of India lying between latitudes 26°40' and 29°25'N and longitudes 91°35' and 97°25' E, and occupies an area of 83,580km² of Indian territory. Formerly, it formed the mountainous part of the Assam State known as the North Eastern Frontier Agency (NEFA). Later, it was made a Union Territory with capital at Itanagar, a newly developed township. It attained statehood on February 20, 1987. The Himalayan Kingdom – Bhutan, lies to its West, the Tibetan Plateau and the Yunnan Province of China form its Northern and North-Eastern Limits and South-Eastern boundary is with Myanmar (Burma).

The rivers draining Arunachal Pradesh form part of the mighty Brahmaputra River which originates on the northern slopes of Himalaya in Tibet. The Bhareli or Kameng and the Subansiri rivers are its principal north bank tributaries draining the Himalayan ranges while the Dibang (Sikang) and the Lohit drain the Mishmi Hills and join the Brahmaputra from the East. The Disang, Nao Dihing and Burhi Dihing rivers are the main drainage channels in the Naga Patkoi Ranges of Arunachal Pradesh and meet the Brahmaputra from the South.

The upper part of the Brahmaputra Plain of Assam separates the Northern part of the state forming the Himalayan ranges from the South-Eastern part in the Arakan Ranges, the latter continuing into the Nagaland State. Arunachal Pradesh is divided into four distinct physiographic segments:

1. Himalayan ranges

2. Mishmi Hills

3. Naga-Patkoi Ranges and

4. Brahmaputra Plain

Each segment or subdivision has a different geology and tectonic history. The Himalayan ranges are the Eastern most part of the Great Himalaya which occurs as a "gigantic crescent" (Mathur, 1991)[7] with its convex side towards south. It rises abruptly from the Brahmaputra Plain at a general elevation of 100 m above sea level to the dizzy height of 7089 m merging with the Tibetan Plateau in the North. It abuts against the Myanmar (Burmese) Arakan Ranges forming the Mishmi Hills. The Himalayas is made up of rocks ranging in age from Proterozoic to Quternary, and has attained its present height during different impulses of Himalayan Orogeny, the last being during Middle Pliestocene. The Mishmi hills, being the Northern continuation of the Proterozoic succession of Northern Mayanmar, contain elements of Cretaceous and Neogene plutonism apparently similar to that of Ladakh. The Naga Patkoi ranges, on the other hand, are made up of Paleogene –Neogene sediments unconformably overlying the concealed

[7] Mathur, S.M. (1991). – The Land and People: Physical Geology of India. National Book Trust, New Delhi, 180p

basement of Precambrian rocks considered to be the Eastern extension of the Shillong Plateau. These ranges also came into existence due to tectonic movements related to the last phase of Himalayan orogeny (Middle Pleistocene). The Brahmaputra is characterized by post-Himalayan Orogeny valley-fill, Quaternary sediments resting unconformable over concealed Precambrian rocks of the Shillong Plateau and Mikir Hills or over the Paleogene - Neogene succession of Assam.

Geographical locations of Arunachal Pradesh and Physiographic divisions of Arunachal Pradesh are provided in **Figure 3.1 and 3.2** respectively.

Figure 3:1 Geographical location of Arunachal Pradesh

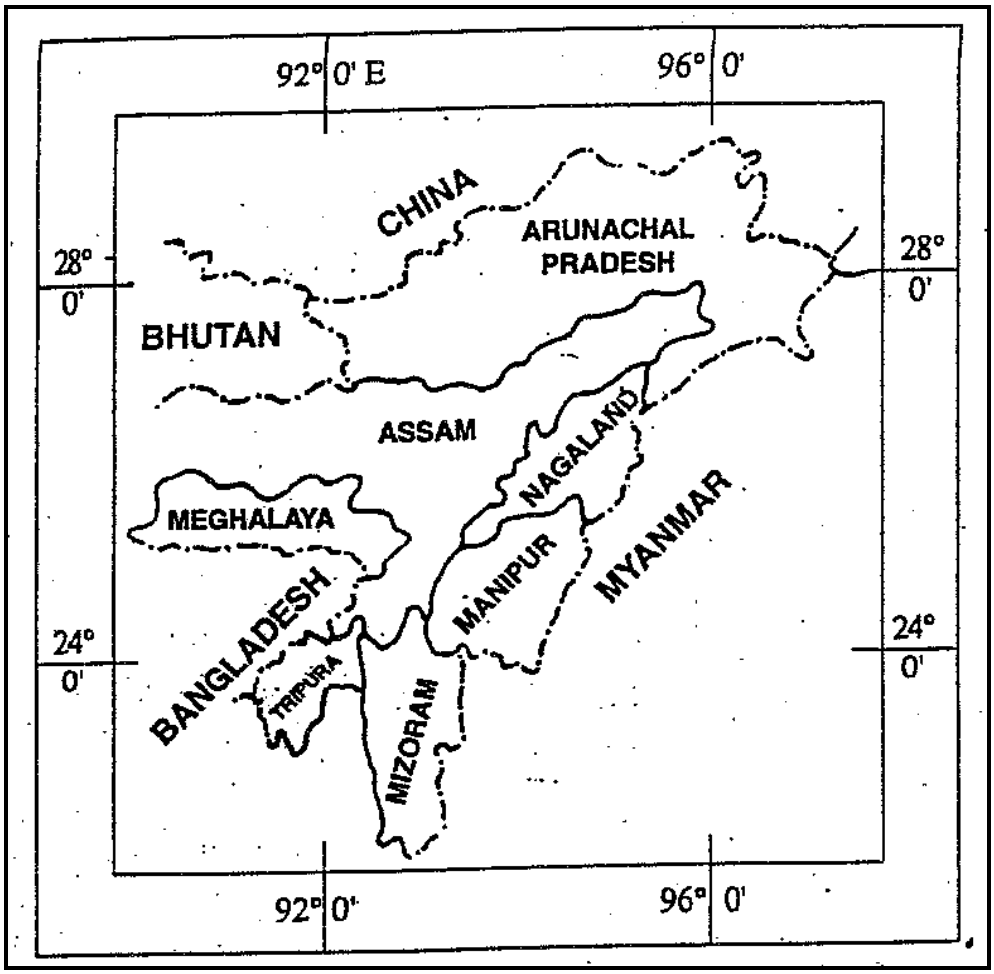
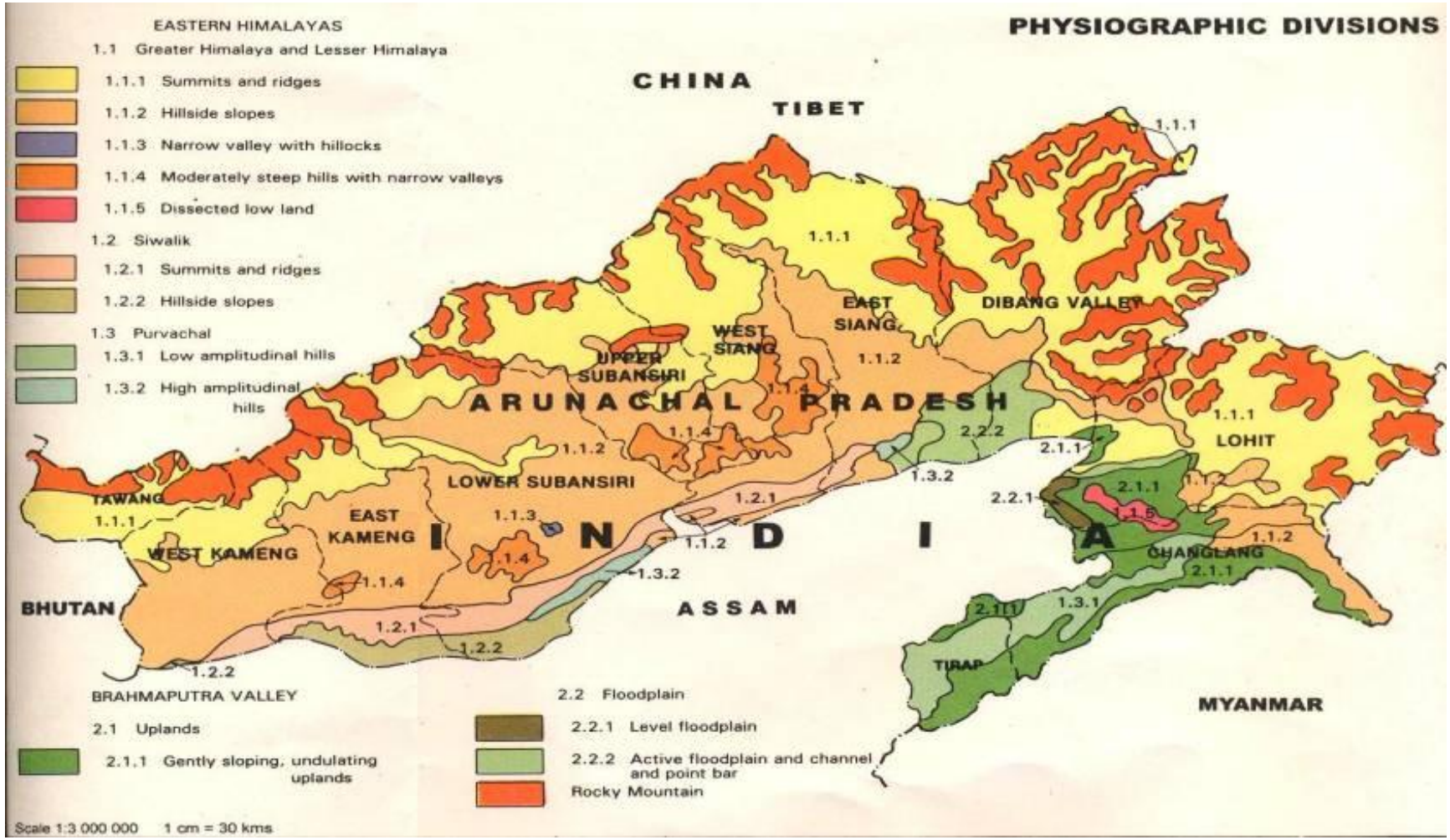


Figure 3:2 Physiographic divisions of Arunachal Pradesh



3.2.1.3 Regional Geology and Structure of Area

The regional geologic framework in this part consists of two distinct groups of rocks – Sela Group and Bomdila Group, Table – separated by a thrust fault, named Main Central Thrust (MCT-II) and a distinct formation, named Dirang Formation, unconformably overlying the Bomdila Group of rocks (Verma and Tandon, 1976).[8]

Tectonic Belt	Group/Formation	Lithology	Probable age
Higher Himalaya	Dirang Formation	Metasediments comprising Conglomerate, Quartzite, Garnet Mica Schist, Marbles, Granite Intrusives	Mesoproterozoic
~~Unconformity~~~~~~~~~~~~~~~~~~~~~~~~~~~~			
Lesser Himalaya	Bomdila Group	Pink to purple ortho quartzite with conglomerate lenses, purple shale with diamictite bands Quartzite-Carbonate, Schist/Phyillite association and Gneisses	Lower to middle Palaeozoic Proterozoic
---------- MCT – II ----------			
Higher Himalaya	Sela Group	High grade gneisses, schist, migmatites, gneisses	Proterozoic

Sela Group

The Sela Group of rocks is well exposed at the Sela pass region towards the North and West of Dibang. It consists of metapelitic and hornblende gneisses intruded by medium to coarse-grained granite.

Bomdilla Group

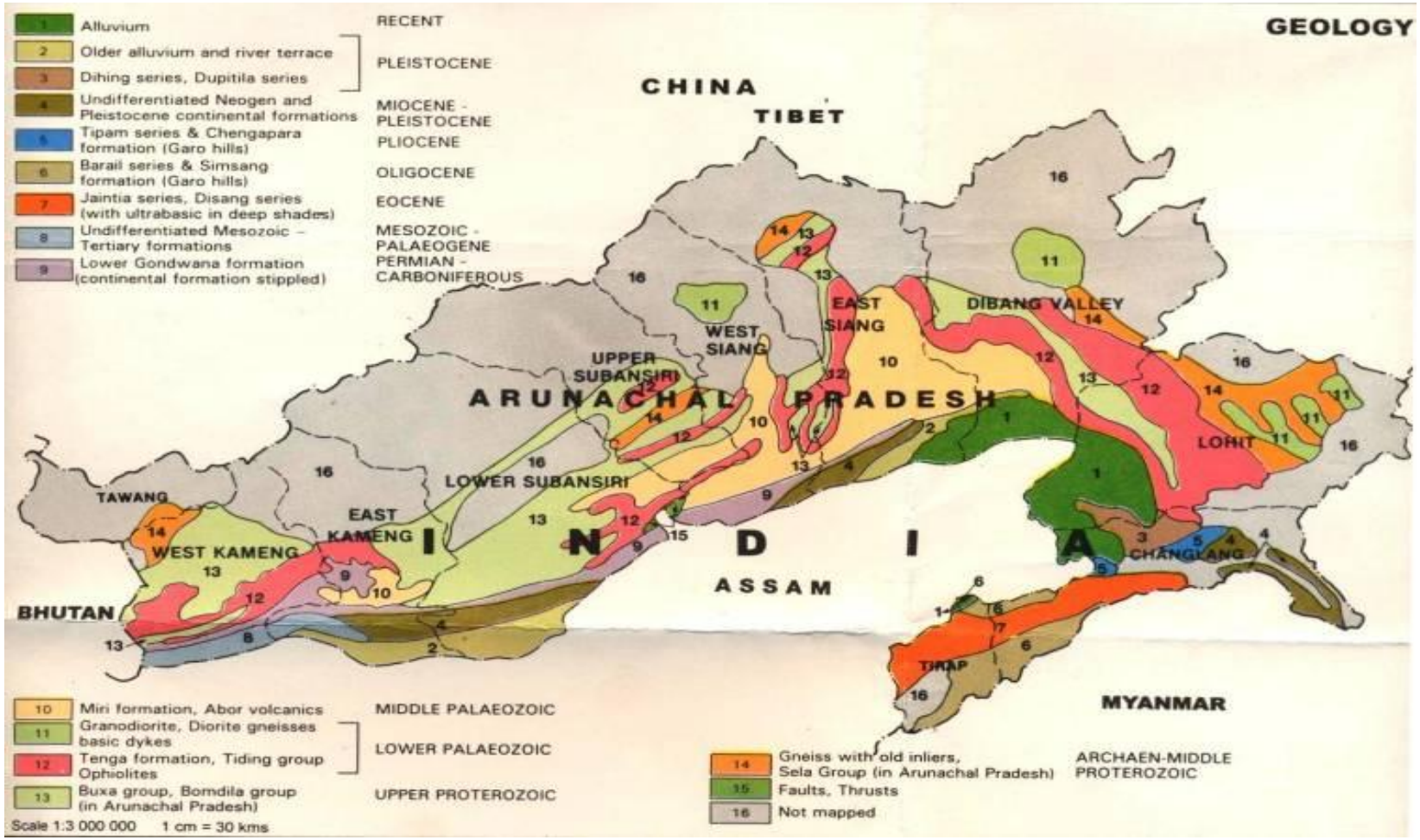
This super sequence includes low to medium grade metasediments comprising quartzite with penecontemporaneous mafic volcanic and carbonates, associates ortho-gneisses and granites and mafic intrusives. It is unconformably overlain by supersequence III constituting the Dirang formation in the North and by lower Gondwana sediments of supersequence IV in the South. The contact with the latter sequence, at most of the places is tectonic.

Structurally the Bomdila Group of rocks shows complex deformation patterns. The first generation of folds is reclined to tight isoclinal folds and at times rootless and the second generation folds are close to open folds showing variable axial attitudes. These folds trend almost N-S in the western part, E-W in the Northern and NE-SW in the Eastern syntaxial bend region in Siang. These features are the result of almost N-S trending regional third generation fold.

The geological map of Arunachal Pradesh has been provided as **Figure 3.3.**

[8] Verma, P.K. and S.K. Tandon, (1976), Geological Observations in parts of Kameng district, Arunachal Pradesh (NEFA). Himalayan Geology, V.6, pp. 259 – 286

Figure 3:3 Geological Map of Arunachal Pradesh



3.2.1.4 Seismicity and Tectonics

Arunachal Pradesh comprises of four geotectonic blocks, viz., i) the Himalayas, ii) the Mishmi Hills, iii) Naga-Patkoi Ranges of the Arakan Youma Moutain and iv) the Brahmaputra Plain, each characterized by distinct startigraphy and structure, and separated from the other by major tectonic lineaments, and therefore, have different geological history beginning from Archaean to Cenozoic. These blocks have witnessed different stages of tectonic development and associated orogenic movements.

The Himalayan segment forms the Eastern-most part of the Himalayan Mobile Belt. It abuts the Central Burmese Plate along the Tiding Suture to the East. Its Northern limit is defined by the Indus-Tsangpo Suture (not exposed in Arunachal Pradesh) separating it from the Indus-Shyok Belt of the Tibetan Plateau.

As a result of collision of the Indian Plate with the Asian Plate, North-South directed compressional forces were generated during Middle Eocene and marks the initiation of the Himalayan orogenic movement-1 (HOM-1). It resulted in development of overturned isoclinal folds (F3) which were refolded (F4) as a result of NE-SW directed compressional forces due to subsequent collision of the Indian Plate with the Central Burmese Plate (Acharya, 1986)[9]. At the same time, sag or the initial foredeep – the Murree Foredeep (Gopendra Kumar et al. 1996)[10], also developed in Northwestern sector of the Himalaya for the deposition of brackish water Murree Formation. The formation of the foredeep in this sector was delayed till the next episode of the Himalayan orogenic movement (HOM-2) in Late Oligocene.

The Arunachal Pradesh forms part of the North-Eastern region of India which is seismologically one of the most active zones in the world. Being situated at the trijunction of three plates, viz., Indian, Indo-Burmese and Eurasian, it is continuously under stress and undergoing crustal adjustments since the last phase of Himalayan Orogeny (HOM-4) in Middle Pleistocene when the Himalayas gained present heights, the Sub-Himalayas and the Naga-Patkoi ranges came into existence. As per the Seismic Zoning Map of India (IS 1893:2002), the whole of the North-East including Arunachal Pradesh falls under Zone V (refer **Figure 3.4**).

3.2.1.5 History of Past Earthquakes in the Area

The **Table 3.3** briefly outlines known earthquakes in this region. General locations are provided for historical events for which "generalized" epicentral co-ordinates are available.

[9] Acharya, S.K. (1986). Cenozoic Plate motions creating the Eastern Himalaya and the Indo-Burmese ranges around the northeastern corner of India. In : Ophiolite and Indian Plate Margin, N.C. Ghose and S. Varadarajan, (Eds.), pp. 143-161

[10] Goprndra Kumar, Khanna, P.C. and Surendra Prasad (1996). Quaternary Stratigraphy of the Indo-Gangetic Plain and Subhimalaya, Uttar Pradesh. Contributions to XV Ind. Colloq. Micropal. Strat. (Eds. J. Pandey, R. J. Azmi, A. Bhandari and A. Dave). K. D. Malviya Inst. Of Petroleum Exploration and Wadia Institute of Himalayan Geology, Dehradun, pp. 811 - 826

Figure 3:4 Seismic Zonation Map of India

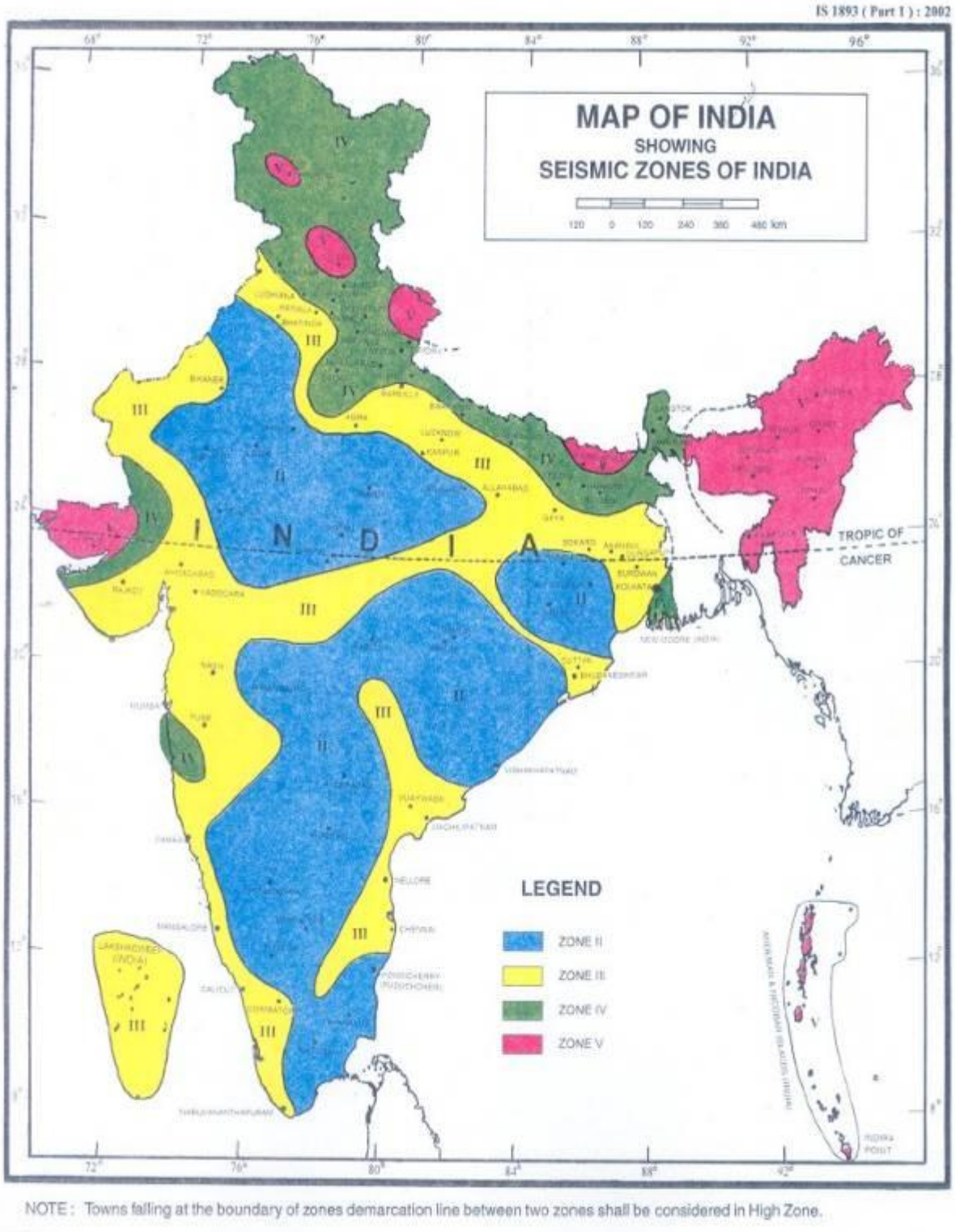


Table 3:3 Significant Earthquakes in Arunachal Pradesh

Sl. No.	Year	Month	Date	Time (utc)	Lat	Long	Ms	Mw	Depth (km)
1	1905	Feb	17	11:42	30.00	95.00	-	7.1	-
2	1906	May	12	05:50	25.00	92.00	-	6.5	-
3	1906	August	31	14:57:30	27.00	97.00	7.0	-	-
4	1908	December	12	12:54:54	26.50	97.00	7.6	-	-
5	1941	January	27	12:41:48	27.00	92.00	6.7	-	-
6	1947	July	29	13:29:25	28.50	94.00	7.5	7.3	-
7	1950	August	15	14:09:28.5	28.7	96.6	-	8.6	-
8	1950	August	15	21:42:16	25.00	95.80	8.0	-	-
9	1950	August	16	06:41:59.5	28.60	95.70	7.0	-	-
10	1950	September	13	11:07:34.1	27.80	94.30	7.0	-	-
11	1951	March	12	14:52:20	28.70	94.20	6.5	-	-
12	1951	November	18	00:44:10	27.70	94.60	6.7	-	-
13	1962	February	20	22:02:35	26.13	96.94	6.7	-	-
14	2000	June	7	21:46:55	26.856	97.238	6.5	6.4	-
15	2003	August	18	09:03:02	29.547	95.562	-	5.5	29
16	2005	June	1	04:16:48	28.871	94.598	-	5.7	18

Source : *IMD, New Delhi.*

3.2.1.6 Review of Geological Features around the Project Area

The project area is located in a deeply dissected terrain with partial structural control of the drainage pattern. The major rivers: Bichom, Dinang Bru and Digo River appear to follow major structural trends. The highest points are The Guriang Peak at 2255 m, located 2.8 km SW from the dam site and Rajang Phu at 2291 m, at the head of the valley of Divya Nala, about 4.5 km north from the dam site. The Bichom is incised up to 1,000 m into the valley floor, from the adjacent peaks. Generally the topography is a ridge and ravine type, with long slopes descending into V- shaped valleys. There is however a major exception on the right side of the Bichom. A large gentle slope extending about 2km up from the river appears to represent the debris from a major landslide that had a source area on the Eastern flank of Guriang Peak. The run out from this slide would have possible blocked the flow of the Bichom in the past as there is evidence in that; part of the slide debris is on the right bank. This distal portion of the debris forms a ridge that is now a barrier at the end of the valley of the Divya Nala. The valley of the Divya Nala is filled with alluvium indicating a restriction of outlet for a period that has since been naturally alleviated by a narrow cut by the stream on the left side of the ridge that descends steeply to meet the Bichom. The toes of the slide debris on the both banks of the main stream are now about 200 m high eroded slopes, with several individual landslides with toes that are being cut by the river action. It is estimated that the total volume of slide debris is about 0.4 km^3. The height of the head scarp is 600-700 m. The debris exposed along the road cutting includes very large blocks of gneiss, which are becoming loosened masses but still retaining the original rock structural features.

A mega landslide could have occurred during a more active tectonic phase in the development of the Arunachal Himalaya. The mode of failure was likely a gravity slide that initially was a

rapid event that was followed by several progressive failures. It remains a significant impact on the terrain and the current geomorphologic processes.

The area at and around the project is represented by the older folded cover sequence over printed by the Himalayan fold thrust movement. The project area is represented by granite gneisses of the Pre-Cambrian Age which are intrusives and have been later metamorphosed. They belong to the Bomdilla Group and comprise Mesocratic, banded granite gneiss with abundant augen structures. The rock has distinct micaceous and quartzo-feldspathic banding. Augen structures are characterized by large eye- shaped feldspathic phenocrysts up to 20-30mm size. These rocks are competent and have high strength in the fresh state. They mostly have a low dipping foliation towards the Southwest.

Most of the area at and around the project is covered by extensive colluvium which is thick along the valley slopes but thin at higher levels. Due to this, in-situ rock exposures in the area are scanty. However at the higher slopes this cover is thin and bedrock outcrops are well defined. They are heterogeneous in composition and contain large angular – sub angular boulders in finer matrix. In dry state they are mostly stable.

Bichom River valley is filled with river borne material comprising mixture of large boulders to pebbles and finer fractions. There are thick terrace deposits in the area. Other prominent geomorphic units in the area are talus cones and fan cut terraces which are mostly in a stable state. Nafra town itself is located on an extensive talus cone sloping at an angle of about 5°. The geological map of project area and dam intake site is provided in **Figure 3.5 and 3.6** respectively.

3.2.1.7 Landslides

A few landslides in the area mostly confined along the drainages and directed towards the Bichom Valley and its major tributaries were detected in the pre-field studies and have been confirmed during the field checks.

A slide about 500m downstream of the present dam axis on the left bank of Bichom River is presently slightly active otherwise most of the slides in the area are under a stable state and thus not of any serious consequence to the project and its catchment. No major failure along this slide (500 m downstream of dam axis) is anticipated which could obstruct the river flow.

Two landslides about 12-13 Km up stream of the dam axis are of no serious concern. Rock slopes with occasional minor rock falls have been reported in them. Another slide about 9 Km upstream of dam site (refer ***Annexure IV***) has been found to exist on the right bank of Bichom River. Here also steep rock escarpments in jointed Granite Gneiss with occasional small rock falls due to wedge formation are noticed.

The rock slopes are stable and some vegetation and shrubs have grown on them. This slide too does not pose any danger to the catchment and consequently to the reservoir in downstream.

Another slide about 2.5 Km upstream of Nafra village on the right bank of river Bichom has been detected. This too is not of any danger to the river upstream of dam axis. Steeper slopes exposing rock with vegetation cover and rare minor rock falls due to wedge failure have been noticed in it.

Figure 3:5 Geological Map of Project Area

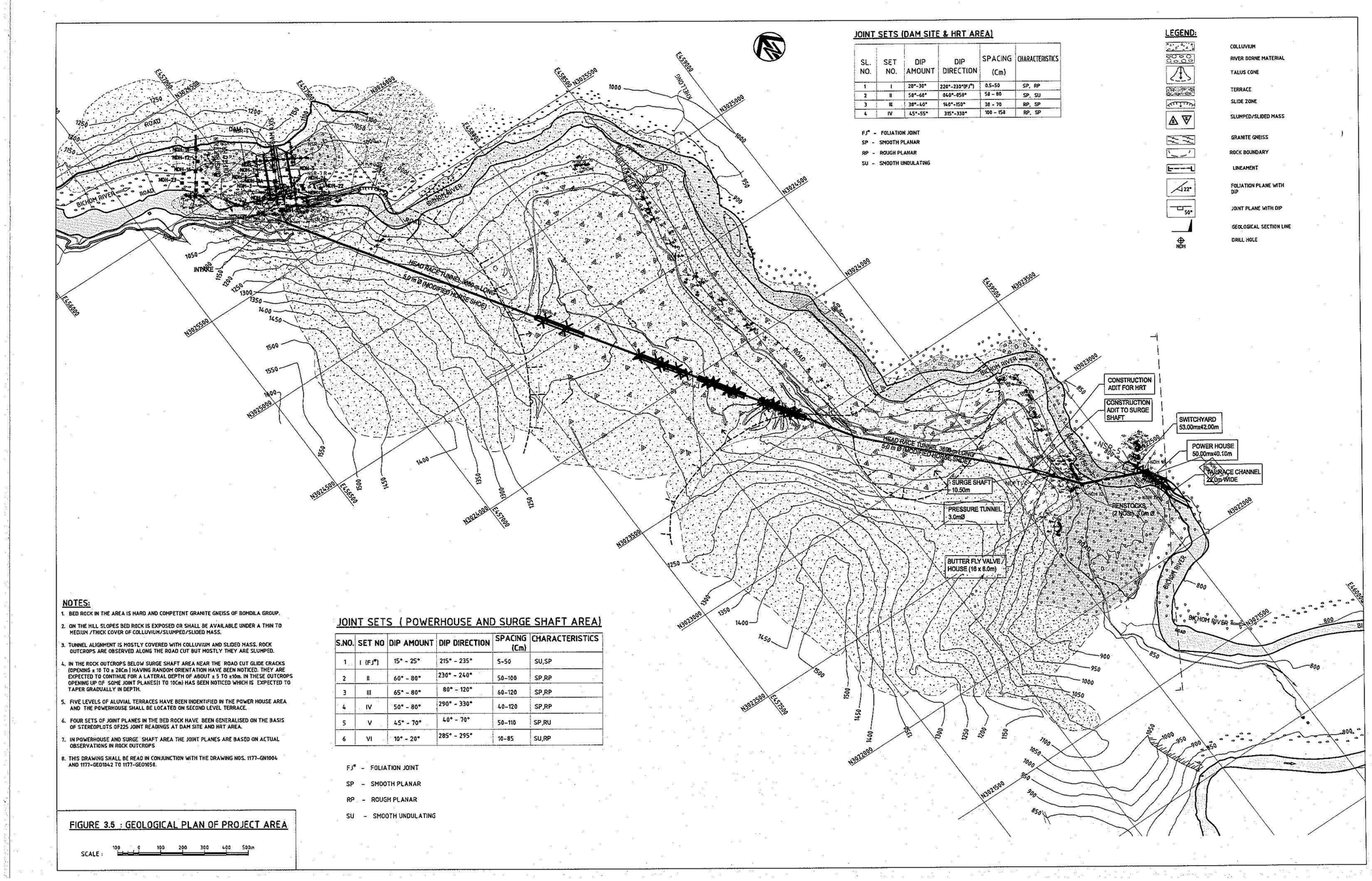
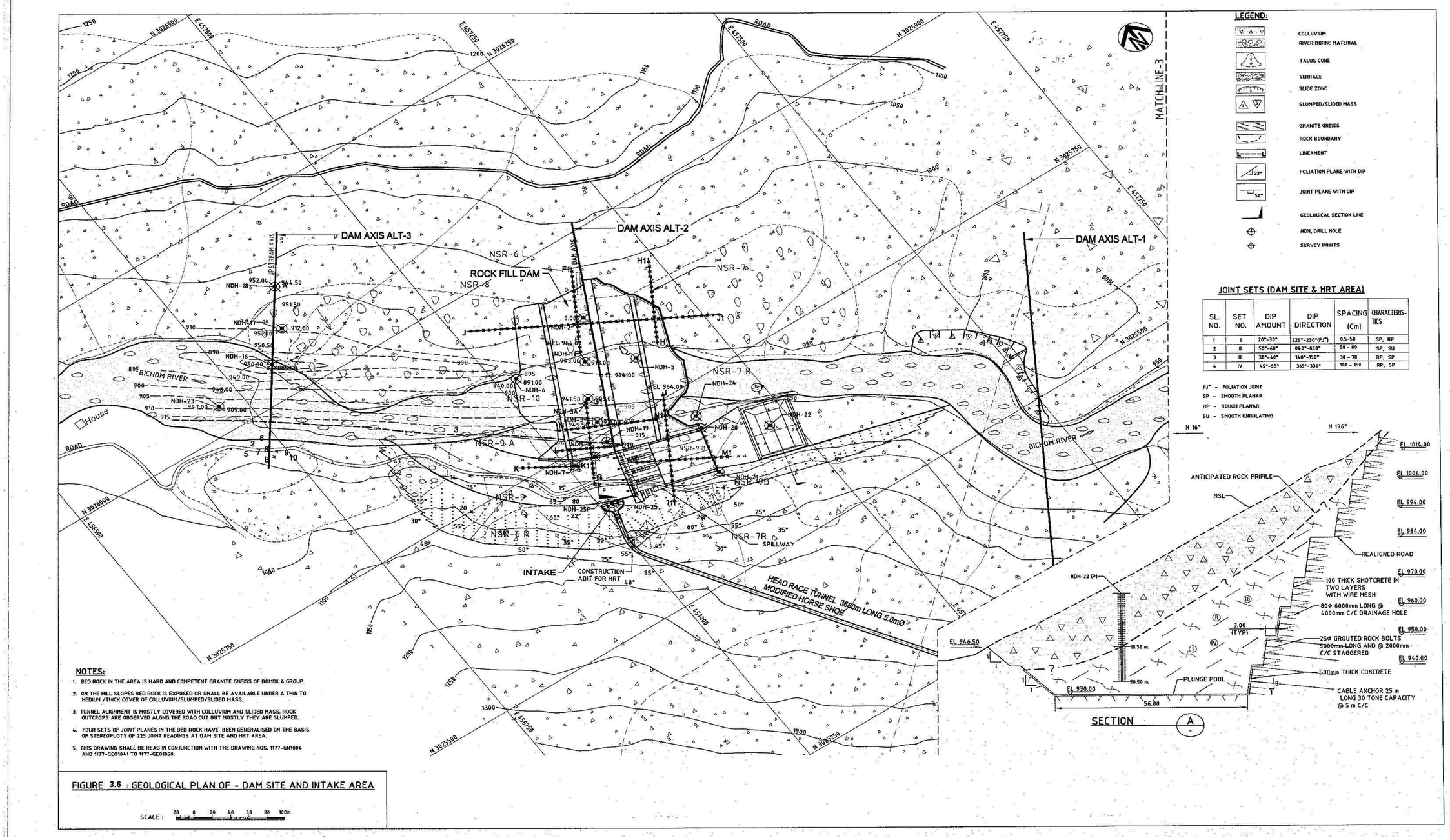


Figure 3:6 Geological Map of Dam Site and Intake Area



SL. NO.	SET NO.	DIP AMOUNT	DIP DIRECTION	SPACING (Cm)	CHARACTERISTICS
1	I	20°-30°	220°-230°(FJ*)	0.5-50	SP, RP
2	II	50°-60°	040°-050°	50 - 80	SP, SU
3	III	30°-40°	140°-150°	30 - 70	RP, SP
4	IV	45°-55°	315°-330°	100 - 150	RP, SP

A slide forming a bluff on the left bank of Bichom River just below the Nafra PHC and downstream settlements of Nafra has been detected in the linear stretch of about 300m (refer ***Annexure IV***). It is located about 700m downstream of the Nafra town. It has been formed due to toe cutting below the capping of a major talus cone by the river. The slided area is about 300m long and 80m high and partly stable on which shrubs and trees (a few tilted) have grown. However the slide is slightly active as sheet erosion in between the vegetation is noticed. It falls in reservoir submergence area near its upstream fringe and no major failure is anticipated along it.

The major slides about 0.5km downstream of dam axis on the left bank of Bichom River and another opposite to it on the right bank about 1.3Km downstream of the dam axis have been picked up in the imagery and checked in the field. This entire zone constitutes the mega slide described in the area. The affected zone continues for a distance of about 3.0 Km along the river. The part on the left (about 400m reach) is slightly active with slow and gradual release of a little slide debris into the river valley (refer ***Annexure IV***). At places its toe is hit by the river current during high floods.

The slide on the right side opposite to it covers a major part of HRT alignment and presently in a stable state. It exhibits a gentle topography sloping towards the river with vegetation grown on it. Above slides do not pose any serious problem of blocking the river downstream of the dam site.

However, the sliding on the right side needs due exploration to check its depth, continuity and aerial extent to ensure the availability of sound rock at the HRT grade. For this three bore holes (NDH-8 to 10) and four seismic refraction traverse lines (NSR 1 to 4) have been planned in the area. The phenomenon of such a mega sliding is quite puzzling. This could have been influenced by mega lineament (No II) described earlier. Sliding on such a large scale could be caused by structural disturbances. Occurrence of gigantic slide from the right bank directed towards the left, which would have blocked the river and caused temporarily lake formation. This is manifested by the presence of terrace deposits in the upstream area, which have distinct horizontally to sub-horizontally disposed sandy layers. Terrace boulders on the left bank above the slide scar (El. ± 985m) have been recorded which also corroborate the above hypothesis.

Along a major part of the right bank, road between the dam and Powerhouse site, thick accumulation of slided debris is noticed along the road cut (refer ***Annexure IV***). This however is not of any major consequence which could slide and impede the river flow.

Further downstream; land sliding at four locations, two along Digo River and the other two along Bichom River has been noticed. However the former are away from the power house area in the Digo Valley and the later are much downstream of power house location and hence not of any significance to the project. Following conclusions have been made regarding landslides in the project area:

- Studies based on LANDSAT imagery with limited field checks indicate that there is no danger from the possibility of any major land slide into the reservoir and in its catchment (covered in SOI Topographic sheet no 83A/11).
- Most of the landslides noticed in the area are in a stable state and as such do not pose any danger to the reservoir. Occasional rock falls of local nature shall not pose any

danger to the structures. Mega slide downstream of the dam site is mostly stable on the right bank. Its significance over the HRT alignment is being assessed by drilling. On the left side it is active in a part of the area particularly in reaches, where its toe is hit by the river flows at higher stages. Under such circumstances also, the release of slide debris into the river valley is assessed to be of small magnitude, which would be flushed by the flowing current and, as such, would not impede the river flow.

- No chances of the generation of a high wave induced due to land sliding into the reservoir are envisaged.
- Routine mass wasting, contributing to the production and transportation of silt load will be a normal phenomenon like any other mountainous valley. However no abnormally high silt formation has been observed in the area.
- Crest lines are mostly sharp and do not show accumulation of thick colluviums which could fall and slide into the reservoir.
- Other features like talus cones and piedmont slopes are also in a stable state as reflected by the compaction of colluviums constituting them along with growth of vegetation.

3.2.1.8 General Slope characteristics of the project area

The slope plays a great role for the loss of soil and water from an area and thereby influences its land use capability. Together with the nature and texture of soil, it also determines the erodibility of the soils. As the slope becomes steeper, the runoff coefficient increases, the kinetic energy and carrying capacity of the surface flow becomes greater, soil stability and as well the slope stability decreases and splash erosion increases. General slope details of directly draining catchment are categorized as follows:

Sr. No.	Degrees (^{0})	Slope type
1	0 to 15	Gentle
2	16 to 30	Moderate
3	31 to 45	Moderately steep
4	46 to 60	Steep
5	> 60	Very steep

As observed at site, slopes of the river valley from river bed up to the submergence level, at the proposed reservoir site are steep. Slope Map of the study area is provided in **Figure 3**:13**.**

3.2.1.9 Soil

The soil properties influencing erodibility include particle size distribution, organic matter content, its association with different morphological features and effective soil depth. Infiltration rate and soil permeability which is function of soil texture, coarse fragments, effective soil depth, etc. determines the quantity of surface flow. Soil erodibility is also governed by the active surface area of the soil particles. Soil structure or aggregate stability is another important factor offering resistance to soil detachment. Standard relationship of soil and erosion as per NBSS and LUP is given in **Table 3.4.**

Table 3:4 Standard Relationship of Soil and Erosion

Sr. No.	Mapping Unit (As per NBSS andLUP)	Soil Description	Association with	Erositivity
1	1	Shallow, excessively drained, loamy skeletal	Moderately deep, excessively drained on moderately steep slope	Very severe
2	2	Deep, loamy skeletal	Deep, somewhat excessively drained loamy skeletal on moderately steep slope	Severe
3	3	Shallow, loamy skeletal	Moderately deep, somewhat excessively drained on moderately steep slope	Severe
4	7	Very deep, fine soils	Moderately shallow, excessively drained clayey soils on steep slope	Severe
5	9	Deep, well drained fine soils	Very deep, well drained, fine loamy soils on moderate slope	Moderate
6	11	Very deep, well drained, fine loamy soils	On moderate slope, very deep well drained fine soils	Moderate

Source: *NBSS and LUP*

According to the soil map of West Kameng and study area (**Figure 3.7**), the soil types of study area are as follows:

Mapping Unit	Description	Soil Taxonomy
1	Shallow, excessively drained, loamy-skeletal soils on very steeply slopping hill summit having loamy surface with very severe erosion hazard and moderate stoniness: associated with; moderately deep, somewhat excessively drained, loamy-skeletal soils on moderately steeply sloping side slopes with severe erosion hazard and moderate stoniness	▪ Loamy skeletal, Lithic Udorthents ▪ Loamy skeletal, Typic Udorthents
2	Deep, somewhat excessively drained, loamy-skeletal soils on moderately steeply sloping summits having loamy surface with severe erosion hazard and moderate stoniness: associated with moderately shallow, excessively drained, sandy-skeletal soils on steeply sloping summits with very severe erosion hazard and slight stoniness	▪ Loamy skeletal, Entic Haplumbrepts ▪ Sandy skeletal, Typic Udorthents
8	Moderately Shallow, somewhat excessively drained, loamy-skeletal soils on moderately steeply sloping side slope of hills having loamy surface with severe erosion hazard and strong stoniness: associated with; moderately deep, somewhat excessively drained, fine-loamy soils with moderate erosion hazard	▪ Loamy-skeletal, Typic Udorthents ▪ Fine-loamy, Typic Eutrochrepts
10	Very deep, somewhat excessively drained, fine-loamy	▪ Fine-loamy, Umbric

Mapping Unit	Description	Soil Taxonomy
	soils on moderately steeply sloping side slope of hills having loamy surface with moderate erosion hazard and slight stoniness: associated with; very deep, well drained, fine-loamy soils with moderate erosion hazard	Dystrochrepts ▪ Fine-loamy, Pachic Haplumbrepts
11	Very deep, well drained, fine-loamy soils on moderately steeply sloping side slope of hills having loamy surface with moderate erosion hazard and slight stoniness: associated with; very deep, well drained, fine soils with moderate erosion hazard	▪ Fine-loamy, Pachic Haplumbrepts ▪ Fine, Typic Palehumults

Soil samples were collected from 3 different locations of the study area during 3 seasons (Monsoon, Post-monsoon and Winter) and analyzed for physico-chemical parameters. The analytical results for each location are provided in **Table 3.5**. Field photographs during soil sample collection are provided in ***Annexure V***.

As per the primary analysis, the soil quality varies from heavy silty clay loam, light sandy loam to heavy clay loam in villages Nafra, Khellong and Lower Jung respectively. Various other parameters like pH, conductivity, permeability, cation exchange capacity, sodium absorption ratio, water holding capacity, porosity, nitrogen, phosphorus, potassium and particle size distribution mark the type and nature of a particular soil type.

Table 3:5 Analytical results of Soil sampling of the study area

Location: Nafra Village

Parameters	Monsoon	Post-monsoon	Winter
pH	6.79	7.82	7.30
Conductivity in ms/cm	0.68	0.174	0.16
Texture	Heavy silty clay loam	Heavy silty clay loam	Heavy silty clay loam
Cation Exchange Capacity (g of Sodium ion per g of soil)	0.049	0.039	0.038
Permeability (cm/ hr)	7.6	7.4	4.0
Sodium Absorption Ratio	0.24	1.53	1.38
Water Holding Capacity in %	6.06	2.58	4.68
Porosity in %	78.56	32.20	21.32
Nitrogen as N in %	0.018	0.022	0.008
Phosphorus as P in %	0.00009	0.0003	0.007
Potassium as K in %	0.445	0.34	0.32
Particle Size Distribution in %	+75 micron – 93.86	+75 micron – 82.33	+75 micron – 78.2
	-75-61.2 micron – 2.50	-75-61.2 micron – 7.86	-75-61.2 micron – 10.8
	- 61.2 – 60 – NIL	- 61.2 – 60 – NIL	- 61.2 – 60 – NIL
	-60– 50 micron– 1.86	-60– 50 micron–4.7	-60– 50 micron– 7.0
	-50 – 42.8 – 1.16	-50 – 42.8 – 3.0	-50 – 42.8 – 2.6
	-42.8 – 37.5 – 0.61	-42.8 – 37.5 – 2.11	-42.8 – 37.5 – 1.4

Source: *Soil Quality analysis report by Mitra S. K. Private Limited*

Figure 3:7: Soil Map of West Kameng District and Study Area

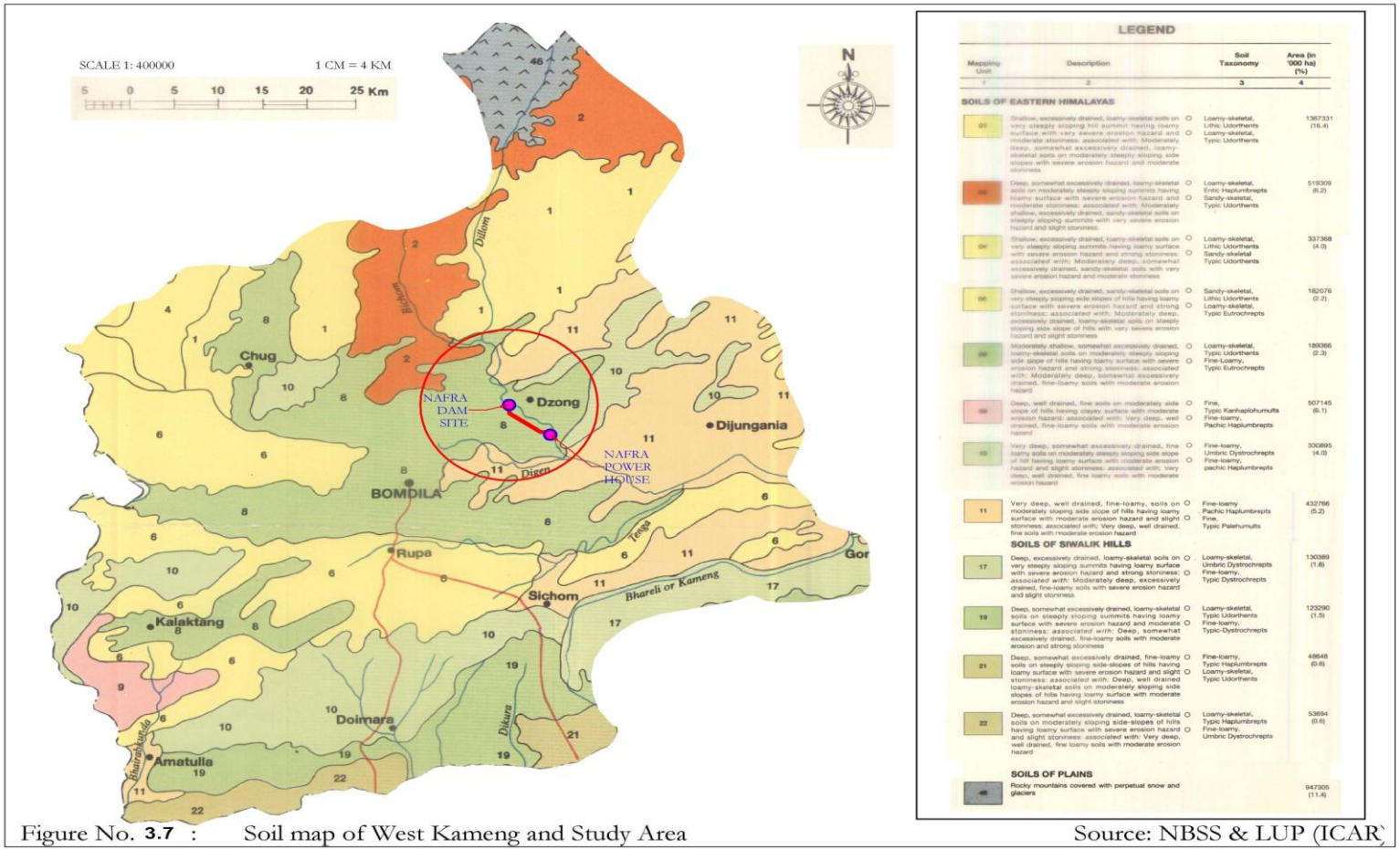


Figure No. 3.7 : Soil map of West Kameng and Study Area

Source: NBSS & LUP (ICAR)

Location: Khellong Village

Parameters	Monsoon	Post-monsoon	Winter
pH	6.82	7.70	7.20
Conductivity in ms/cm	0.14	0.182	0.18
Texture	Light sandy loam	Light sandy loam	Light sandy loam
Cation Exchange Capacity (g of Sodium ion per g of soil)	0.052	0.042	0.032
Permeability (cm/ hr)	5.9	6.9	5.2
Sodium Absorption Ratio	0.154	0.83	1.27
Water Holding Capacity in %	7.01	1.86	4.01
Porosity in %	74.74	31.82	36.0
Nitrogen as N in %	0.019	0.027	0.023
Phosphorus as P in %	0.00012	0.002	0.0038
Potassium as K in %	0.204	0.13	0.78
Particle Size Distribution in %	+75 micron – 81.66	+75 micron – 78.53	+75 micron – 81.1
	-75-61.2 micron – 7.90	-75-61.2 micron – 9.70	-75-61.2 micron – 11.7
	- 61.2 – 60 – NIL	- 61.2 – 60 – NIL	- 61.2 – 60 – NIL
	-60– 50 micron– 5.53	-60– 50 micron– 6.07	-60– 50 micron– 3.6
	-50 – 42.8 – 2.80	-50 – 42.8 – 3.03	-50 – 42.8 – 2.1
	-42.8 – 37.5 – 2.10	-42.8 – 37.5 – 2.67	-42.8 – 37.5 – 1.50

Source: *Soil Quality analysis report by Mitra S. K. Private Limited*

Location: Lower Jung Village

Parameters	Monsoon	Post-monsoon	Winter
pH	6.70	8.15	7.92
Conductivity in ms/cm	0.11	0.30	0.25
Texture	Heavy clay loam	Heavy silty clay loam	Heavy silty clay loam
Cation Exchange Capacity (g of Sodium ion per g of soil)	0.062	0.109	0.04
Permeability (cm/ hr)	9.80	5.3	5.2
Sodium Absorption Ratio	0.35	0.38	1.52
Water Holding Capacity in %	0.43	4.08	2.08
Porosity in %	21.28	32.70	28.86
Nitrogen as N in %	0.02	0.025	0.019
Phosphorus as P in %	0.00011	0.0001	0.002
Potassium as K in %	0.574	0.6	0.18
Particle Size Distribution in %	+75 micron – 85.03	+75 micron – 84	+75 micron – 79.3
	-75-61.2 micron – 7.03	-75-61.2 micron – 6.0	-75-61.2 micron – 8.0
	- 61.2 – 60 – NIL	- 61.2 – 60 – NIL	- 61.2 – 60 – NIL
	-60– 50 micron– 4.1	-60– 50 micron– 5.17	-60– 50 micron– 6.5
	-50 – 42.8 – 2.3	-50 – 42.8 – 2.83	-50 – 42.8 – 3.7
	-42.8 – 37.5 – 1.53	-42.8 – 37.5 – 2.0	-42.8 – 37.5 – 2.5

Source: *Soil Quality analysis report by Mitra S. K. Private Limited*

As observed from tables above, pH of the soil is in neutral ranges. The levels of NPK indicate moderate to high soil productivity. In this Hydro Electric project the impact on soil will be limited to the construction sites and muck disposal sites. If appropriate amelioration measures implemented, it would further minimize the impact on soil quality of the study area.

3.2.1.10 Land use and Land cover of the study area

Land use describes the way in which land is used for example farming, settlements, roads etc by mankind. Accurate land use and land cover identification is the key to most of the planning processes. Land cover is the physical material at the surface of the earth. Land covers include grass, asphalt, trees, bare ground, water, etc. the land cover of a particular area can be studied by field survey and/or by analysis of remotely sensed imagery.

Geometric Correction:

- The SoI Topographic Sheet at 1:50,000 was developed on polyconic and Everest projection and datum. The sheet was geo-coded using ERDAS with 0 RMS value. The sheet was then re-projected into WGS 84 and UTM projection system, in which the study area falling into zone 46. It was further geo-referenced using control points from the ground.
- High resolution multiband image was geo-coded using SoI topographic sheet by image to image geo-coding process using ERDAS, similarly high resolution Pan Data was registered.

Data Fusion or Merging:

To get better resolution along with information on vegetation degraded lands, water bodies etc. high resolution LISS panchromatic data has been fused or merged with multi-band data of low resolution LISS.

Signature collection and Ground Truthing of the project area:

Ground truthing was done in month of Jan 2009. Signature extraction is very crucial part in image classification methods, Image characteristics comprise of various elements of image interpretation such as i) tone or color ii) size iii) shape iv) texture v)pattern vi) location vii) association viii) shadow ix) aspect x) resolution. This image interpretation key was developed by NRSA based on the spectral response of surface features observed on IRS (LISS-III) standard FCC with a band combination of 2, 3 and 4. This process helps to get an accurate signature of the surface or area of interest / classes. The signatures of the study area have been summarized below:

Sl. No.	Land Use Class	Photographic View
1.	**Dense Mixed Forest** The dense mixed forest is mainly found around Village DixuPam, Guriang, Minzing, Migiang Pam, Darang, Nachibhan, and beyond Khazlong. Types of vegetation found in the forest are mainly mixed in nature – few local trees (Bajar, Bans, Kuttku, Badami) and some pine trees. This vegetation is capable of producing timber and other forest produce.	
		Dense Mixed Forest Beyond Dixu Village

Sl. No.	Land Use Class	Photographic View
2.	**Pine Forest** Pine forest is found around town Nafra and villages Jang, Khelong, Singson Pam, Giji, Thaling Pam, Rajang Phu and dense pine Gurian, and Bwojin. Pine Forest covers major portion of the area of the study.	
		Pine Forest at Power House Site
3.	**Agriculture Land** There are two types of agriculture practices in the study area viz. Step / Jhum cultivation and river bed cultivation	
3.1	**step and Jhum cultivation** The agriculture practice commonly observed was Step and Jhum cultivation in the study area. The corn is the major crop grown by villagers. Apart from corn, other crops like rice, vegetables and fruits (orange and bananas) are also cultivated.	
		Step Cultivation at Kjjlong
3.2	**River bed cultivation** River bed cultivation practice was observed mostly in lower Jung, Nafra town, and near Bichom village. The types of crops grown are mainly vegetables such as Tomatoes, Potatoes, Cabbage, and Chilly.	
		River Bed Cultivation at Jung Village
4.	**Settlements and Built Up Land:** The study area is mainly rural, except Nafra which can be categoriesed as semi-urban. The main built up area of the study consists of Nafra, Lower Jung, Kasrang, Khelong, Nizum, Kazlong, Zamnachi, Bichom. **Nafra Village**	

Sl. No.	Land Use Class	Photographic View
5.	**Barren/ Rocky Area** Rock exposures of varying lithology, often barren and devoid of soil cover and vegetation or covered with sparse vegetation, were noticed in the study area.	
6.	**Degraded vegetation in the study area**	
		
7.	**Shrubs:** Shrubs and bushes were noticed around the banks of the river before Nafra Bridge and constitute about 1.1% of the total area of study.	

Free Draining Catchment: The FCC generated from the LISS-III scene for the free draining catchment of Bichom and generated land use / land cover map for this region are shown in **Figures 3.9** and **3.10.** Areas of different land use/ land cover classes **(Table 3.6 & Fig 3.8)** have been calculated using standard software. The classified Image is provided in **Figure 3.11.**

Table 3:6 Land use Pattern of the study area

Sl. No.	Class	% Area Covered
1	Dense Forest	27%
2	Open / Pine Forest	31.20%
3	Agriculture Land / Settlements	15.30%
4	Water Bodies	1.80%
5	Degraded Forest	3.60%
6	Shrubs	21%

Figure 3:8 Land use and land cover of study area

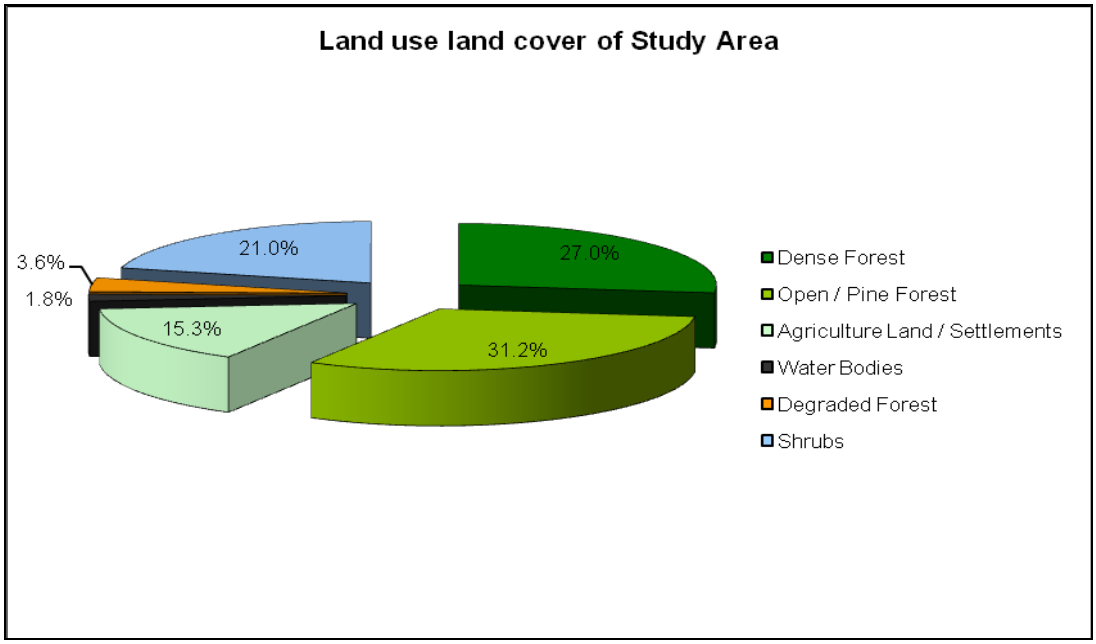


Figure 3:9 False Color Composite of Directly Draining Drainage of Bichom River

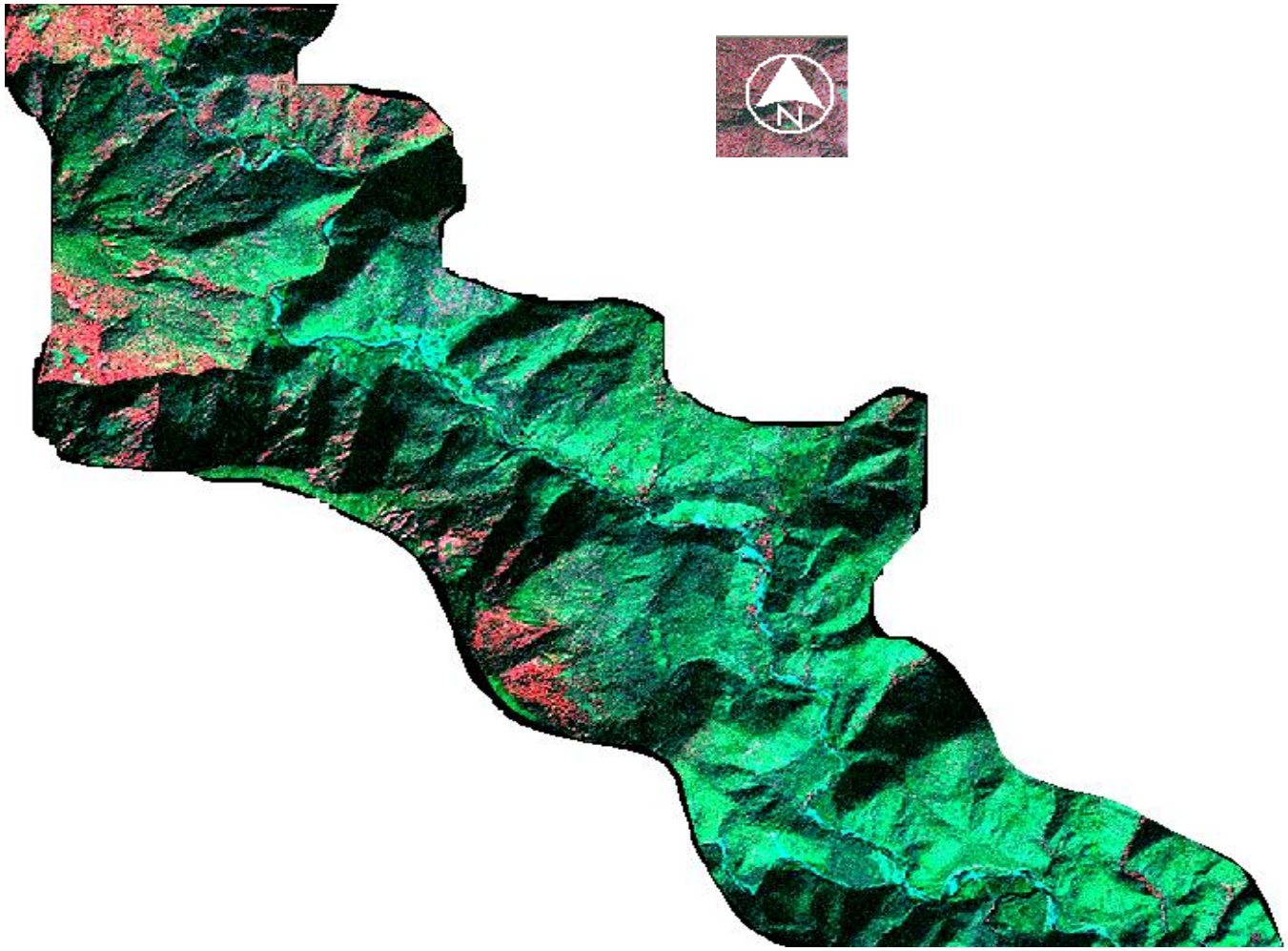


Figure 3:10 False Color Composite of study area

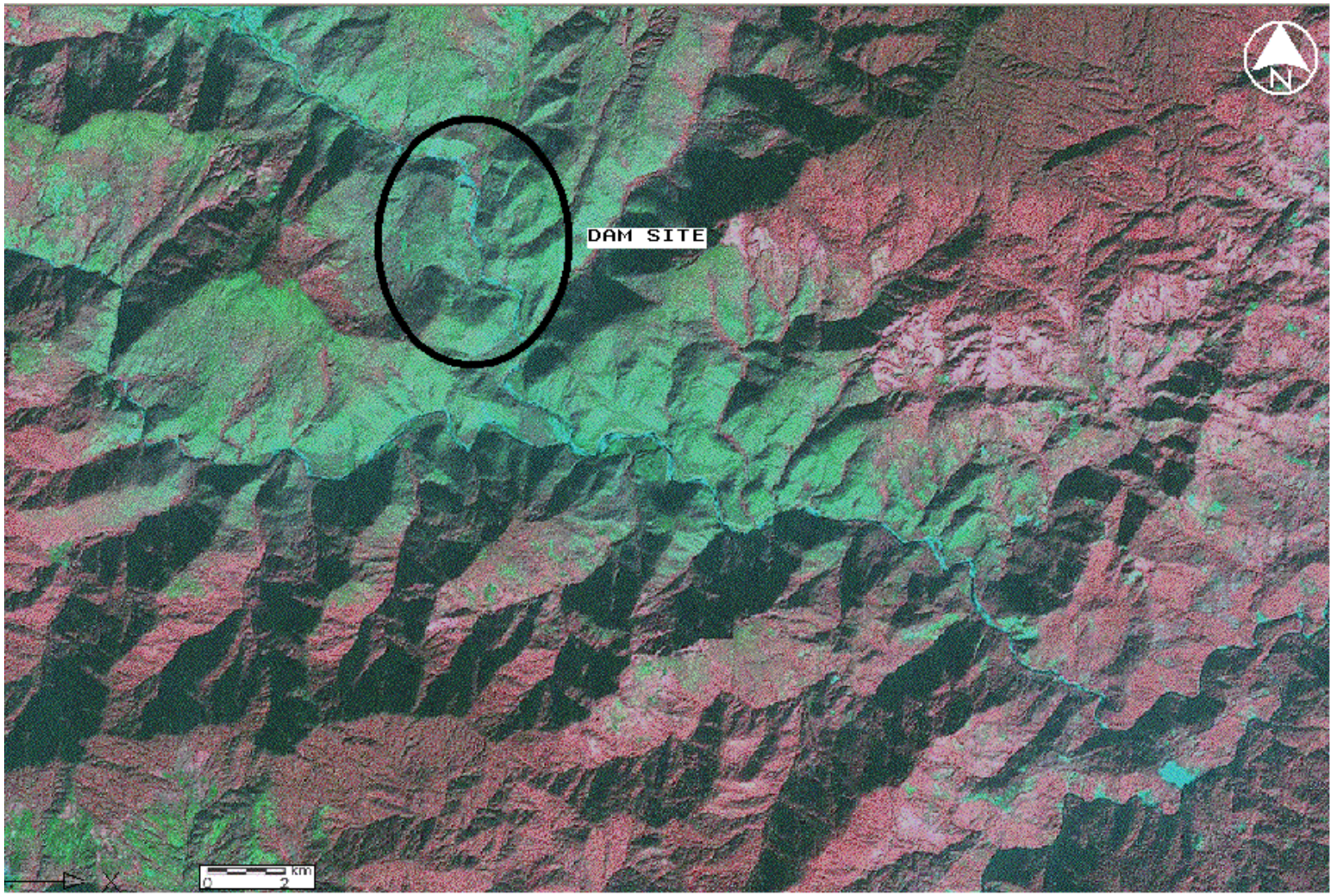
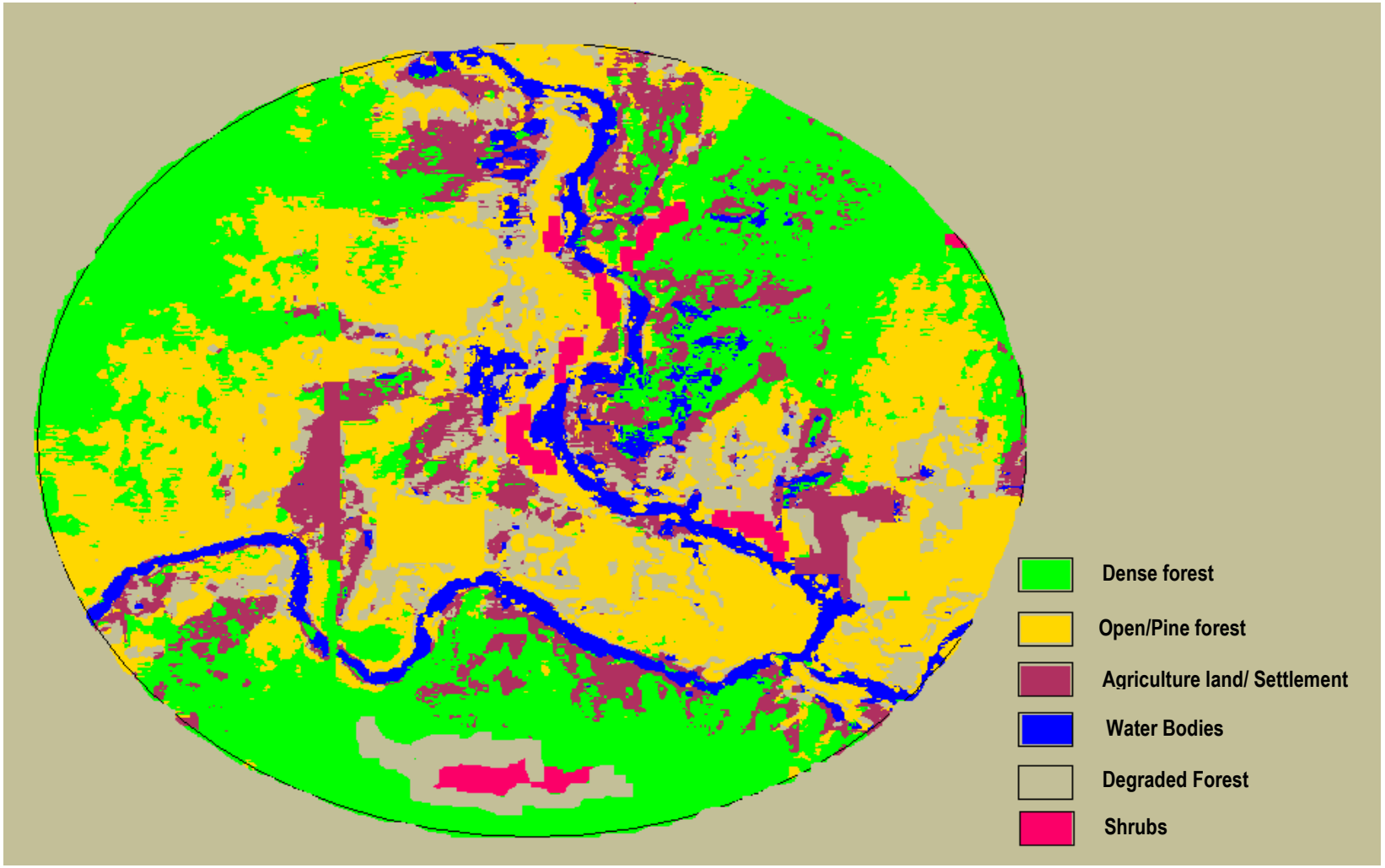


Figure 3:11 Land Use / Land Cover of the study area



3.2.1.11 Water Resources

Kameng River Basin

The Kameng River (previously named Bhareli River) in the Eastern Himalayan mountains, originates in Tawang district from the glacial lake below snow capped Gori Chen mountain 27°48'36"N 92°26'38"E/ 27.81, 92.44389 (6,300 metres or 20,669 ft) on the Indo-Tibet border in South Tibet and flows through Bhalukpong circle of West Kameng District, Arunachal Pradesh and Sonitpur District of Assam, India. It is one of the major tributaries of the Brahmaputra River, joining it in Tezpur, just east of the Kolia Bhomora Setu Bridge.

River Kameng forms the boundary between East Kamemg and West Kameng Districts and is also the boundary between the Sessa and Eagle Nest sanctuaries to its West and the Pakke Tiger Reserve to the East. The Dafla Hills are East and the Aka Hills (home of Aka tribe) are West of the Kameng River. The entire stretch of forest along the Bhalukpong-Bomdila highway on the West bank of the river in West Kameng has in the last few years destroyed though the forest across the river continues to be in a healthy state.

Tributaries

The Eastern half of Eagle Nest-Sessa Wildlife sanctuaries is drained by the Tippi Nala which joins Kameng River near village Tippi along the Bhalukpong-Bomdila highway. The other major rivers flowing through West Kameng District, Tenga, Bichom and Dirang Bru, are also tributaries of Kameng.

Nafra Basin

The Nafra Basin is characterized by a bifurcated network of several streams. The proposed project is located in between Dibbin H E project and Kameng HE Project. The total length of Bichom River from origin to proposed HE site is 60 km while the catchment area being 776 sq km. The details of the project area are as under.

Location	:	92^{0}34'25"Longitude and 27^{0}21'04" Latitude		
Catchment Area	:	Total	776 sq km	
		Rain fed	745.00 sq km	(96%)
		Snow fed	31.00 sq km	(4%)

3.2.1.12 Hydrology

Kameng drains a catchment of area of about 776 sq km at the proposed dam site. The submergence area at pond level is estimated as 32.67 ha having a live pondage volume of 2.413 MCM.

Water availability for the project is worked out on the basis of monthly discharge series available at Bichom G&D site considering the two basins as hydro-meteorologically homogeneous. Correction factor with respect to rainfall and catchment area is applied. The computed monthly inflow series has been converted into 10-daily inflow series based on daily rainfall data available in the same basin. The computed inflow series has been utilized for assessing water availability and power potential studies. The design discharge at 90% dependability has been estimated as 61.38cumec for power generation. The design flood has been assessed as 5978 cumec (PMF) and 4752 cumec (SPF).

Studies were carried out to calculate discharge, velocity and sediment measurements for Bichom River. The mean velocity calculated was observed to be in the range of 1.43 to 2.20 m/sec. Following table provides the sediment concentrations in the river observed in various samples:

Table 3:7 Sediment Concentrations in the Bichom River

Date and Time	Water level (M)	Seg No -	Weather condition	Condition of Water	Sediment concentration in ppm			
					Course	Medium	Fine	Total
10-7-08	990.920	1, 2, 3	Sunny	Muddy	Trace	90	108	302
11-7-08	991.160	1, 2, 3	cloudy	Muddy	Trace	100	116	216
12-7-08	991.320	1, 2, 3	cloudy	Muddy	Trace	99	105	204
13-7-08	991.410	1, 2, 3	cloudy	Muddy	Trace	99	114	213
22-7-08	991.760	1, 2, 3	sunny	Muddy	Trace	113	189	302
26-7-08	991.670	1, 2, 3	Cloudy	Muddy	Trace	108	169	277

An estimation of minimum lean season flow of Bichom River has been calculated based on release of minimum flow during lean season so as to maintain the aquatic ecological life forms. The same is estimated to be 0.913 cumecs during lean season in a 50% dependable year. The discharge of the perennial streams joining Bichom River between Dam and the Power House will supplement this minimum discharge from the Dam. The flow details of Dinang Bru and Divya Nala adjoining tributaries of river Bichom, joining Bichom between the Dam site and Powerhouse site are provided in table below:

Table 3:8 Flow of adjoining tributaries of Bichom River

Month / Year	Dirang Bru	Divya Nala
December 2007	8.84	1.43
January 2008	6.08	0.98
February 2008	5.00	0.81
March 2008	5.99	0.97
April 2008	6.27	1.01
May 2008	10.83	1.75
June 2008	31.70	5.11
July 2008	34.71	5.60
August 2008	34.97	5.64
September 2008	27.93	4.5
October 2008	17.96	2.9
November 2008	8.18	1.32
December 2008	7.15	1.15
January 2009	4.85	0.78
February 2009	4.51	0.73
March 2009	5.13	0.83

The model developed using HEC-RAS[11] 4.0 Beta and details have been provided in ***Annexure VI***. The hydro-meteorology and catchment area of the basin are depicted in **Figure 3.12 and 3.13** respectively.

[11] Hydrologic Engineering Centre – River Analysis System

Figure 3:12 Hydro meteorology of Study Area

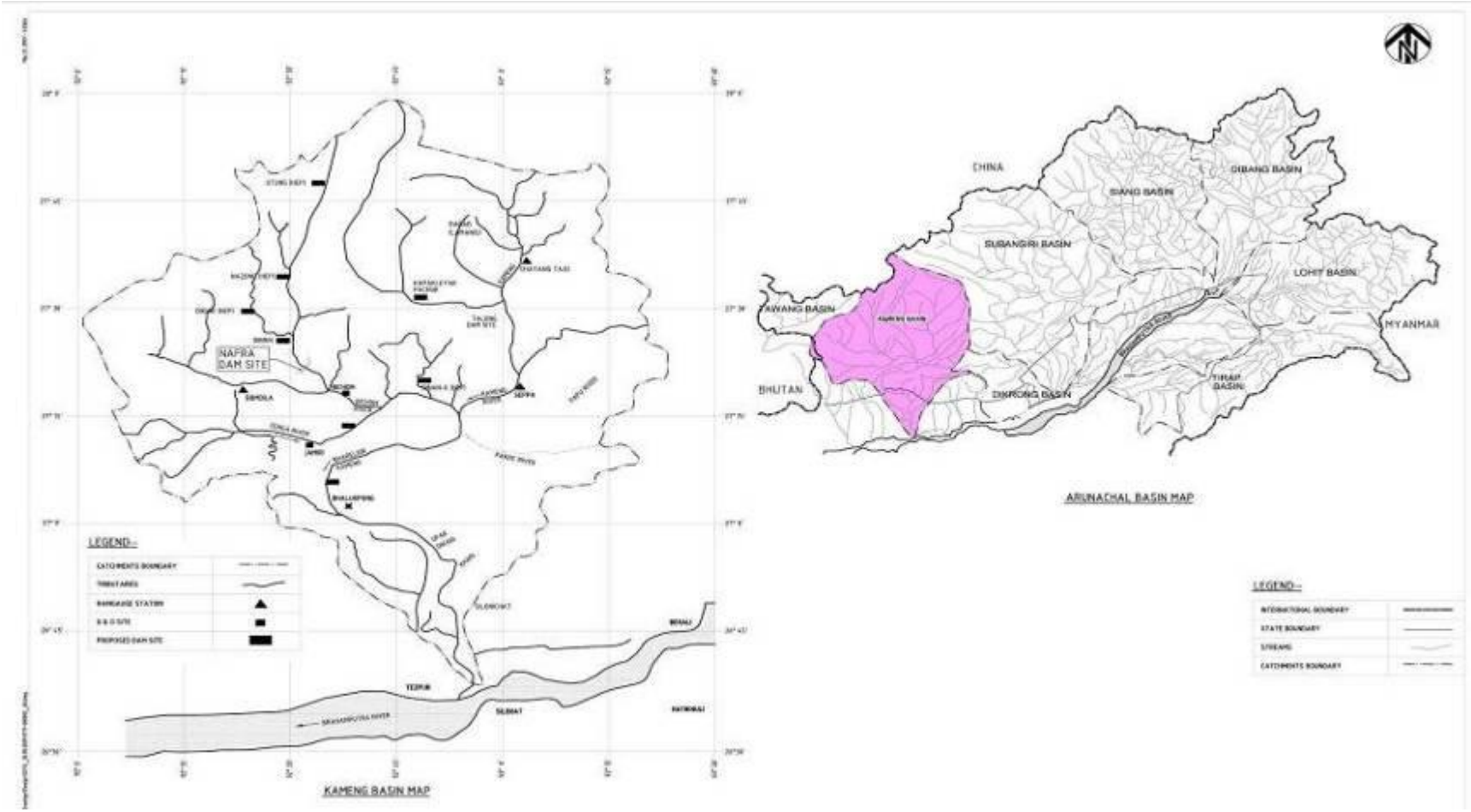
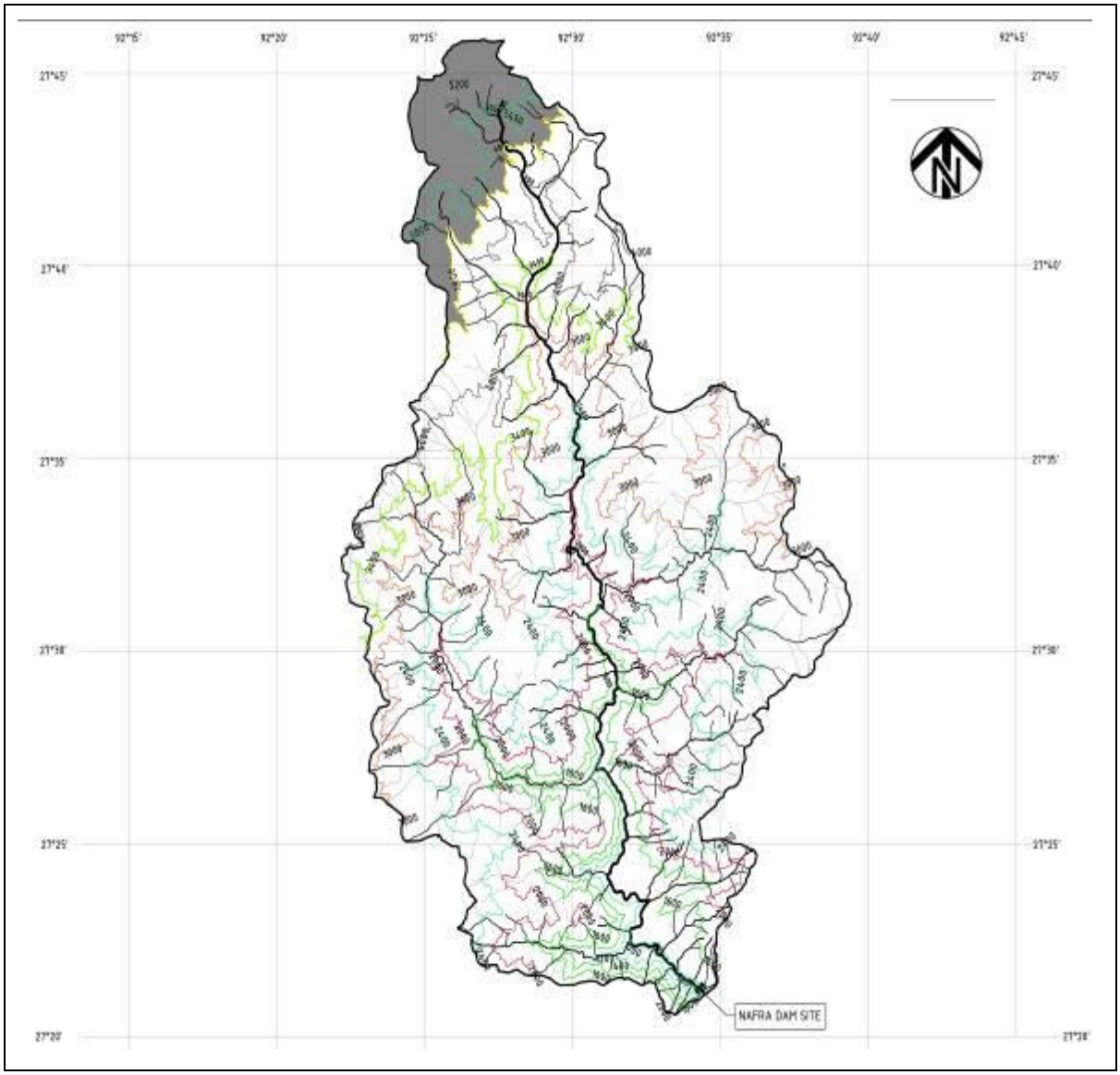


Figure 3:13 Catchment Area and Slope Map of River Bichom



3.2.1.13 Drainage

The project area lies within the Bichom River Sub-basin of Kameng River Basin. Kameng River is formed after the confluence of Bichom and Tenga River which ultimately joins Brahamputra River in Assam. Kameng is called Jia-Bhareli in the foot hills. Kameng River drains the entire Kameng district and part of Subansiri district of Arunachal Pradesh. The river Bichom is perennial in nature. The natural drainage map (refer **Figure 3.14**) has been derived using IRS-P6, LISS-III, 30 Mar-2007.

3.2.1.14 Surface Water Quality

The water samples from at two sampling locations i.e. upstream of dam site and downstream of power house site at approx 1.00-1.50 km distance were collected for monitoring of river water quality during Monsoon, Post-monsoon and Winter seasons. The average analytical results of each location are given in **Table 3.9**. Photographs of water sampling are enclosed in ***Annexure V***. The permissible limit for various water quality parameters is provided as ***Annexure VII***.

Table 3:9 Water Quality Analysis of Bichom River

Location: Upstream of Dam site

Parameters	Monsoon	Post-monsoon	Winter
pH	6.49	7.10	6.73
Temperature	18.5 ^{0}C	15 ^{0}C	15^{0}C
Turbidity in N.T.U	< 1.0	< 1.0	< 1.0
Free Ammonia (as N) (mg/l)	< 0.02	< 0.2	< 0.2
BOD 5 days at 20^{0}C (mg/l)	3.0	3.2	< 2.0
Dissolved Oxygen (mg/l)	6.1	5.5	5.5
Electrical Conductivity in ms/cm	36.5	38.5	44
Boron as B in mg/l	< 0.5	< 0.5	< 0.5
Sodium Absorption Ratio	1.27	1.77	1.73
Total Coliform Organisms (MPN/100 ml)	114	42	3

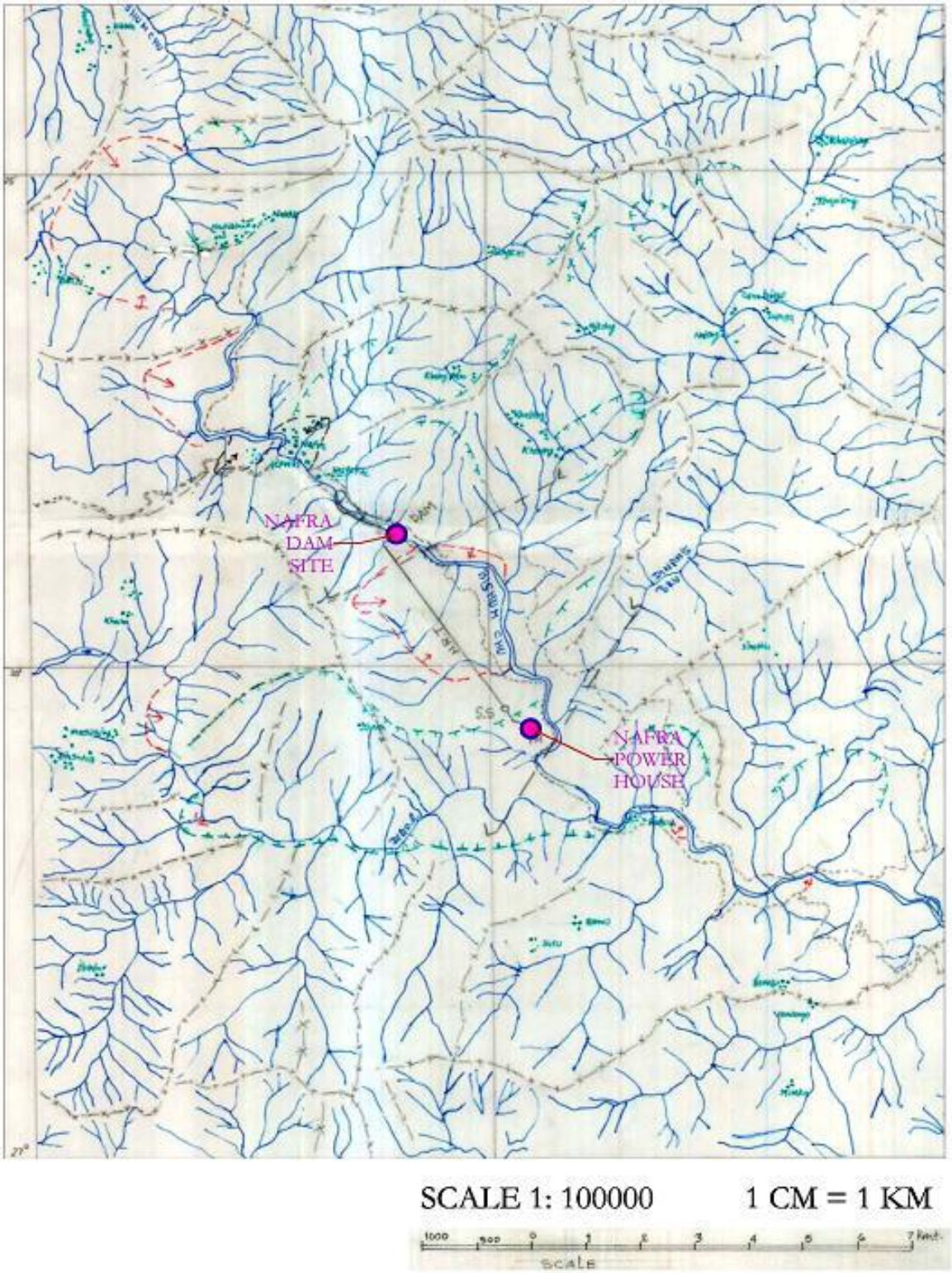
Source: *Surface Water Quality analysis report by Mitra S. K. Private Limited*

Location : Downstream of Dam site

Parameters	Monsoon	Post-monsoon	Winter
pH	6.46	7.09	6.92
Temperature	19 ^{0}C	15 ^{0}C	14^{0}C
Turbidity in N.T.U	<1.0	< 1.0	< 1.0
Free Ammonia (as N) (mg/l)	<0.02	< 0.2	< 0.2
BOD 5 days at 20^{0}C (mg/l)	3.0	3.0	< 2.0
Dissolved Oxygen (mg/l)	6.05	5.5	5.6
Electrical Conductivity in ms/cm	32	47	43.5
Boron as B in mg/l	0.70	< 0.5	< 0.5
Sodium Absorption Ratio	1.41	1.84	1.76
Total Coliform Organisms (MPN/100 ml)	285	15	20.5

Source: *Surface Water Quality analysis report by Mitra S. K. Private Limited*

Figure 3:14 Drainage Map of the Study Area Generated from IRS-P6, LISS-III, 30 Mar-2007



Since the river is fast flowing devoid of industrial pollutants and chemicals and enriched with aquatic vegetation (algae etc), the water bears a good concentration (mg/l) of dissolved oxygen (5.5-6.2). The biological oxygen demand (BOD mg/l) of the water recorded from < 2 to 4.5, the pH concentration of river water varies form 6.43 to 7.11. The concentration of free ammonia has been recorded <0.02 ppm and total Coliform (MPN / 100 ml) was in the range of <2 to 500.

It is revealed from the data that the E. coli and total Coliform increases in the river water as the slope wash gets carried away from the entire catchment during Monsoon period. The upper catchment area of Bichom and its tributaries hosts a number of villages, from where organic waste is discharged into the river. Due to temperatures and other associated factors the propagation of faecal Coliform gets activated during Monsoon season.

The overall result recommended the water quality of study area being in the range of B and C classes of water and is hence recommended for outdoor bathing and to be used for drinking water after conventional treatment and disinfection.

3.2.1.15 Drinking Water Quality

Drinking water samples were collected from Nafra village for monitoring of drinking water quality during Monsoon, Post-monsoon and Winter seasons. The analytical results of drinking water quality are given in **Table 3.11**. Photograph of water sampling is enclosed in ***Annexure V***.

Table 3:10 Drinking Water Quality

Parameters	Monsoon	Post-monsoon	Winter	Norms as per IS: 10500-1991	
				Desirable Limit	Permissible Limit
Temperature (at the time of sampling)	20.5 ^{0}C	18.5 ^{0}C	15.5 ^{0}C	--	--
Odour	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable
Taste	--	--	--	--	--
Turbidity in N.T.U	1.2	2.7	3.0	5	10
pH (at 25 ^{0}C)	7.05	7.62	7.47	6.5 – 8.5	No Relaxation
Alkalinity in mg/l	29.65	36.23	44.0	200	600
Total Hardness as $CaCO_3$ (mg/l)	40.4	24.25	38.0	300	600
Sodium as Na in mg/l	5.44	9.78	6.58	--	--
Iron as Fe in mg/l	0.55	0.95	0.21	0.3	1
Total Dissolved Solid (TDS) in mg/l	85.0	46.0	79.0	500	2000
Total Solid (TS) in mg/l	91.65	75.5	78.5	--	--
Total Suspended Solid (TSS) in mg/l	7.4	29.5	< 2.5	--	--
Calcium as Ca in mg/l	16.16	5.24	8.6	75	200
Potassium as K in mg/l	2.12	1.78	1.97	--	--
Magnesium as Mg in mg/l	5.82	3.0	3.96	30	100
Sulphate as SO_4- in mg/l	< 4.0	< 4.0	< 4.0	200	400

Parameters	Monsoon	Post-monsoon	Winter	Norms as per IS: 10500-1991	
				Desirable Limit	Permissible Limit
Sulphate as SO_3^{-2} in mg/l	Nil	Nil	Nil	--	--
Phosphate as PO_4^{-3} in mg/l	0.22	0.5	0.17	--	--
Nitrate as NO_3 in mg/l	0.54	< 0.4	0.3 5	45	100
Ammoniacal Nitrogen as N in mg/l	0.02	0.81	< 0.02	--	--
Fluoride as F in mg/l	0.11	< 0.1	< 0.1	1	1.5
Chloride as Cl in mg/l	6.95	4.23	4.22	250	1000
BOD 5 days at 20^0C	< 2.0	4.2	< 2.0	--	--
Dissolved Oxygen Demand (mg/l)	5.5	4.9	5.75	--	--
Chemical Oxygen Demand (mg/l)	17.85	15.6	< 4.0	--	--
Oil and Grease (mg/l)	< 1.4	< 1.4	< 1.4	--	--
Lead as pb in mg/l	< 0.05	< 0.05	< 0.05	0.05	No Relaxation
Electrical Conductivity ms/cm at 28^0C	90.5	97	84	--	--
Total Coliform Organisms (MPN/100 ml)	80	90	33.5	Not more than 10 organisms / 100 ml	--
Faecal Coliform Organisms (MPN/100 ml)	Present	Present	Absent	Absent	--

Source: *Water Quality analysis report by Mitra S. K. Private Limited*

The water quality as observed from the above results is acceptable and within the desirable limit as per IS: 10500 drinking water standards. However, biological parameter analysis of the water samples shows the presence of Total Coliform MPN/100ml and Faecal Coliform/100ml more than the recommended limit. Low level of total dissolved solids (TDS), cations like manganese (Mn++), Iron (Fe3+), organic and inorganic phosphates (PO_4^{3+}), lead (Pb++) and anions such as sulphates (SO_4--), cloride (Cl-), etc. indicate that the water in general is good in quality. At present local communities are using the water for drinking purpose with conventional treatment.

3.2.1.16 Ground Water Quality

No ground water usage has been observed in the area during reconnaissance survey followed by primary field visits; hence ground water quality analysis was not done.

3.2.1.17 Ambient Air Quality

An extensive study of air parameters around the project area was carried out during three seasons (Monsoon, Post-monsoon and Winter) at 3 locations. The baseline data on following parameters was collected:

- Suspended Particulate Matter (SPM)

- Respirable Suspended Particulate Matter (RSPM)
- Sulphur dioxide (SO_2)
- Oxides of Nitrogen (NOx)
- Carbon Monoxide (CO)

The monitoring results for all the three seasons are tabulated in the **Table 3.12** and field photographs are given in ***Annexure V***.

Table 3:11 Ambient Air Quality monitoring (Unit: μg/m3)

Location: NafraVillage **Category: Residential**

Parameters	Monsoon	Post-monsoon	Winter	Permissible limits as per CPCB
SPM	67.25	99.5	118.5	200
RSPM	29.25	43.75	60.5	100
SO_2	4.50	4.75	4.50	80
NOx	27.25	33.25	47.25	80
CO	ND	ND	ND	2000

Location: Khellong Village **Category: Residential**

Parameters	Monsoon	Post-monsoon	Winter	Permissible limits as per CPCB
SPM	45	64.5	79.75	200
RSPM	17.5	29	39.25	100
SO_2	4	4	4	80
NOx	21	26.25	36.25	80
CO	ND	ND	ND	2000

Location: Lower Jung Village **Category: Residential**

Parameters	Monsoon	Post-monsoon	Winter	Permissible limits as per CPCB
SPM	53.5	79.75	110	200
RSPM	22.5	36.75	54.5	100
SO_2	4.25	4.25	4.5	80
NOx	25.75	31.25	40.75	80
CO	ND	ND	ND	2000

Source: *Ambient Air Quality monitoring report by Mitra S. K. Private Limited*

The results of ambient air quality in the study area are within the permissible limits as prescribed by CPCB standards. During monsson season the Suspended particulate matter (SPM) and Respirable Particulate matter (RPM) concentration in the study area varies from 45 to 67 μg/m^3 and 18 to 23 μg/m^3 respectively. The concentration of SO_2 and NO_X varies from 4 to 5 μg/m^3 and 21 to 27 μg/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-monsson season the Suspended particulate matter (SPM) and Respirable Particulate matter (RPM) concentration in the study area varies from 65 to 100 µg/m^3 and 29 to 44 µg/m^3 respectively. The concentration of SO_2 and NO_X varies from 4 to 5 µg/m^3 and 26 to 33 µg/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 µg/m^3 and 39 to 61 µg/m^3 respectively. The concentration of SO_2 and NO_X varies from 4 to 5 µg/m^3 and 36 to 47 µg/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. CO & HC in Ambient Air are determined by Gas Chromatography Method. Detection limit of CO is 1250 ug/m^3 and HC as CH4 is 714 ug/m^3. The other gases in the atmosphere are also within safe limits. There is no dust producing sources except vehicular traffic which is also very small.

Based on the findings of the ambient air quality it can be concluded that the ambient air quality is quite good in the project area and are well within the permissible limits as prescribed by CPCB. The absence of major air pollution sources is responsible for the good ambient air quality in the project as well as study area.

3.2.1.18 Noise Environment

Ambient noise level was monitored at various locations in the study area during Monsoon, Post-monsoon and Winter seasons. The day and night noise levels was monitored at each location using sound pressure level meter SL-4010 and mean noise level has been calculated. The equivalent noise levels at various sampling stations are given in **Table 3.15**. The noise standards for various categories are given in **Table 3.16**. Ambient Noise Monitoring photographs are provided in ***Annexure V***.

Table 3:12 Equivalent Noise Level of the study area

Location: NafraVillage **Area : Commercial**

Date	Monsoon	Post-monsoon	Winter	Permissible limits as per CPCB
Leq day dB(A)	53	56	59	65
Leq Night dB(A)	50	50	49	55
Mean Noise Level dB(A)	52	53	54	--

Location: Khellong Village **Area : Residential**

Date	Monsoon	Post-monsoon	Winter	Permissible limits as per CPCB
Leq day dB(A)	42	44	45	55
Leq Night dB(A)	43	44	41	45
Mean Noise Level dB(A)	43	44	43	--

Location: Lower Jung Village **Area : Residential**

Date	Monsoon	Post-monsoon	Winter	Permissible limits as per CPCB

Leq day dB(A)	50	54	53	55
Leq Night dB(A)	51	51	46	45
Mean Noise Level dB(A)	51	53	50	--

Source: *Ambient Noise Level Monitoring Report by Mitra S. K. Private Limited*

Note: ***Day time*** *(6 AM and 10 PM) and* ***Night time*** *(10 PM and 6 AM)*

Ambient noise level monitoring results show that Leq (day) and Leq (night) is under the desired limit (specified by CPCB) at all the project locations during all the three seasons. During monsoon season Ldeq varies from 42 to 53 dB(A) and Lneq 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 label in night is because of noise created by the insects appearing during monsoon season.

During post monsoon season Ldeq varies from 44 to 56 dB(A) and Lneq 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 Ldeq varies from 45 to 59 dB(A) and Lneq varies from 41 to 49 dB(A). The maximum concentration was found in the Nafra Town followed by Lower jung and Khellong Village.

3.2.2 Biological Aspects

Situated on the North-Eastern tip of the country, the state of Arunachal Pradesh is a part of Eastern Himalayan Ranges. It occupies the largest area in the North-Eastern region of India, and consists of mountainous ranges sloping to the plains of Assam. Arunachal falls within the Himalayan global biodiversity hotspots (Mayers, 2000)[12] and is also among the 200 globally important eco-regions[13]. It harbours the world's Northern-most tropical rainforest and is estimated to contain nearly 50% of the total flowering plant species in India (Rao and Hajra, 1986)[14]. The diversity of topographical and climatic condition has favoured the growth of luxuriant forests, which are home to countless plant and animal forms. A unique feature of the state is that it still has an undisturbed virgin area both within and outside the protected area network. For 20 major tribes in Arunachal Pradesh the forests and wildlife have a special significance. Out of these 20 major tribes 5 live in West Kameng district.

Arunachal has a wide altitudinal range varying from 100m to 7,090m (amsl). There are nine wildlife reserves covering total area of 9,246 km^2. It largely covers the low and mid elevation forests. This is despite the fact that 23% of Arunachal lies above 3,000m. Only small parts of some of the existing reserves extend into the high altitude zone. Ecological studies and wildlife surveys have been largely confined to low and mid elevation forests and most of the high altitude fauna of the state are yet to be explored through studies.

[12] Norman Mayers, Russell, A.Mittermeier Christina, G, Mittermeier, Gustava,A.B. Da-Fonseca and Jennifer Cent . 2000." Biodiversity hotspot conservation priority . Nature Vol.403,p 853-858

[13] Olson, D. and Dinerstein, E. (1998) The Global 200: a representation approach to conserving the earth's most biologically valuable ecoregions. Conserv. Biol. 12: 502–515.

[14] Rao, R.R. and P. K. Hajra, (1986) Florestic diversity of Eastern Himalaya in a conservation prespective. Proc. Indian Acad. Sci. (Anim./Plant .sci) Suppl.(Nov) 103-125

The existence of the Sessa-Eagal Nest landscape in West Kameng is out of the study area. Sessa Orchid Sanctuary falls between 27^0 3 -27^0 11 N and 92^0 23.4 - 92^0 36 E. Its original area of about 85 hectares was subsequently extended to over 100 sq. km so as to provide natural habitat for a greater number of orchids. Apart from that, it is home for some wild animals including birds like Red Panda, Pheasant, Serrow, Goral etc.

There are more than 220 species of mammals and more than 500 species of birds recorded in the state.At present, in the project area there is no sighting of the wild mammals except some domestic animals, birds, reptiles and butterflies. Secondary literatures indicate 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.

The study area is thinly populated. Local villagers in the nearby areas practice hunting, their chief hunts being various species of mammals and birds. They travel to different sites and forest locations as far as 20 km for hunting a wild animal. Moreover, they are given gun permits to defend them from the attack of wild animals. As per tradition, they often keep the skull or other body parts of the hunted wildlife as a decorative piece in their house.

3.2.2.1 Terrestrial Ecology

Wide altitudinal variations, network of streams and rivers, unique geo-morphological characteristics, meso-thermal (moderate temperature), muggy (high humidity) winter dry (no or very less rainfall during winter) climatic condition has made this state unique in terms of biodiversity and ethnic diversity. This makes “the terrestrial ecology” an important aspect for understanding the existing ecological setup and thereby assessing prospective impacts of this HEP.

Arunachal Pradesh has Indo-Chinese, Indo-Malayan, Tibetan elements, apart from Indian elements in plants and animals species. The existence of 24 species of primitive plants, recorded in the state like Alnus nepalensis, Betula alnoides, Euptelea pleiosperma, Magnolia griffithii, Magnolia hodgsonii, Parvatia brunoniana, etc. indicates the evolutionary aspects of plants in the region. Floral diversity of Arunachal Pradesh and distribution of selected medicinal plants are provided in **Figure 3.15** and **3.16** respectively.

3.2.2.1.1 Vegetation

The phyto-geographic position, irregular and undulating topography with lofty hill ranges and deep valleys accompanied by wide variation in climate and soil have resulted in the formation of varied ecological diversity which has influenced the rich vegetation of the state of Arunachal Pradesh.

Forests are the mainstay for the people of Arunachal Pradesh and are the richest bio-geographical province in Eastern Himalayan zone. The richness is vividly indicated due to the presence of around 4117 angiosperms (1295 genera and 192 families) in the state. There are around 238 endemic taxa. Apart from that there are 452 species of pteridophytes, 23 species of conifers, 35 species of bamboos, 20 species of canes, 52 Rhododendron species and more than 545 species of orchids has been recorded from the state, and is considered as one of the Himalayan biodiversity “Hot Spots”. The forests are resource rich and the sources for various timber and non-timber forest products like bamboo, cane, medicinal plants, orchids, thatch, broom grass, resin etc. Thus, forests generate the largest employment and constitute the single largest source of revenue for the State.

The field survey for the ecological study has been conducted seasonally during the year 2008 and 2009. Survey has been carried out on both banks of Bichom, including the areas of inundation due to dam construction.

A. Types of Forest

Based on altitude, rainfall and dominant species composition, vegetation of the study area can be broadly classified as Tropical Evergreen forest with an altitudinal variation up to 900m and Subtropical Forests with an altitudinal variation from 900m to 1800m. (Champion and Seth, 1968)[15]

i. Tropical Evergreen forest

The tropical evergreen forest extends up to 900m in the areas of Arunachal Pradesh receiving maximum rainfall. The top canopy or the upper storey in these forests mainly consists of tall trees. Some of the commonly occurring species are *Agalaia hiernii, Atlingia excelsa, Artocarpus chama, Bischofia javanica, Bombax ceiba, Callicarpa arborea, Castanopsis indica, Dillenia indica, Dipterocarpus retusus, Duabanga grandiflora, Dysoxylum gobara, Echinocarpus assamica, Magnolia campbelli, Mesua assamica, Quercus griffithii, Shorea asamica, Shorea robusta, Terminalia chebula* etc.

[15] Champion, H.G and S.K. Seth, 1968, A revised survey of the forest types of India. Govt. of India Press, Nashik

Figure 3:15 Floral Diversity of Arunachal Pradesh

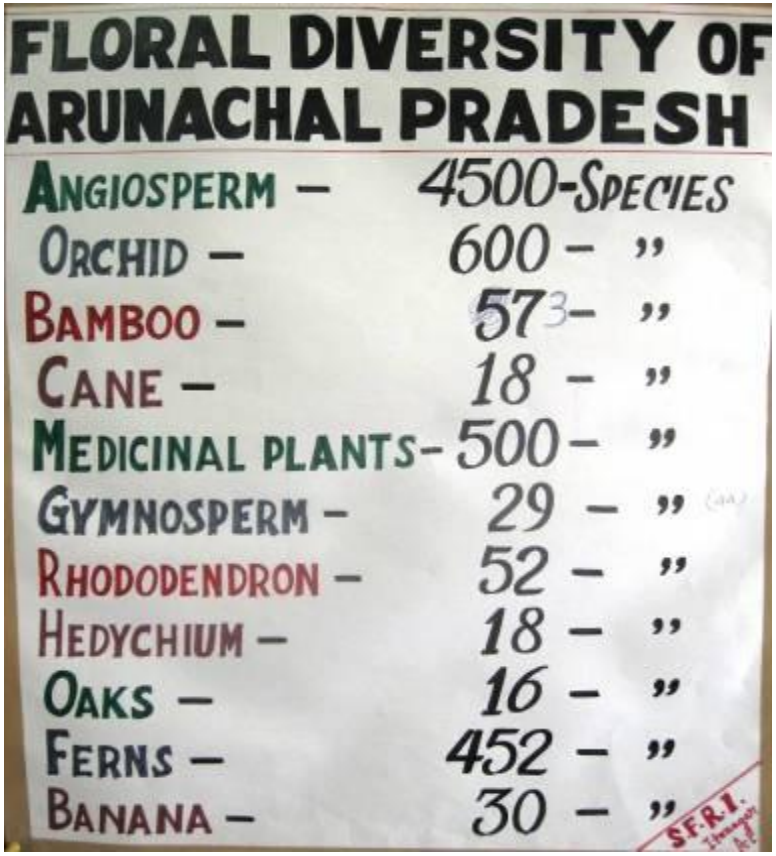


Figure 3:16 Distribution of Selected Medicinal Plants

The next canopy is dominated by small trees and shrubs. Some of them area *Ardisia crispa, Bauhinia purpurea, Baliospermum corymbiferum, Buddleja asiatica, Coffea benghalensis, Dendrocnide sinuata, Illicium manipurense, Leea robusta, Magnolia hodgsonii, Grewia disperma, Micromelum minutum, Oxysopra paniculata, Solanum torvum, Sambucus hookeri*. Cane like *Calamus erectus* and *Calamus leptospadix* occur in the swampy areas and form impenetrable thickets.

The forest is dominated by densely covered lianas and epiphytes. Some of the common lianas species are Acacia, Bauhinia, Derris, Entada, Gnetum, Hodgsonia, Mucuna, Piper, Thunbergia, Toddalia, Vitis etc. Several species of Calamus also stretch long distances from one tree to another. Some of the common epiphytic orchids are species of Aerides, Dendrobium, Cymbidium, Eria, Oberonia, Pholidata, and the epiphytic ferns belong to Asplenium, Nephrolepis, Drymoglossum, Colysiis etc.

The ground flora is dominated by herbaceous elements such as *Begonia roxburghii, Chirita oblongifolia, Commelina sp., Derringia amaranthoides, Floscopa scandens, Globba sp., Oxalis corniculata, Lobelia pyramidalis, Ploygonum sp.* etc.

The conspicuous rhizomatous monocotyledons forming a green belt at lower elevation along with bamboos are of *Amomum sp., Arisaema sp., Colocasia sp,.Curculigo capitulate, Curcuma sp., Curcumorpha longifolia, Hedychium sp., Homalomena aromatica, Musa rosacea, Phrynium rheedei, Zingiber sp.* etc.

ii. Subtropical Forests

The subtropical forest in the mid hill zone are rich in hardwood species like oaks and chestnuts, pine and number of medicinal plants, bamboo and orchid. Depending upon the species composition this vegetation type can be further divided into two subtypes – Subtropical Pine Forests and Subtropical Broadleaved Forests.

a) Subtropical Broadleaved Forests

The top canopy is dominated by species like *Cinnamomum bejolghota, Bielschmedia pseudomicropora, Engelhardtia spicata, Castanopsis indica, Euodia trichotoma, Quercus griffithii, Lithocarpus fenestrata, Magnolia caveana, Michelia doltsopa, Ostodes paniculata, Sterculia guttata,Ulmus lancifolia, Acer oblongum, Schima wallichii,* etc. On the Northern side of the valley *i.e.* with a southern aspect where the soil is calcareous and alkaline *Quercus griffithii* tends to be gregarious, as it seems to prefer a drier soil while on Northern aspects *Quercus griffithii* and *Quercus listerii* tend to form consociations on the more humid slopes. In valleys where the soil is same but moisture condition is little more *Populus* and *Alnus* flourish. This phenomenon may be due to the weather condition alone, and that the species found on the drier slopes are probably better adapted to such conditions while those in the valley require moisture and are not able to survive in arid situation.

In the next canopy layer small tree species like *Camelia caudata*, *Illicium griffithii, Eurya acuminata, Saurauia macrotricha, Prunus cerasoides, Rhododendron arboreum, Rhus hookeri, Albizia arunachalensis*, etc are the most common elements. Among the shrubs most commonly occurring species are *Berberis asiatica, B. dasyclada, Mahonia nepalensis, Capparis acutifolia, Hypericum griffithii, H. hookerianum, Hydrangea robusta, Zanthoxylum armatum, Z.*

acanthopodium, Z. oxyphyllum, Dobinea vulgaris, Senecio scandens, Elaeagnus pyriformis, Lyonia ovalifolia, Gaultheria fragrantissima, etc. Climbers like Fissistigma wallichii, Holboellia latifolia, Cucubalus baccifer, Actinidia callosa, Clematis buchananiana, C. connata, C. cadmia, C. grewiiflora, Rubia cordifolia, Crawfurdia speciosa, etc are found to occur commonly in this forest type.

Among the epiphytic flora ferns and orchids are the dominant groups along with some species of *Rhododendrons.* Some of the common species are *Rhododendron dalhousiae* var. *rhabdotum, Davallia griffithiana, Asplenium finlaysonianum, Arthromeris himalayense, Dendrobium densiflorum, D. wardianum, D. chrysanthum, Coelogyne nitida, C. punctulata, C. barbata, Arachnis clarkei, Bulbophyllum gutulatum, Cymbidium devonianum,* etc.

At the ground level herbaceous plants like *Corydalis leptocarpa, Dicentra scandens, Viola betonicifolia, Polygala cantoniensis, Hypericum elodeoides, Astilbe rivularis, Bergenia ciliata, Crassocephalum crepidiodes, Anthogonium gracile, Calanthe biloba are generally seen. On the damp and humus rich forest floors, orchids like Malaxis josephiana, Phaius flavus, P. mishmensis, Acanthephippium striatum,* etc. are of very common. Two interesting saprophytic orchids *Cymbidium macrorhyzon* and *Epipogium roseum* are also found to occur on the damp forest floor.

b) Subtropical Pine Forests

This particular forest type occurs between 1200-1800 m mainly in Selari-Nafra, Khellong, Tenga valley, Dirang valley, and Lama Camp area near Eagle Nest Wild Life Sanctuary. It is seen that the areas where rainfall is comparatively low, the physiographic factors play a vital role in influencing the vegetation type.

The Nafra valley area is comparatively drier and sandy, and constituted by well drained soil. *Pinus roxburghii or Pinus wallichiana* are seen either as pure patches or mixed, where 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 leaved 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, Poplus ciliata.*

Other floral species have been observed in the Pine forests are small trees like *Alnus nepalensis, Lyonia ovalifolia, Betula alnoides, Rhododendron arboreum, Quercus listerii,Q. griffithii, Photinia integrifolia, Rhus javanica* and *Populus ciliata.* In the next layer shrubby and herbaceous elements like *Coriaria nepalensis, Plectranthus japonicus, Elsholtzia pilosa, Desmodium concinnum, Indigofera exilis, Rubus ellipticus, R. calycinus, Luculia grandiflora,* etc. has been found as the most common species.

B. Legal Status

Administratively, the forest area is under jurisdiction of Bomdila Forest Division. The legal status of forests is Unclassified State Forest (USF)[16]. Though the State Government is the ultimate owner of these forests, these are neither surveyed nor demarcated and as such no detailed

[16] Unsurveyed forests where status and rights and ownerships are not settled are classified as unclassified state forest (USF).The USF is a very ambiguous word and there is no much departmental control on it.

record and maps are available with the Forest Department. The village community traditionally enjoys the rights of physical possession of forest land and removal of timber and forest produce, free of royalty for domestic use.

C. Floral Diversity

A number of scientists have worked on the various aspects of the flora of Arunachal Pradesh. One of the important scientific works on flora done by Choudhury *et al*. (1996)[17] of Botanical survey of India and (Kanjilal *et al)*[18] between 1943-40 in their pioneering work- Flora of Assam, covered a number of areas of Arunachal Pradesh

Major plants were identified in the study area during field visits those were economically and taxonomically important. Lists of plant species representing trees, shrubs and herbs are presented in the following **Tables 3.14 3.15, 3.16** Photographs of some of the reported plant species are provided as ***Annexure –VIII.***

Taxonomically important species

Albizia arunachalensis (Family: Fabaceae) species are considered as taxonomically important because these are endemic to Arunachal Pradesh.

Table 3:13 Plant Species Reported in the Study Area

Scientific name	Family	Phenology
Herbs		
Clematis connata DC.	Ranunculaceae	fl. and fr. June-Oct
Clematis connata	*Ranunculaceae*	fl. and fr. June-Oct
Ranunculus cantoniensis DC.	Ranunculaceae	fl. and fr. May-Sept.
Sida acuta Burm.	Malvaceae	fl. andfr. Sept.-May
Urena lobata L.	Malvaceae	fl.andfr. July-Jan
Kalanchoe pinnata (Lamarck) Persoon.	Crassulaceae	fl.andfr. March-May
Shrubs		
*Lyonia ovalifolia(*Wall.) Drude.	Ericaceae	fl. andfr. May-August
Gaultheria fragrantissima Wall.	Ericaceae	fl. andfr. March-June
*Oxyspora paniculata (*D.Don) DC.	Melastomaceae	fl.andfr. July-March
Cannabis sativa L.	Cannabaceae	fl. and fr. June-August
*Tolypanthus involucratus (*Roxb.) van Tieghem	Loranthaceae	fl.andfr. March-May
Rubus calycinus D.Don	Rosaceae	fl. andfr. April-May
Rubus ellipticus Smith.	Rosaceae	fl. andfr. Feb- April
Boehmeria penduliflora Long.	Urticaceae	fl. andfr. August-December
Cassia mimosoides L.	Fabaceae	fl. andfr.July-November.
Fleminga strobilifera (L.) Aiton.	Fabaceae	fl. andfr. February-March
*Woodfordia fruticosa (*L.) Kurz.	Lythraceae	fl. andfr. March-May
Trees		
Streblus asper Loureiro.	Moraceae	fl.andfr. March-April
Michelia dotsopa DC.	Magnoliaceae	fl. andfr. April- Nov.

[17] Choudhury H. J., Giri G. S., Pal G. D., Pramanik A., Das S. K. (eds : P. K. Hajra, D. M. Verma, G. S. Giri); Materials for the Flora of Arunachal Pradesh – Volume 1, (Ranunculaceae – Disacaceae). Botanical Survey of India, GoI, 1996

[18] Kanjilal U. N., P. C. Kanjilal and A. Das, 1934-1940; Flora of Assam

Scientific name	Family	Phenology
Magnolia caveana (Hook. f. and Thomson)	Magnoliaceae	fl. and fr. March-July
Castanopsis indica (Roxb.) A.DC.	Fagaceae	fl.andfr. September-May
Quercus griffithii Miquel.	Fagaceae	fl. andfr. April- June.
Ulmus lanceifolia Roxb.	Ulmaceae	fl. andfr..October-February
Engelhardia spicata Blume.	Juglandaceae	fl. and fr. April-May
Camellia kissi Wallich.	Theaceae	fl.andfr. Nov.-March
Eurya acuminata DC.	Theaceae	fl. andfr.sept.- Nov.
Rhododendron arboreum Smith.	Ericaceae	fl. andfr. March-May
Acer oblongum DC.	Aceraceae	fl. and fr.. March-April.
Saurauia nepalensis DC.	Actinidiaceae	fl. andfr. April-Sept.
Bombax ceiba L.	Bombacaceae	fl. andfr. Feb-June.
*Pterospermum acerifolium (*L.) Willdenow.	Sterculiaceae	fl. andfr.April-June.
Rhus javanica L.	Anacardiaceae	fl. andfr. May-March
Elaeagnus pyriformis Hook. F.	Elaeagnaceae	fl. andfr. Nov.- March
Zanthoxylum acanthopodium DC.	Rutaceae	fl. andfr. December-May
Zanthoxylum armatum DC.	Rutaceae	fl. andfr.April-October.
Desmodium concinnum DC.	Fabaceae	fl. and fr. Sept.-Nov.
Milletia pachycarpa Benth.	Fabaceae	fl. andfr. August-September
Bauhinia glauca Wallich ex. Benth	Fabaceae	fl.and fr. August-April.
Albizia arunachalensis Sahniand Nathani	Fabaceae	fl.andfr. October-May
Erythrina variegata L.	Fabaceae	fl. andfr. March-May
Emblica officinalis Gaertner.	Euphorbiaceae	fl. andfr. March-April
Pinus wallichiana A.B. Jackson.	Pinaceae	fl. andfr. April-May
Pinus roxburghii Sargent.	Pinaceae	fl. andfr. March-May
*Duabanga grandiflora (*Roxb.ex.DC) Walp.	Sonneratiaceae	fl. andfr. Feb.- Oct.

Table 3:14 Economically Important Species reported in the study area

Scientific Name	Family Name
Used as valuable timber	
Michelia dotsopa DC	Magnoliaceae
Quercus griffithii Miquel.	Fagaceae
*Duabanga grandiflora (*Roxb.ex.DC) Walp	Sonneratiaceae
Engelhardia spicata Blume	Juglandaceae
Camellia kissi Wallich	Theaceae
Streblus asper Loureiro	Moraceae
Erythrina 72ariegate L	Fabaceae
Pinus wallichiana A.B. Jackson	Pinaceae
Pinus roxburghii Sargent	Pinaceae
Fruits edible	
Rhus javanica L.	Anacardiaceae
Elaeagnus pyriformis Hook. F.	Elaeagnaceae
Rubus calycinus D.Don	Rosaceae
Castanopsis indica (Roxb.) A.DC.	Fagaceae
Rubus ellipticus Smith.	Rosaceae
Zanthoxylum acanthopodium DC.	Rutaceae

Scientific Name	Family Name
Zanthoxylum armatum DC.	Rutaceae
Emblica officinalis Gaertner.	Euphorbiaceae
Medicinal Plants	
Urena lobata L.	Malvaceae
Zanthoxylum acanthopodium DC.	Rutaceae
Zanthoxylum armatum DC.	Rutaceae
Emblica officinalis Gaertner.	Euphorbiaceae

Table 3:15 Plants used for Economic or other purpose at study area

Scientific Name	Family Name	Remarks
Engelhardia spicata Blume	Juglandaceae	Wood is of multiple use, bark used as fish intoxicant
Camellia kissi Wallich	Theaceae	It is a hard and strong Timber, used for axe and hoe handles and walking sticks.
*Lyonia ovalifolia (*Wall.) Drude	Ericaceae	Foliage used for poisoning cattles
Urena lobata L.	Malvaceae	Antidote for snake bite
Bombax ceiba L.	Bombacaceae	Wood used to make tea boxes and matches, bark produces a useful gum, cotton from capsule
*Pterospermum acerifolium (*L.) Willdenow.	Sterculiaceae	Flowers collected and used as a disinfectant and to purify bedclothes; wood sometimes used.
*Oxyspora paniculata (*D.Don) DC.	Melastomaceae	Bark is removed and raw stem in eaten; sweetish.
Cannabis sativa L.	Cannabaceae	Used as a source of fiber and oil and also for toxicating resin.
Streblus asper Loureiro.	Moraceae	Timber useful, fruits edible, twigs used as toothbrushes and leaves as sandpaper.
Boehmeria penduliflora Long.	Urticaceae	Fibre used to make rope and fishing lines.
Zanthoxylum armatum DC.	Rutaceae	Fruits are used as spices, bark and fruits are used in treatment of small pox.
Milletia pachycarpa Benth.	Fabaceae	Roots and pods are used as fish poison.
Erythrina variegata L.	Fabaceae	The wood though light is durable and used for making jars and boxes for household use.
Emblica officinalis Gaertner.	Euphorbiaceae	Fruits are edible, rich source of vitamin C. Bark used as tannin, wood durable in water.
*Woodfordia fruticosa (*L.) Kurz.	Lythraceae	An attractive ornamental flower. Dry flower yield a yellow dye used to dye silk and also used as medicine in Dysentery
Pinus roxburghii Sargent.	Pinaceae	Timber useful; trees traps to produce resin to produce turpentine

Relative frequency, relative density etc. for herbs, shrubs and trees and IVI for trees have been calculated by Quadrat method[19] and provided as ***Annexure IX.***

3.2.2.1.2 Fauna

The fauna of Arunachal Pradesh is rich with as many as 25 species of mammals is Schedule – I of the Wildlife (Protection) Act, 1972. The large herbivores of the foot-hills and adjoining plains are the elephant (*Elephas maximus*), gaur (*Bos gaurus*) and the wild buffalo (*Bubalus bufalis*) have been reported. This is the richest state for pheasants, with as many as ten species distributed in different altitudes from the plains to the snowy heights. The State also abounds in a variety of reptiles, amphibians, pisces and innumerable species of butterflies, moths, beetles and other insects[20].

The proposed project area is neither potential site for wildlife sanctuary nor offers migration route to any major animal species. 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.

Status of the Terrestrial Fauna

The project area is located very near to Nafra township. Both licensed and unlicensed fire-arms are available in large numbers to the villagers. The area of operation of the hunters both from the Nafra town and other nearby villages covers project area. Because of the comparative easy accessibility of the hunters the wild animals particularly the mammals have been eliminated from the project area and surroundings.

The terrestrial fauna covers a wide variety of the taxa from vertebrates and invertebrates. In the present context mammals, aves, amphibia and reptiles have been assessed from vertebrates and insects from invertebrates. The butterflies act as environmental indicator as well as pollinators.

Information about the fauna has been collected based on primary survey and secondary information gathered from Department of Forests, Zoological Survey of India, other scientific publications and from villagers. The primary survey has been conducted during the 2008-2009.

1. Mammals

Most of the referred mammalian fauna are scarce and cannot be sighted during day time. According to the local people, hunting pressure is very high around the project location. 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 mammalian fauna in the project site might have been rich, as the past record indicates with a number of threatened species.

Some of the important mammalian fauna which have been reported (Mishra *et al*.2006)[21] from West Kameng are given in **Table 3.17.**

[19] The most common quantitative sampling methods are the quadrat method, which allows the user to define a fixed area, called a plot, within which plant characters can be measured. Usually, a rectangular quadrat frame is used to define the sampling area.

[20] *Source : arunachalpradesh.nic.in/wildlife.htm*

[21] Charudutt Mishra, M.D. Madhusudan and Aparajita Datta, 2006. Mammals of the high altitudes of western Arunachal Pradesh, Eastern Himalaya : an assessment of threats and conservation needs; Oryx, Vol. 40 No. 1, Page 1 – 7

Table 3:16 Mammalian fauna of West Kameng district

Scientific Name	Common Name	Family	Status (IUCN/ WLPA)
Primates			
Macaca munzala	Arunachal macaque	Cercopithecidae	NE
Macaca assamensis	Assamese macaque	Cercopithecidae	VU/ Sch - II
Macaca mulatta	Rhesus macaque	Cercopithecidae	--
Trachypithecus pileatus	Capped langur	Cercopithecidae	EN
*Macaca thibetana**	Chinese stump-tailed macaque	Cercopithecidae	NE
Ungulates			
Muntiacus muntjak	Barking deer	Cervidae	Sch-I
Pseudois nayaur	Bharal	Bovidae	Sch-I
Nemorhaedus goral	Himalayan goral	Bovidae	LR : nt
Nemorhaedus baileyi	Red goral	Bovidae	VU
Bos gaurus	Gaur, Indian 'Bison'	Bovidae	--
Moschus chrysogaster	Musk deer	Moschidae	LR : nt
Cervus unicolor	Sambar	Cervidae	Sch - III
Capricornis sumatraensis	Serow	Bovidae	VU/ Sch - I
Budoreas taxicolor	Takin	Bovidae	--
Sus serofa	Wild pig	Suidae	VU/ Sch - III
Carnivorous			
Neofelis nebulosa	Clouded leopard	Felidae	VU / Sch-I
Panthera pardus	Common leopards	Felidae	--
Cuon alprinus	Wild dog	Canidae	VU/ Sch - II
Ursus thibetanus	Himalayan black bear	Ursidae	EN/
Felis marmorata	Marbled cat	Felidae	VU
Felis bengalensis	Leopard Cat	Felidae	Sch - I
Felis Chans	Jungle Cat	Felidae	_
Ailurus fulgens	Red panda	Ailusridae	EN
Martes flavigula	Yellow-throat marten	Mustelidae	--
Rodents			
Tamiops macclellandi	Himalayan striped squirrel	Sciuridae	DD
Patanrista pataurista	Flying squirrel		--
Dremomys lokriah	Orange bellied himalayan squirrel	Sciuridae	DD
Necogale elegens	Water shrew	Soricidae	VU
Rattus sikkiminsis	Sikkim rat	Muridae	DD
Langomorphs			
Ochotona mocrolis	Large eared pika	Ochotonidae	DD
Ochotona lhibetana	Moupinpika	Ochotonidae	DD
Pholidata			
Manis pentadactyla	Chinese pangolin	Manidae	LR : nt
Chiroptera (Bats)			

Scientific Name	Common Name	Family	Status (IUCN/ WLPA)
Taphozous nudiventris	Nacked ballied tomb bat	Emballonuridae	LR: nt
Myotis siligorensis	Whiskered bat	Vespertilinidae	LR
Myotis mystacinus	Whiskered bat	Vespertilinidae	LR
Tylonycteris pachypus	Bamboo bat, uncommon flat headed bat, club footed bat	Vespertilinidae	LR: nt
Pipistrellus dormeri	Dormer's bat	Vespertilinidae	LR: nt
Murina leucogaster	Greater tube-nosed bat, white bellied tube-nosed bat	Vespertilinidae	DD
Murina huttonii	Huttons tube-nosed bat	Vespertilinidae	DD
Murina cyclotis	Orange tube-nosed bat, round ear tube-nosed bat	Vespertilinidae	DD
Pipistrellus peguensis	Pegupipistrelle	Vespertilinidae	DD

NE = Not Evaluated; VU = Vulnerable; EN = Endanger; DD=: Data Deficient; LR: nt : Least Risk

Note : *IUCN - International Union of Conservation of Nature and Natural Reserves*

WLPA – Wild Life (Protection) Act

After the initial establishment of the human habitation in and around the location, the prime source of protein must have been the mammals. Some animal parts are also being used for medicinal purpose. A number of houses, in the townships and village areas had displayed mammalian skull and other parts of wildlife as trophies. There is almost no selection or preference in terms of protein from the wild and thus all species from the range has been wiped out. This adverse anthropogenic pressure, in and around the project sites, has restricted the present distribution, both large and small mammals to the protected areas (Sanctuaries and National Parks) only.

During the field visit, some domestic animals like methun (also semi-domesticated), dog, cat, goat, poney and pigs were recorded from the study area.

Table 3:17 Mammalian fauna reported in the study area

Scientific Name	Common Name	Family	Status (IUCN/ WLPA)
Primates			
Macaca assamensis	Assamese macaque	Cercopithecidae	VU/ Sch – II
Ungulates			
Sus serofa	Wild pig	Suidae	VU/ Sch – III
Rodents			
Rattus sikkiminsis	Sikkim rat	Muridae	DD
Chiroptera (Bats)			
Myotis siligorensis	Whiskered bat	Vespertilinidae	LR

VU = Vulnerable; DD=: Data Deficient; LR: nt : Least Risk

Note : *IUCN - International Union of Conservation of Nature and Natural Reserves*
WLPA – Wild Life (Protection) Act

2. *Birds*

West Kameng district of Arunachal Pradesh is rich in avifauna. There was some general faunal survey in the area that covered avifauna also (Athrey 2006)[22]. The habitat condition for the large sized avifauna is nonexistent, where as only the habitats of small birds exist.

Table 3:18 Bird species recorded in the study area

Scientific Name	Common Name	Family Name	RDB Status
Motacilla alba	White wagtail	Motacillidae	Migratory
Motacilla cinerea	Grey wagtail	Motacillidae	Migratory
Passer domesticus	House sparrow	Ploceidae	LC
Passer montanus	Tree sparrow	Ploceidae	LC
Vanellus indicus	Red wattled lapwing (river side)	Charadriiae	Local Migrant
Corvus macrorynchos	Jungle crow	Corvidae	LC
Copsychus saularis	Mackpie robin	Muscicapidae	LC
Parus hypermelas	Great tit	Paridae	LC
Aegithalos concinnus	Red headed tit	Aegithalidae	LC
Parus monticolus	Green back tit	Paridae	LC
Melanochlra sultanea	Sultan tit	Paridae	--
Megalaima virens	Great Hill barbet	Megalaimidae	LC
Gracula religiosa (?)	Hill mayna	sturnidae	--
Megalaima asiatica	Blue thtoated barbet	Megalaimidae	LC
Coracina melaschistos	Smaller Grey shrike	Corvidae	LC
Pericrocotus flammeus	Scarlet minivet	Corvidae	--
Chloropsis cochinchinensis	Orange billed chloropsis	Irenidae	LC
Pycnonotus cafer	Red vented bulbul	Pycnonotidae	LC
Criniger flaveolus	White throated bulbul	Pycnonotidae	--
Yuhina bakeri	white napped yuhina	Sylviidae	LC
Yuhina occipitalis	Rufous vented yuhina	Sylviidae	LC
Yuhina flavicollis	Yellow neped yuhina	Sylviidae	LC
Yuhina nigrimenta	Black chinned yuhina	Sylviidae	LC
Stachyris chrysaea	Golden headed babbler	Sylviidae	LC
Alcippe cinerea	Yellow throated tit bubbler	Sylviidae	LC

Note : *RDB – Red Data Book*

The avifauna of Arunachal Pradesh is very rich with more than 500 species (Singh, 1999; Pawer and Birand, 2001)[23]. The project area is located in a depression with general ecology and habitat condition being dominated by the pine forest in the hills and the hill streams. The dominant tree species, particularly the pine is not suitable for colonization of any residential

[22] Athrey. R , 2006; Eaglenest biodiversity project (2003-2006): conservation resources of eaglenest wildlife sanctuary, Kaati Trust.

[23] Singh. P 1999; "Bird survey in selected localities of Arunachal Pradesh, India, Wildlife Institute of India. Dehradun Power S and Birand. A 2001; A survey of Amphibian, Reptiles and birds of North east India.CERC Technical report 6. Centre for ecological research and conservation. Mysore. Pp 118

avifaunal community, as it does not support the habitat requirement for nesting, as well as feeding niche for avifauna.

The location is largely being used by the frugivore and insectivorous birds during fruiting seasons only. The sightings of the bird do not necessary mean the residential status of the species. Moreover, there is not a single species which can be termed as having a very narrow range of distribution, restricted to only the project site. Moreover, the project location has not been under IBA (Important Bird Area) - Islam and Rahamani, 2004[24]. Therefore, it is expected that no species of bird or its habitat will be adversely affected.

3. Amphibia

There were some records of amphibian from ZSI (Zoological Survey of India)[25], SFRI (State Forest Research Institute) and publication from other scientists (Bordoloi and Borah, 2001)[26], (Ahmed et al. 2009)[27]. But these were not extensive and only opportunistic distributional records were mentioned. Apart from that there was no study of biology or ecology of any of them, which could have given the specific habitat requirement of a species.

On the basis of the range, and altitudinal distribution, following species might be distributed in the area but not necessarily on the specific project location. Hence, any adverse affect on the species is not anticipated.

Table 3:19 Amphibia of the study area

Scientific Name	Common Name	Family	Status
Duttaphrynus melanostictus	Common Asian toad	Bufonidae	LC
Duttaphrynus himalayana	Himalayan toad	Bufonidae	RT range, but com
Amolops afghanus	Mountain stream frog	Ranidae	VU
Euphylyctis cyanophlyctis	Indian skipping frog	Dicroglossidae	Com LC
Hoplobatrachus tigerinus	Indian bull frog	Dicroglossidae	LC
Fejervarya limnocharis	Indian cricket frog	Dicroglossidae	LC
Polypedates leucomystax	Six line tree frog	Rachophoridae	LC
Polypedates himalayana	Himalayan tree frog	Rachophoridae	LC
Rhacophorus maximus	Large tree frog	Rachophoridae	VU

LC= Least concern; Rt range: Resticted range; VU = Vulnarable

The amphibian species recorded during field study are presented in table 3.21 below.

[24] Islam, M.Z. and Rahamani, A. R, 2004; Important bird areas of India; Priority sites for conservation, Indian Bird Conservation network: Bombay Natural History Society and Birdlife International (UK). *Pp.xviii+1133)*

[25] Fauna of Arunachal Pradesh, State Fauna Series 13, Part – 1 and Part - 2, Zoological Survey of India, 2006

[26] Bordoloi Sabitri and M. Borah 2001; "A study of the Amphibian fauna of Arunachal Pradesh, India". page;114-116 in Arunachal forest News: Biodiversity special 2001. Vol.19. No.1 and2

[27] Ahmed, M.F., A.Das and S. K. Dutta 2009; Amphibian and Reptiles of North East India-Photographic guide. Aaryanak, Guwahati, Assam

Table 3:20 Amphibia recorded in the study area

Scientific Name	Common Name	Family	Status
Euphylyctis cyanophlyctis	Indian skipping frog	Dicroglossidae	Com LC
Fejervarya limnocharis	Indian cricket frog	Dicroglossidae	LC
Polypedates leucomystax	Six line tree frog	Rachophoridae	LC
Tadpoles		--	--

LC= Least concern

4. Reptiles

The reptilian species covering snakes, lizards, skinks etc. are expected to be rich in the project site and in the whole of the districts. More over the community do not normally hunt them for protein purpose.

Power and Birand (2001)[28] recorded a number of reptilian species of Arunachal Pradesh. But the detailed work of Borang and Bhatt (2001)[29] listed 113 species of reptiles in Arunachal Pradesh covering crocodiles, tortoises and turtles, lizards and snakes, skinks etc. Majority of the species are not listed as threatened species .Those listed is only in *Schedule –IV* of the Wildlife Protection Act. Among the turtles and tortoise, few species fall under *schedule- I.*

There are no detailed survey records of the reptilian fauna of the project area. But the survey conducted by (Ahmed et al. 2009) offer some information. Hence, majority of the species will fall under data deficient category. The species that are recorded from the study area are also available in the whole of the districts and hence, the project is not expected to have serious impact on the population of any of the species mentioned in **Table 3.22.**

Table 3:21 Reptiles of the study area

Scientific Name	Common Name	Family	Status
Lizard			
Hemidactylus frenatus	Asian House Gecko	Gekkonidae	LC
Mictopholis austeniana	Arunachal Lizard	Agamidae	Not listed
Japalura tricarinata	Three-crested japalura	Agamidae	Not listed
Japalura variegate	Variegated mountain lizard	Agamidae	Not listed
Snake			
Elaphe cantoris	Darjeeling trinket snake	Colubridae	Sche-IV
Elaphe mandarina	Mandarina ratsnake		Sche-IV
Xenochropis piscator	Checkered Keelback	Colubridae	Sche-II
Amphiesma platyceps	Himalayan Keelback	Colubridae	Sche-iv
Boiga ochraceus	Tawny Cat Snake	Colubridae	
Viridovipera cf. yunnanensis		Viperidae	DD
Ophiophagus Hannah	King Cobra, Hamadryad	Elapidae	Sche-II

[28] Power S and Birand. A 2001; A survey of Amphibian, Reptiles and birds of North east India.CERC Technical report 6. Centre for ecological research and conservation. Mysore. Pp 118

[29] Borang A and B. B. Bhatt, 2001; Checklist f the reptiles of Arunachal Pradesh, page: 132 -148 in Arunachal forest News: Biodiversity special 2001. Vol.19. No.1 and 2

Scientific Name	Common Name	Family	Status
Skinks			
Mabaya dissimilis	Striped olive sunskink	Scincidae	Not listed
Sphenomorphus maculatus	Streamside forest skink	Scincidae	Not listed
Sphenomorphus indicum	Large forest skink	Scincidae	LC

LC = Least Concern; DD = Data Deficient

During the field study in the study area and in Bichom, neither any turtle/ tortoise were sighted nor past record indicate their presence. Moreover, there is no site specific or narrow range endemic species in reptiles in West Kameng. Hence, no species is restricted due to its very specialized habitat quality and restricted only to the project site.

Table 3:22 Reptiles reported in the study area

Scientific Name	Common Name	Family	Status
Lizard			
Mictopholis austeniana	Arunachal Lizard	Agamidae	Not listed
Japalura variegate	Variegated mountain lizard	Agamidae	Not listed
Snake			
Elaphe mandarina	Mandarina ratsnake		Sche-IV
Viridovipera cf. yunnanensis		Viperidae	DD
Ophiophagus Hannah	King Cobra, Hamadryad	Elapidae	Sche-II

DD = Data Deficient

5. Insects

In the hotspot of biodiversity like West Kameng covering the study area is expected to have a large number of insects' species apart from Achanids and Crustaceans. The class Insecta represents 36 orders. All the orders cannot be assessed. Out of these orders, Lepidoptera (butterflies & moths) is important because of its color diversity, pollinating characteristics and acting as environmental health indicators. Hence this specific group of Insects has been assessed in the present study. Other insects sighted in the study area are short and long horn grasshopper, mantis, a number of beetles (Coleoptera), stoneflies, demselflies, draggonflies (Neuroptera and Odonata), few species of diptera (flies) and few species of ants (Isoptera).

Majority of the butterflies can be found during flowering season, i.e. after winter, as they are mainly dependent on flowering species. The common species have been noticed in the study area during field visit are given in **Table 3.24**.

Table 3:23 Butterflies reported in the study area

Scientific Name	Common Name	Family Name
Atrophaneura polyeuctus	Common windmill	*Papilionidae*
Eurema sani	Chocolate Grass yellow	*Hesperiidae*
Copora nadina	Lesser gull	*Pieridae*
Parantica melaneus	Chocolate tiger	*Nymphalidae*
Poritia hewitsoni	Common gem	*Lycaenidae*
Rapala pheretima	Copper flesh	*Nymphalidae*
Hypolycaena erylus	Common tit	*Lycaenidae*

Scientific Name	Common Name	Family Name
Symbrenthia hypselis	Himalayan jester	*Nymphalidae*
Spindasis lohita	Long banded silver line	*Lycaenidae*
Bhagadatta austenia	Grey commodore	*Nymphalidae*
Aglais cashmiriensis	India tortoise shell	*Nymphalidae*
Neope yama	Dusky labyrinth (rare)	*Nymphalidae*
Apatura ambica	Purple emperor	*Nymphalidae*
Sumalia daraxa	Green commodore	*Nymphalidae*
Lethe sinorix	Tail red forester	*Nymphalidae*
Heliophorus androcles	Green sapphire	*Lycaenidae*
Tirumala limniaee	Blue Tiger	*Nymphalidae*
Rohana parisatis	Black prince	*Nymphalidae*
Chersouesia risa	Common maplet	*Nymphalidae*
Lethe distans	Scarce red forester	*Nymphalidae*
Euthalia phemius	White edged blue brown	*Nymphalidae*
Spindasis lohita	Long banded silver line	*Lycaenidae*
Aglais cashmiriensis	Indian tortoise shell	*Lycaenidae*
Apatura ambica	Purple emperor	*Nymphalidae*
Chersouesia risa	Common maplet	*Nymphalidae*
Euthalia phemius	White edged blue brown	*Nymphalidae*
Dodona adonira	Striped punch	*Lycaenidae*
Heliophorus tamu	Powdery green sapphire	*Lycaenidae*
Ethope himachale	Dusky labyrinth	*Nymphalidae*

Photographs of some of the fauna reported in the study area are presented as ***Annexure – X.***

3.2.2.2 Aquatic Ecology

The state of Arunachal Pradesh is the largest in geographical as well as in river drainage area in North-Eastern India and harbours innumerable rivers and rivulets which are home to diverse fish species, the invariable living components of water body. These organisms are important food resource and good indicator of ecological health of the water they inhabit. The state is characterized by the hilly terrain and crisscrossed by a number of rivers/ streams along with a good number of beels in the lower belt and lakes in the middle and higher belts adding to the scenic beauty of its topography. The state has 7000 ha and 2000 Km of lentic (non-flowing) and liotic (flowing) water resources respectively, of which, 30-40% is falling in the cold water zone of the state.

3.2.2.2.1 Ecological status of River Bichom

River Bichom is a snow fed stream arising from the high hills of West Kameng district of Arunachal Pradesh. Bichom is a 3rd Order River [30] and its flow is dependent on the 1st and 2nd 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. As the gradient decreases and the width, depth and volume of water increases, silt and decaying organic matter accumulate at the bottom. As a result, the character

[30] 3rd order stream = when two second order streams unite, the stream becomes a third order one. 2nd order stream = where two streams of the same order join. 1st order stream = a small head water stream without any tributaries.

of the stream changes from fast water to slow with an associated change in the water quality in respect to the altitude, seasonality and also in species composition.

Water current in Bichom ranges between 0.50 - 1.54 m/sec which is ecologically considered to be “fast” (Fast streams are those whose velocity is 50 cm/sec or higher). At this velocity, the current will remove all particles less than 5mm in diameter and will leave behind a stony bottom. High water increases the velocity; it moves bottom stones and rubbles, scours the stream bed, and cuts new banks and channels. As the gradient decreases and the width, depth, and volume of water increases, silt and decaying organic matter accumulate on the bottom (Smith, T. M. and R. L. Smith, 2006).[31]

3.2.2.2.2 River characteristics

Physical and chemical characteristics

The detailed analysis of physical and chemical characteristic of Bichom has been furnished in chapter 3 of this report.

Biological characteristics

Biological parameters are very important in the aquatic ecosystem, since they determined the productivity of the water body. Primary productivity is an important indicator of pollution levels in aquatic ecosystem. Fish production depends on production of zooplankton, which in turn depends on the phytoplankton or primary productivity. All these are related to the physico-chemical characteristics of the water.

3.2.2.2.3 Aquatic biota

The planktonic community in the Bichom River is inherently poor. Because of the high water current in the core of the river bed, the essentialities for the formation of the planktonic community are broadly missing. But few types of plankton could be identified in comparatively slower and fringed areas, where the tendency of the smaller pools exists.

Phytoplankton

Phytoplanktons are floating microorganism. Their distribution depends on the temperature, nutrient supply. The overall species were dominated by Basillariophycea followed by Myxophycea, Chlorophycea and Xanthophycea. Diatoms, flagellates and algae normally constitute the bulk of the phytoplankton. The size and species diversity of phytoplankton community are the indicator of the pattern of energy flow in the aquatic ecosystem. The listed species are gathered from primary and secondary sources (Saikia and Das, 2008).[32] The phytoplankton that may be found in the slower areas are reported as follows :

[31] Smith, T. M. and R. L. Smith, 2006; Elements of Ecology, 6th Edition; Publication : Dorling Kindersley (India) Pvt. Ltd., New Delhi

[32] Saikia, S.K. and D.N.Das 2008 Periphyton diversity in rice Fish integrated fields at a High Altitude of Eastern Himalaya. International Journal of Ecology and Environmental sciences 34 (4):299-306.

Table 3:24 Phytoplankton species of Bichom river basin

Family	Species
Bacillariophyceae	*Amphora sp*
	Cocconeis sp
	Achnanthes sp.
	Cymbella sp
	Caloneis sp
	Diatomella sp
	Eunotia sp
	Fragillaria sp
	Frustualia sp
	Gomphonema sp.
	Mastegloia sp
	Melosira sp.
	Meridion sp.
	Hyalothece sp.
	Navicula sp.
	Neidium sp.
	Pinnularia sp.
	Surirella sp.
	Synedra sp.
Chlorophyceae	*Actnophrys sp.*
	Ankistrodesmus sp
	Bulbochaete sp.
	Chaetophora sp
	Chlorella sp
	Closterium sp.
	Desmidium sp.
	Geminella sp.
	Gloeotaenium sp.
	Spirogyra sp.
	Ulothrix
Myxophyceae	*Oscillatoria sp* (not in main river)
	Rivularia sp.
	Anabaena sp
	Spirilina sp. (in organic rich area)
Xanthophyceae	*Traychyloron sp.*
	Goneochlorises sp.

Zooplankton

The planktons that are composed mainly of the members of the animal groups are the zooplankton. Zooplanktons are consumers' heterotrophs and their representations are very negligible in all season investigations. Their presence is an important indicator of the health of the aquatic ecosystem. A list of zooplankton is furnished in **Table 3.26**. The listed species are gathered from primary and secondary sources (Battish, 1992; Dutta Munshi *et al*. 2006; Saikia and Das, 2008).[33]

Table 3:25 Zooplankton species of Bichom river basin

Family	Species
Brachionidae	*Brachionus sp*
Brachionidae	*Keratella sp*
Euchlandae	*Euchlandae sp*
Euchlandae	*Triplenchlanis sp*
Notommatidae	*Cephaloddla sp*
Ostracods	*Cypris sp*
Arcellidae	*Arcella sp*
Bdelloidae	*Bdelloid sp.*
Arcellidae	Arcella sp
Bdelloidae	*Bdelloid sp*
Bosminidae	*Bosmina sp*
Bosmidae	*Bosminopsis sp*
Brachionidae	*Colurella sp*
Cyclopidae	*Cyclops sp*
Difflugidae	*Diflugia sp*
Epistylididae	*Epistylis sp*
Testudinellidae	*Filinia sp*
Lecanidae	*Lecane sp*
Moinidae	*Moina sp*
lecanidae	*Monostyla sp*
Cladocera	*Nauplia*
chydoridae	*Pleuroxus sp*
trichocercidae	*Trichocera sp*
Diptera	larvae
Placoptera larve	larvae

[33] Battish, S.K. 1992 Fresh water zooplanktons of India. Pub: Mohan Primlani for Oxford and IBH Publishing company. Pvt. Ltd
Dutta Munshi, J and J.S.Dutta Munshi- 2006. Fundamentals of fresh water Biology. Pub: Narendra Publishing House., 1417, Kishan Dutta Street, Maliwara. New Delhi-110006
Saikia and Das, 2008 : ibid

Periphyton

The river is fairly rich in periphyton's abundance which remains attached to the stone or other object. Winter months have been found to be the peak season for its concentration. The Bacillariophycea represents the largest group in the order.

3.2.2.2.4 Fish and Fisheries

The state is the habitat for a rich fish fauna with more than 150 species, out of which 20% represents the cold water forms and the remaining 80% is contributed by the admixture of cold and warm water species. It may also be mentioned that environmental disturbance and habitat alterations are the main threats to the fish species diversity. The conservation of hill stream fishes of this region is a great challenge, because they typically use different habitat along the river stretch for spawning, feeding and shelter. Further, the fish in the riverine sector shows spatial and temporal variation depending on water depth, velocity of current, substrate, water discharge, physico-chemical condition, etc.

The present section provides an overview of the fish composition, status of fish, endemicity, etc. based on actual fish catch during primary survey and on the basis of secondary literatures. In recent years, the number of studies on fishery resources of the state has increased. Scanning of literature shows that 131 ichthyospecies were recorded by Nath and Dey (2000)[34], and 150 species by Sen (2000). Out of this, 20% represent the cold water forms and remaining 80% is contributed by the mixture of cold water and warm water species. Although the ethnic population have unique food habit, yet fish forms the most common component in their diet. The increase in the human population and rapid urbanization has resulted in the shrinkage, wanton destruction and degradation of aquatic habitat thereby affecting the availability of the freshwater fishes in the region to a large extent.

Composition and Distribution

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.

These fishes could be further grouped into 3 sections on the basis of the body form, adaptive modification, habitat and ecological adjustments. They are :

I. True hill stream forms
II. Semi terrestrial forms
III. Migratory forms.

The composition and the conservation status of the fishes of River Bichom is given in **Table 3.27**.

[34] Nath, P. and S. C. Dey (2000), Fish and Fisheries of North East India, Narendra Publishing House, New delhi

Table 3:26 Fish composition and their status of Bichom River basin

Sl. No.	Species	Family	Status
I	**True hill streams forms**		
1.	*Garra gotyla gotyla*	Cyprinidae	VU+
2.	*Psilorhynches balitora*	Psilorhynchidae	NE
3.	*Exostoma labiatum*	Sisoridae	EN
4.	*Glytothorax pectinopterm*	Sisoridae	NE
5.	*Pseudocheinis sulcatus*	Sisoridae	VU+
II	**Semi terrestrial forms**		
6.	*Crossocheilus latius latius*	Cyprinidae	LR : nt
7.	*Souieleptes gougota*	Cobitidae	LR : nt
8.	*Botia dero*	Cobitidae	NE
9.	*Botia rostrata*	Cobitidae	NE
10.	*Acanthocubitis botia*	Balitiridae	NE
11.	*Noemamacheilus rupecola rupecola*	Balitiridae	LR : nt
12.	*Lepidocephalus guntea*	Cobitidae	NE
13.	*Belone cancila*	Belonidae	VU
14.	*Danio aequipinnatus*	Cyprinidae	LR : nt
15.	*Channa gachua*	Channidae	NE
III	**Migratory forms**		
16.	*Acrossocheilus hexagonlepis*	Cyprinidae	VU
17.	*Tor putitora*	Cyprinidae	EN
18.	*Tor tor*	Cyprinidae	EN
19.	*Orinus richardsoni*	Cyprinidae (oeinninae)	VU+
20.	*Recoma proyasta*	Cyprinidae (oeinninae)	LR : nt
21.	*Barilius bendelisis*	Cyprinidae	LR : nt
22.	*Raimas bola*	Cyprinidae	NE
23.	*Barilius tileo*	Cyprinidae	LR : nt
24.	*Labeo dero*	Cyprinidae	VU+
25.	*Labeo pangusia*	Cyprinidae	VU+
26.	*Labeo dycheilus*	Cyprinidae	VU+
27.	*Semiplotus semiplotus*	Cyprinidae	VU+

VU: Vulnerable; NE: Not Evaluated; EN: Endanger; LR: nt : Lower Risk and near threatened [35]

Distribution pattern

In the construction of river valley projects, the sole concern remains with the migratory fishes. The damming hinders their migration either for breeding or feeding. Of course, migration is of seasonal nature viz. monsoon months for breeding and winter months for feeding except for the *Schizothorax spp* which breeds during winter in the middle or lower elevations depending on the

[35] The status has been assessed from Central Inland Fisheries Research Institute (CIFRI)

temperature that varies between 7- 8^{0}C. Otherwise, all other species reported above breeds during monsoon months. On the basis of altitudes, the fishes reported above can be distributed in the following groups:

(i) High altitude fishes (2500 - 3000 m, msl): They are *Schizothorax richardsoni, Schizpygopsis progastus, Exostoma labiatum, Pseudocheinis sulcatus, Glyptothorax pectinopterus. Schizothorax spp* has a high market demand and could be cultured with exotic trout species, while other species are of ornamental value.

(ii) Middle altitude fishes (1500 m, msl) : They are Mahseers, *Garra spp, Semiplotus semiplotus, Noemacheilus spp, Barilius spp* etc. Mahseers is a prized fishes and also a sport fish for angling lovers.

(iii) Lower belt fishes (Below 1500 m, msl) : They are *Labeo spp, Botia spp, Crossocheilus latius latius, Channa gachua* etc, All these fishes has a good market and *labeo sp.* forms one of the component in composite fish farming.

Fish Diversity

Dominant fish species

The dominant fish species of River Bichom are Mahaseers (*A. hexagonolepis, Tor tor, Tor putitora*), Snow Trouts (*O. richardsnii, S. progastus*), Minor carps (*L. dero, H. pangusia, H. dyiocheilus*); *Semiptolus semiptolus*.

Endangered / Vulnerable fish species

The species categorized as endangered (EN) as per available literature (BCPP, 1997)[36] 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.

Ornamental fish

Of the 27 fish species, 8 nos. have been identified are having ornamental value and highly priced in domestic and international markets. They are *Exostoma labiatum, Pseudocheinis sulcatus, somileples gongata, Botia dero, Botia rostrata, Raimus bola, Balilius telio, Semiplotus semiplotus.*

Migratory fish

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.

[36] BCPP (Biodiversity conservation Prioritization Project) 1997
CIFRI (Central Inland Fishery Research Institute) 2007

Fishing society

The local tribes of the district are involved in fishing for domestic purpose and often community fishing is also carried out as a part of observing various religious ceremonies of the area. It may be worth mentioning that in absence of permanent fishermen with fishes as primary livelihood (either by caste or creed), no large scale fishing has been noticed. The general experience in fish catch is that the effort per man-hour in 1 km stretch is 0.5 – 1.5 kg in the upstream and in the lower reach 1 – 2 kg. The fishing appliances used is cast net, rod and line, beside the use of local bamboo traps are very common amongst other local people in the West Kameng district. There is no landing ground for fish marketing; therefore commercial fishing is virtually non-existent.

3.2.3 Socio-economic Aspects

The state is divided into 16 districts (as on 31st Mar 2004) with 44 subdivisions, 85 blocks and 169 Circles, 17 towns and 3863 villages. West Kameng district constitutes about 8.86 percent of the total area of the state of Arunachal Pradesh and is located between 91°-56'E and 28°-01'N. The district is divided into 3 sub-divisions, viz., Bomdila, Rupa and Thrizino. Nafra is one of the five circles that constitute Thrizino sub-division. The Deputy Commissioner, West Kameng district is the overall in-charge of the district administration. The villages have their own 'customary administrative system' in the form of traditional village councils. The village council usually consists of the *'Gaon Burahs'* and '*Panchayat Members'*. The Assam Frontier Administration of Justice Regulation 1945' authorizes the village councils to settle all civil matters falling within their jurisdiction.

There are 16 settlements in the radius of 10 kms from the central axis of the proposed Dam. However, Nafra, Lower Jung and Khellong are the only villages which are located on the water partings towards Bichom. The rest of the settlements are located on the other side of the drainage line, and each consists of only a few households. Hence, the socio-economic baseline data was collected from these three major settlements i.e. Nafra, Khellong and Lower Jung.

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

Chapter 4

ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

4 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. Some anticipated physical, environmental and social problems during development of the project are discussed in the following section:

- Impacts due to siting of the project
- Impacts due to construction works, and
- Impacts due to project operation

For each of the above factors, potential adverse impacts have been discussed in the following paragraphs, while recommendations for mitigating measures have been enumerated in Chapter 5.

4.1 IMPACTS DUE TO PROJECT LOCATION

In general the environmental impacts associate in infrastructural project due to project location have summaries below, the applicability of the same in the proposed project have been discussed in section 4.1.1 to 4.1.10 below:

- Loss of land
- Change in land use
- Displacement of People
- Acquisition of forest land
- Encroachment into nature reserves and wildlife
- Loss of archaeological / cultural heritage sites
- Loss of infrastructure
- Disruption of hydrological balance
- Risk due to earthquake
- Environmental risks due to future developments.

4.1.1 Loss of Land

The proposed Nafra HE project involves change in land use of about 74.96 hectares of land including the submergence. Total permanent land acquisition is 45.04 ha and 29.92 ha for temporary acquisition. The details are as follows:

Table 4:1 Land Required for Different Project Features

Label in Index Map **	Title of the Project Feature	Land Requirement in Hectare	Land Ownership
I. LAND REQUIRED FOR PERMANENT ACQUISITION			
A (LB)	Submergence Area- Left Bank	10.78	Community Land
A (RB)	Submergence Area- Right Bank	3.72	Community Land
B(L)	Left Bank Dam Site	5.93	Forest Land
B(R)	Right Bank Dam Site	7.98	Forest Land
D	Surge Shaft and Valve House	1.76	Forest Land
E	Approach Road to Surge Shaft	0.81	Forest Land
E1	Approach Road to Valve House	0.35	Forest Land
F	Power House Site (Including Penstock and Switch Yard and Tail Race) Channel)	7.43	Forest Land
G	Approach Road to Power House	0.25	Forest Land
H	Staff Colony and Guest House	3.22	Community Land
J	Approach Road to the Dam Top	0.64	Forest Land
K(F)	Nafra-Bichom Replacement Road in Forest Land	1.24	Forest Land
K(C)	Nafra-Bichom Replacement Road in Community Land	0.27	Community Land
K(I)	Nafra-Bichom Replacement Road in Individually Possessed Area	0.14	Community Land
S	Approach Road to Spillway	0.52	Forest Land
Total land required for permanent acquisition		**45.04**	
II. LAND REQUIRED FOR TEMPORARY ACQUISITION			
C	Head Race Tunnel	2.73	Forest Land
L (S)	Quarry Area for Stone	2.00	Forest Land
M1	Muck Dump Area-1	4.60	Community Land
M2	Muck Dump Area-2	3.68	Community Land
N	Labour Colony	3.06	Community Land
Q1	Facility Area-1	1.30	Community Land
Q2	Facility Area-2	11.96	Community Land
R	Quarry Material Transporting Road	0.48	Forest Land
T	Deviation Road Near Power House	0.11	Community Land
Total land required for temporary acquisition		**29.92**	
Grand Total		**74.96**	

***Note :** refer **Annexure XI** for Label*

4.1.2 Change in Land use

The land required for tunnel adits, muck disposal area, construction camps etc would change the land-use temporarily till the construction phase is over. Permanent change in landuse shall be due to the reservoir, dam structure, powerhouse, colony and other ancillary structures. The headrace and tailrace tunnels being underground would not have any effect on land-use.

4.1.3 Displacement of People

Only 2.3 ha. Of the total submerged land is under private possession (5 Families) and used for agriculture/ horticulture purpose. **No residential land is getting submerged; hence there is no displacement due to reservoir.** The details of Project Affected Person (PAP) are reported in *Social Impact Assessment (SIA) including Land Acquisition and Rehabilitation Plan Report as Volume-II*.

4.1.4 Acquisition of Forest Land

The proposed project envisages acquisition of about 32.12 hectares of forest land; out of which 26.91 ha will be acquired permanently (refer **Table 4.1**) and 5.21 ha temporarily (refer **Table 4.2**) for the construction period. During construction and operation of the project, there may be efforts to collect wood from nearby forest for various purposes, which can affect the forest. Such efforts should be prevented by adopting suitable mitigating measures, as per provisions made in Chapter 8.

Table 4:2 Permanent Land Acquisition from the Forest Department, Govt. of Arunachal Pradesh

Title of the Project Feature	Label in Index Map**	Area of the Land in Ha.
Dam Site Left Bank	BL	5.93
Dam Site Right Bank	BR	7.98
Surge Shaft and Valve House	D	1.76
Approach Road to Surge Shaft	E	0.81
Approach Road to Valve House	E1	0.35
Powerhouse Site	F	7.43
Approach Road to Power House	G	0.25
Approach Road to Dam Top	J	0.64
Nafra-Bichom Replacement Road	K(F)	1.24
Approach Road to Tail Race	S	0.52
TOTAL		**26.91**

***Note :** Refer **Annexure XI** for Labels*

Table 4:3 Temporary Land Acquisition from the Forest Department, Govt. of Arunachal Pradesh

Title of the Project Feature	Label in Index Map **	Area of the Land in Ha.
Quarry for Stone	LS	2.00
Quarry Material Transporting Road	R	0.48
Head Race Tunnel	C	2.73
TOTAL		**5.21**

***Note :** Refer **Annexure XI** for Labels*

4.1.5 Encroachment into Nature Reserves and Wildlife Habitat

The project will not result in any encroachment on natural reserves, as neither the study area nor its surroundings have been declared as natural reserve. No rare or endangered species of wildlife have been sighted in the study area. There is no indication that the project area functions as corridor for movement of wildlife. Hence, the project will not have any impact on wildlife.

4.1.6 Loss of Archaeological / Cultural Heritage Sites

There is no archaeological or cultural heritage site within the study area that comes under direct or indirect impact of the project.

4.1.7 Loss of Infrastructure

Infrastructure facilities, such as schools, hospitals, establishments, communication facilities, post offices, community resources, etc. are not getting affected due to the project. There is no permanent residential structure coming under submergence. There are a few labour sheds on the agriculture/horticulture plots in the submergence area that are used to keep a watch over the crops. These wooden huts will be dismantled and compensated appropriately (details provided in Social Impact Assessment (SIA) including Land Acquisition and Rehabilitation Plan Report as Volume-II). However a small portion of road connecting Nafra and Bichom would be lost due to alignment of HRT. Provision for constructing the alternative road has been made in the project design as well as in the cost estimate.

4.1.8 Disruption of Hydrological Balance

The flow of water downstream of the dam site at the HRT portion, about 3.68 km stretch, will be affected due to the project. A minimum perennial flow 0.91 cumec in this stretch will be ensured by providing an opening in the dam structure. This minimum flow discharged from the reservoir will be further supplemented by flow of the Dirang Bru and Divya Nala which joins Bichom River between the Dam Site and Power House Site. The water from this stretch of river is not drawn for any purpose and access to the riverbed on this stretch is difficult as the slope is very steep. Moreover, settlements are far away and located at a higher altitude. Therefore, reduction of flow in this particular stretch of the river will have no impact on water use by any community. After TRT confluence point, the river will receive its original flow downstream.

4.1.9 Risk due to Earthquake

Project is located in the seismic zone –V as per IS 1893-2002 (refer Map 3.4). The seismic parameters for the design of civil structure has been taken from Kameng HEP (construction stage) which is downstream of the Nafra HEP. However at detailed engineering stage site specific studies will be carried out.

4.1.10 Environmental Risks due to Future Developments

The project on its completion would create conditions favorable for setting up of new small scale industries in the surrounding areas. Setting up of new industries in the area has to be well planned and regulated by the local and state administration to prevent any adverse effect on the environment. However there is a fairly good chance of developing the area as tourist place, hotels and small scale industries can pose environmental hazards if not done in planned manner.

4.2 IMPACTS DUE TO PROJECT CONSTRUCTION

It is envisaged that a very few environmental impacts during construction phase will be permanent. Most of the environmental impacts attributed to construction works may be temporary in nature, lasting mainly during the construction phase and often little beyond the construction period.

However, if these issues will not be properly addressed, the impacts can continue even after the construction phase for longer duration.

The time required for construction of the project has been calculated as 36 months. Appropriate measures need to be included in the work plan and environmental budget (provided in subsequent section). The most likely hazards related to the construction works are described in following paragraphs:

4.2.1 Impacts on Land

The major anticipated impacts during construction phase are as follows:

A. Environmental degradation due to immigration of labour population.

B. Quarrying operations.

C. Operation of construction equipment.

D. Soil erosion / increased siltation

E. Muck disposal

F. Construction of roads

A. Environmental degradation due to immigration of labour population

A total of 400 staff (workers and technical) will reside in the project area during the peak construction phase. Unless adequate measures are taken, the congregation of labour force is likely to create problems of sewage disposal, solid waste management and felling of trees for meeting fuel requirements, etc.

B. Quarrying operations

The total quantity of coarse aggregate required for the project is about 85000 m^3. Quarries have been identified for extraction of coarse aggregates. The boulders in the river bed are also available. These may be crushed at the crushing plant and could be used as aggregate for construction. Excavated rock from the underground works may also be used as aggregates.

C. Operation of construction equipment

During construction phase, various types of equipment will be brought to the site. These include crushers, batching plant, drillers, earth movers, rock bolters, etc. The siting of this construction equipment would require significant amount of space. In addition, land will also be temporarily acquired, i.e, for the duration of project construction for storage of the quarried material before crushing, crushed, rubble etc.

During construction phase, there will be increased vehicular movement for transportation of various construction materials to the project site. Large quantity of dust is likely to be entrained due to movement of trucks and other heavy vehicles on unpaved road. As the proposed project is located in valley such ground level emissions do not travel for long distances. In addition, there are no major habitations in the project area. Thus, no significant impacts are anticipated.

D. Soil erosion/ increased siltation

For some distance downstream from major construction sites, such as dam, power house, etc. there is a possibility of increased sediment levels in river water, which may lead to reduction in light

penetration. This in turn may reduce the photosynthetic activity of aquatic vegetations including phyto planktons to some extent. The likelihoods of this probable impact will not be considered to be significant since river Bichom and tributaries, have sufficient flow even in the lean season.

E. Problems of muck disposal

Construction of the project involves generation of muck from various work sites. Total quantity of muck generation is estimated as 4.78 lacs cum as a result of tunneling operations, construction of dam, power house and appurtenant works (**Table 4.4**). The muck quantity expected to be generated from various work sites is tentatively assessed hereunder.

Table 4:4 Details of muck generation

Sr. No.	Structure	Approx. Muck Qty. Cum (Lacs)
A	Upstream Structures i.e. spillway, intake, upstream stretch of HRT upto 0.8 Km	2.5
B	Surge Shaft , D/s HRT, Adits, Part penstock	0.61
C	Pressure Tunnel, Power house, Tail race channel etc.	1.67
Total Quantity of Muck Generation		**4.78**

Source: *Detailed Project Report*

- Muck disposal may lead to impacts on various aspects of environment. Normally, the land is cleared before muck disposal. During clearing operation trees are cut and undergrowth perishes as a result of muck disposal.
- In many of the sites, muck may be stacked without adequate stabilization measures. In such a scenario, the muck may move along with runoff and create landslides like situations. There is possibility that boulders/ large stone pieces enter the river/ water body, affecting the benthic fauna, fisheries and other components of aquatic biota.
- The increased vehicular movement near muck disposal sites may lead to adverse impacts on ambient air quality as well. However, increase in vehicular traffic is not anticipated as significant to cause major impact on ambient air quality.
- Muck disposal at low lying areas may gets chilled up due to stacking of muck. This may affect the natural drainage pattern of the area leading to accumulation of water or partial flooding of some areas which can provide ideal breeding habitat for mosquitoes.

Thus, it is necessary to develop a proper muck disposal plan for amelioration of above referred impacts. Various management measures on this aspect have been covered in Chapter 8 of this Report.

F. Construction of roads

The topography of the project area has steep slopes, which descends rapidly into narrow valleys. The condition may give rise to erosion hazards due to downhill movement of soil aggregates. The project construction would entail significant vehicular movement for transportation of large amount of construction material, heavy construction equipment, etc.

Nafra dam site is approachable through PWD road from Rupa and Power house site is approachable through same road leading to Bichom. However access roads to work sites will be

required. The requirement of access roads to the work sites from the existing roads shall be as under.

i) Realignment of existing road

The existing road near the dam site on right side will come under submergence and will require realignment at a higher elevation of approx. 1.65 km length.

ii) Surge shaft / Valve house - Penstock roads

For surge shaft top EL 1005.0m and valve house EL 953.90m, required approach roads of length 1.5 km and 1.2 km respectively will be diverted from the existing road from dam site to Bichom. For surge shaft, this diversion will be from a point on the existing mud road, connected to the main road.

iii) Power house

1 km of road (Approx.) is required to access Power house and Switchyard from existing road to Bichom.

iv) Other approach roads

- Approach roads to quarry sites/borrow areas
- Approach road to adit inlet portal u/s of dam location
- Haul roads to dumping areas for muck disposal
- Approach roads to explosive magazine, crusher, B&M plant, stores, workshops penstock fabrication yard, sheds etc.
- Temporary bridge for access to the left bank

Construction and improvement of the roads, bridges and cross - drainage works will be a priority and is planned to be completed during the pre-construction stage. In all about 7.35 km length of approach road is required to be constructed. Details of the project road are as follows:

Table 4:5 Construction of required approach road

Sr. No.	Description	Length (m)	Length (Km)
1	Submergence Road	1650	1.65
2	Road to Surge shaft/Valve house	2700	2.70
3	Road to Power house / Switchyard	1000	1.00
4	Other Misc. Roads	2000	2.00
Total		**7350**	**7.35**

The construction of roads may lead to removal of trees on slopes and networking of the slopes in the immediate vicinity of roads which increases the vulnerability of the area to landslides, gully erosion, etc. The indirect impact of the construction of new roads is the increase in accessibility of hitherto undisturbed areas, resulting in greater human interferences and subsequent adverse impacts on the ecosystem. Various management measures on this aspect have been covered in Chapter 5 of this Report.

4.2.2 Impacts on Water Resources

Construction of dam will lead to the formation of a reservoir. The passage of flow through a reservoir

will lead to the reduction in peak flow. The lean season flow in the river too will be regulated. The river stretch downstream of the dam site up to the confluence point of tail race discharge will have reduced flow. The reduction in flow of the river in the intervening stretch is not likely to have any adverse impact on the downstream users. This is mainly because of the fact that no settlement exists near this stretch; thus there will be no dependency on the water of river Bichom in the specific stretch. However, less flow in the river stretch can have impacts on the riverine ecology.

Apart from the above, a water reservoir will be formed due to construction of dam, which can be utilized for fisheries development, creation of new biodiversity and other purpose. Thus it will have positive impacts on water resources.

4.2.2.1 Impacts on Water Quality

The major sources of water pollution during project construction phase are presented as follows:

- Sewage from labour camps/ colonies
- Effluent from crushers

Sewage from labour camps

The project construction is estimated to last for a period of 36 calendar months. Most of the employees/ workers during construction phase are likely to be employed from outside the project area. Moreover, the construction phase also may lead to mushrooming of various allied activities to meet the demand of immigrant labour population in the project area.

The influx of population during construction phase is anticipated to be 400. Water requirement of the immigrant population is expected to be in the order of 0.028 mld @ 70 lpcd. It is assumed that about 80% of the water supplied will generate sewage. Thus, the total quantum of sewage generated is calculated to be 0.022 mld. The BOD load contributed by domestic sources will be about 18 kg/ day. Even if, the sewage is discharged without treatment in river Bichom, then the flow required for dilution is much below the existing flow even in lean season.Thus, no major adverse impacts are likely to incur as a result of disposal of even untreated sewage from labour camp.

Effluent from crushers

During construction phase, two crushers will be commissioned with a total capacity of 80 ton per hr. About 0.1 m^3 of water is required per ton of material crushed to wash the boulders and to lower the temperature of the crushing edge. The effluent from the crusher would contain high suspended solids. The quantum of effluent generated is of the order of 5 m^3/hr. The natural slope in the area is such that, the effluent from the crushers will ultimately find its way in river Bichom through natural drains. No major adverse impacts are anticipated due to small quantity of effluent compared to large volume water available for dilution in river Bichom. However, turbidity levels in small tributaries, especially, in lean season may increase marginally. Various management measures on this aspect have been covered in Chapter 5of this Report.

4.2.3 Impacts on Ambient Air Quality

Consumption of fuel in construction activities and movement of construction vehicles will be the principal cause of increase in air pollution. In the present project diesel powered trucks used for the haulage of construction material and running of construction machinery at the construction sites will be the major sources of air pollution. However, background concentration of pollutants, as reported

in Chapter 3, will be within the permissible limit.

Lots of construction materials like sand, fine aggregates, etc. will be stored at sites during project construction phase. Normally, due to blowing of winds, some of the stored materials may get entrained in the atmosphere, especially when the environment is dry. Such impacts are visible only in and around the storage sites. However, increase in concentration of air pollutants during construction will be of temporary nature. As the construction site is located away from human habitations, the impacts will be insignificant in nature.

4.2.4 Impacts on Ambient Noise Level

During construction, the major sources of noise pollution will be from movement of vehicles for transportation of construction material to the construction yard and the noise generating activity at the yard itself. The primary noise generating activities at construction yards may be:

- Blasting and drilling,
- Concreting and mixing,
- Casting and material movement.

The expected noise levels due to operation of construction machinery at site are summarized in **Table 4.6**.

Table 4:6 Typical Noise Levels of Construction Equipments

Sl. No.	Machine	Noise Level in dB(A)
1.	Drilling Machine	120-130
2.	Motor Scraper	85-95
3.	Face Shovel	80-90
4.	Dump Truck	80-90
5.	Compactor	81-85
6.	Dozer	80-85
7.	DG Set	80-110
8.	Pumps	80-100
9.	Grouting m/c	100-120

Source: *US Environmental Protection Agency, Noise from Construction Equipments and Operations*

Construction activities are expected to produce noise levels in the range of 80 -130 dB (A), which will decrease with increase in distance. During excavation of earth, cutting of rock, crushing, loading and transportation activities, the noise generated will be in the range of 90 -130 dB (A), if all the above activities are carried out simultaneously. The construction works will be carried out during the daytime. Due to the high noise levels of construction machinery, the personnel operating the machines and the workers stationed close to the machines are prone to exposure of high levels of noise. Various management measures on this aspect have been covered in Chapter 5 of this Report.

4.2.5 Impacts on Terrestrial Ecology

Flora

During the project construction, a number of trees will be lost due to submergence at the dam site (towards upstream) and construction of other component structures. Moreover, temporary

population will be increased in number as the technical staff, workers will likely to congregate in the area. Workers and population groups residing in the area may use fuel wood, if alternate fuel source is not provided and as a result there will be a probability for large number of trees being cut. Thus, the project will have a direct impact on the dominating tree species, such as *Pinus wallichiana, Pinus roxburghii*.

Fauna

It has been confirmed during field survey and interaction with local people that no major wildlife is reported from the submergence area. In addition, the area does not lie on any migratory route. Thus, it is expected that creation of reservoir will not cause any significant adverse impact on wildlife movement / habitat.

No large scale fauna has been observed in the area. As per the secondary literature, the project area and its surroundings are rich in avi-fauna, but there are no nesting records.

4.2.6 Impacts on Aquatic Ecology

During construction of the project, muck generated if not properly disposed, invariably will flow down the river during heavy precipitation. Such condition may lead to adverse impacts on the development of aquatic life. Moreover, the increase in labour population during construction phase, may lead to increased pressure on fish fauna, as a result of indiscriminate fishing by them.

4.2.7 Health Risk

Health risk during construction phase of the dam and other works include disease hazards due to lack of sanitation (human waste disposal), vector borne diseases and hazards due to local carriers etc. Therefore, mitigation measure must include the proper sanitation health care and human waste disposal facilities.

The effect of high noise levels on the operating personnel may be harmful. It is known that continuous exposures to high noise levels above 90 dB(A) affects the hearing acuity of the workers/ operators. Various management measures on this aspect have been covered in Chapter 5 of this Report.

4.2.8 Cultural Hazards

The inhabitants of the project area belong to Sajolang Tribe which has its distinct culture. People of this area have distinct habits of food and clothing. They have deep religious faiths and celebrate their festivals with great enthusiasm. During construction phase, problems may arise due to difference in customs of outside workers and local residents. The local population for the first time may be exposed to outside populations with ethnic, religious, and cultural differences with them. They have to share and compete with them for public services in their day to day life. Hence, the local people are more likely to feel alienated and subverted in their own land.

4.2.9 Socio-economic Impacts

The socio-economic impacts of the project are dealt in SIA report (Vol. II) in Chapter-5.

4.3 IMPACTS DUE TO PROJECT OPERATION

The impacts due to project operation will be long term and may be both positive and negative in nature. The main impacts will be on the following components:

- Water Quality
- Terrestrial Ecology - Flora / Fauna and Wildlife
- Aquatic Ecology
- Public Health - Increased incidence of water borne diseases

4.3.1 Impact on Water Quality

Effluent from project colony

In the project operation phase, about 40 families i.e. 160 persons (considering 4 members in a family) will be residing in the area which would generate about 0.017 mld of sewage (considering water supply @135 lpcd). The quantum of sewage generated is not expected to cause any significant adverse impact on riverine water quality.

Eutrophication Risks

The climate in the project area is in general cool and humidity is high throughout the year. In this particular case, keeping in view a very small area of reservoir (32.67 ha), evaporation loss will become insignificant.

4.3.2 Effect on Terrestrial Ecology

The diversion of the forest land is minimized by acquiring most of the land on lease for construction period only. Appropriate mitigation and enhancement measures are prescribed in Chapter 5, which will ensure minimum impact on the terrestrial ecology. Further, the project area has a thin forest cover and no wild life being reported, it will have negligible impact on the wildlife.

4.3.3 Impact on Aquatic Ecology

Impact on aquatic ecology due to the project has been described in the following paragraphs.

4.3.3.1 Due to damming of river

The dam will create a submergence area of 32.67 ha which in turn bring about a number of alterations in physical, abiotic and biotic parameters both in downstream and upstream directions of the proposed dam. The macro and micro fauna is likely to be affected as a result of the proposed project.

4.3.3.2 Diversion of water

Due to diversion of water through HRT, the river bed will not be dried up, but the natural flow of the river Bichom will be reduced only for 3.68 km stretch. Reduction in flow is likely to increase turbidity level in downstream of the dam and the natural river bed will not be maintained in that specific stretch. As a result, semi-desiccation in certain stretches of the river may be created. The species in terms of plankton and fish fauna, which are available in the stretch of 3.68 km, will be affected including their distribution in upper and lower reaches. The planktons are distributed throughout the length of the river system, but their composition varies to some extent

due to changes in the temperature and nutritional availability. Hence, their distribution is not restricted to the "stretch of river in question" where water will be withdrawn. Hence, it is expected that the biodiversity will not be exterpreted (local extinction) due to diversion of water.

The river bed of 3.68 km stretch will have less water flow compared to the water flow in the other part of the river. Due to the stagnancy of water in this stretch of the river, the habitat condition for aquatic life will change. This will offer a unique situation of the formation of new type of habitat and initiate niche occupancy by other species from high altitude amphibian, mollusk, and insect species. This may also offer partial habitat support to smaller mammals as well as some avian species.

4.3.3.3 Migratory fish species

The migratory fish species, e.g. Snow Trout are likely to be affected during breeding times due to obstruction created as a result of construction of the proposed dam. The sam site may be converted into a cold water fishery. Moreover most of the fish species will shift to the section of the river where they find favourable environment for breeding.

4.3.3.4 Ecological alterations due to reduction in flow

A hill streams located at higher altitude like Bichom show a characteristics of "raffles and pools". These mechanisms are crucial for the growth and reproduction of the hill stream fishes.

The change in the water flow due to dam construction and the consequent reduction in the flow of the river stretch between Dam site and Power House site (3.68 km) will be affected. This will alter the physical, chemical and biological characteristics of this stretch of river. In such a situation the following changes in the river bed in this stretch is expected:

a. Water will flow in a restricted width during the period of most of the lean period. That area will have stream characteristic.

b. Some portion will be dry in winter only, for a period of 4 to 5 months, October to February (based on the period of active monsoon and initiation of the pre-monsoon showers)

c. The fringe area boulders will be dry for longer period of time.

d. Temperature of water will increase in this stretch.

4.3.4 Public Health

Public health facilities, such as water supply and sanitation are much needed at colony, power house and dam site. Approximately, 40 residential quarters are likely to be constructed for operation of the project. Therefore, domestic water requirements for 160 persons (considering 4 persons per family) will be 0.0216 mld @ 135 lpcd.

Increased Incidence of Water Related Diseases

The factors enhancing the proliferation of water related diseases are vectors and pathogens. Stagnant water and vegetation provide favourable breeding places for vector life such as mosquito and snails. However, field survey showed that the typical vector borne diseases are not common in the project area.

4.4 MITIGATION MEASURES

The Nafra hydroelectric project will provide clean & cheap power, employment opportunity, enhancement in economic standard of local population, additional water reservoir, habitat for aquatic life and tourism potential. The environmental issues likely to occur during project construction and operation phases could be minimized by making necessary provisions in project design and adopting Environmental Management Plan (EMP).

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. A summary of anticipated environmental impacts and specific mitigation measures is provided hereunder.

Summary Environmental Impacts and Mitigation Measures

Parameters	Anticipated Impacts	Management Measures	Implementing Agency
During Project Pre-construction / Construction Phase			
Air Quality	▪ Fugitive emissions due to HMP/ crusher operation at site	▪ Commissioning of dust extraction unit on HMP/ crusher in compliance with the statuary guideline given in the NOC by the SPCB	SEW/ Sub-contractor SEW
Water Quality	▪ Water pollution due to disposal of sewerage from labour camp ▪ Disposal of effluents with high turbidity from crushers commissioned at various sites and effluents from adits at tunnel	▪ 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 ▪ 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	SEW / Project Sub-contractor
Noise	▪ Increase in noise levels due to operation of various construction equipments	▪ Noise standard at processing sites, will be strictly enforced as per Govt. of India noise standards. ▪ Workers in vicinity of strong noise will wear earplugs and their working time should be limited as a safety measure.	SEW/ Sub-contractor
Land / Soil Environment	▪ Soil erosion due to the extraction of construction material from various quarry sites ▪ Temporary acquisition of private / forest land for siting of construction equipment and material, waste material, etc. ▪ Generation of solid wastes from labour camps / colonies ▪ Spillage or leakage of oil	▪ Proper treatment of quarry site, belly benching, Crate walls, re-vegetation and other measures ▪ Proper mitigation measures will be adopted during construction and temporary acquired land will be reclaimed after designated use ▪ Proper collection and disposal of construction spoils/ solid waste at designated landfill sites ▪ Refueling stations will be constructed and maintained so as to prevent spillage or leakage of oil.	SEW, Sub-contractor and Forest Dept., Bomdila

Parameters	Anticipated Impacts	Management Measures	Implementing Agency
Terrestrial Ecology	▪ Cutting of trees to meet fuel requirements by labour ▪ Acquisition of forest area ▪ Disturbance to wildlife due to operation of various construction equipment	▪ Adequate supply of kerosene/ LPG for consumption of labour colony so that dependence on firewood for cooking is avoided completely to the extent possible. ▪ Compensatory afforestation as per the Forest Conservation Act (1980) ▪ Contractual agreements will include penalties for poaching. ▪ Proper traffic management and safety measures should be adopted during construction period.	SEW/ Sub-contractor and Forest Dept.
Aquatic Ecology	▪ Marginal decrease in primary productivity due to increased turbidity and lesser light penetration ▪ Discharge of domestic waste water from labour camp	▪ Mitigation measures will include appropriate engineering design to minimize increases in suspended solids, including minimizing blasting. ▪ All justifiable measures will be taken to prevent the wastewater produced in construction from entering directly into rivers	SEW/ Sub-contractor
Public Health - water related diseases	▪ Increased hazards of outbreak of water-borne diseases as a result of lack of sewage treatment and disposal facilities in labour camps	▪ Reservoirs operation, surveillance, insecticide sprays, medical check-ups and development of medical facilities ▪ Maintenance of good drainage at overall construction areas to avoid creation of stagnant water bodies. ▪ Provision of septic tanks, absorption trenches and settling tanks	SEW and Public Health Dept.
Socio-economic	▪ Acquisition of land and other properties ▪ Increase in employment potential	▪ Compensation as per Rehabilitation Plan	SEW / District Administration
During Project Operation Phase			
Water Resources	▪ Reservoir sedimentation	▪ Catchment Area Treatment	Forest Dept. / SEW
Water Quality	▪ Disposal of sewerage from project colonies/ quarters	▪ Commissioning of STP	SEW
water related diseases	▪ Increase in water-related diseases due to creation of suitable habitants for growth of vectors	▪ Reservoirs operation, surveillance, insecticide sprays, medical check-ups and development of medical facilities	SEW and Public Health Dept.
Aquatic Ecology	▪ Reduction in natural flow of river due to diversion of water ▪ Natural ecological life will be hampered ▪ Expected ecological alterations due to reduction in environmental flow ▪ Obstruction in the path of migratory fishes	▪ 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. ▪ The water pool can be created artificially and converted that into natural breeding pools for insects and amphibians ▪ Stocking of reservoir and river stretch downstream and upstream of the dam	SEW/ Fisheries Dept. of A.R.
Socio-economic	▪ Increased power generation and greater employment opportunities	▪ 12% of the power generated will be provided to the State Government free of cost. ▪ Company shall contribute an amount @ one paisa per unit of electricity sold towards local area development fund	--

Summary of Impact on Land Acquisition

Type of Impact	Description	Extent of Impact
Impact on Private Property	Loss of Private Property due to Nafra Hydro Electric Project.	10 PAFs (5 from Khellong and 5 from Lower Jung)
	Loss to NCPL on loss of Resin Collection from Plantation on its Leased Forest Plantation Area	Plantation from 29.64 hectare
Impact on Community Land	Land Owned collectively by Village Communities due to Nafra Hydro Electric Project.	37.56 hectares of land
	Lease Price for the Land Temporarily Acquired from the Village Community	25.01 hectares of land
Impact on Government Land	Land to be temporarily acquired or leased from Government of Arunachal Pradesh.	5.32 hectares of land

Chapter 5

ENVIRONMENT MANAGEMENT AND MONITORING PLAN

5 ENVIRONMENT MANAGEMENT AND MONITORING PLAN

Based on the impact assessments made and mitigation measure in chapter 4, a more specific environment management plan is developed and discussed hereunder.

5.1 CONTROL OF POLLUTION FROM LABOUR CAMPS

The engagement of large labour population and technical staff during construction phase is likely to put significant stress as a result of discharge of sewage, solid wastes and other pollutants. About 400 worker and technical staff are likely to work during the peak construction phase in the project area. In addition to this, 5% of the total labour force is assumed to work as various service providers to them. This additional population in the project area is likely to affect the existing infrastructure. Thus, adequate provisions should be made to maintain quality of life in labour camps and people residing in the nearby areas do not suffer from any discomfort. Various issues covered in environmental management during construction phases are:

- facilities in labour camps
- sanitation and sewage treatment facilities
- solid waste management

5.1.1 Facilities in labour camps

It is recommended that project promoter should provide semi-permanent structures for their workers. These sheds can have internal compartments allotted to each worker's family. The labour camp site should have facilities like electricity, water supply and community latrines for the proposed construction activities. It is recommended that project proponent should provide a block of large rooms in which about 30-40 workers can stay. Community toilets for each block can be constructed at an easily approachable distance. During winter months, a central heating system can also be provided so that workers are not forced to cut trees to meet the fuel requirements.

Water requirements can be met by the river or nearby streams flowing upstream of the labour camps. The water can be transported to the point of consumption under gravity. The labour camp site is proposed at upstream of dam site and right bank of the river Bichom. Thus, water of Bichom can be used to meet the domestic requirements. However, it is recommended that bacteriological analysis of water to be done regularly. Normally, under such scenario, disinfection by chlorination is adequate. The chlorine dosage should be fixed judiciously so that there is adequate residual chlorine in water being used by consumers at various locations.

5.1.2 Sanitation facilities

Latrines should be provided to minimize sewage load in the river. Considering water requirement @ 70 lpcd[37], the total water requirement works out to 29.40 KLD. Considering sewage generation as 80% of the total water supplied, the total sewage generation works out to 23.52 KLD. As per the guideline given in *The Contract Labour (Regulation and Abolition) Act, 1970* provision of one community latrine for every 25 persons[38] and one urinal for every 50 persons have been kept in the

[37] CPHEEO guideline on recommended value for domestic and non-domestic purpose
[38] Chapter V *Welfare And Health of Contract Labour* ; Contract Labour (Regulation & Abolition) Act, 1970

project. The effluent from these latrines can be treated in septic tanks. Provision of soak pits should be made available along with each latrine.

5.1.3 Solid waste management from labour camps

During construction phase, labour, clerical staff and technical personnel are likely to congregate. The increase in population is expected to be of the order of 400. The solid waste likely to be generated from labour camp shall be approx 0.01 tones / day (considering average per capta solid waste generated @ 210 gm/day/person[39]) Adequate facilities for collection, conveyance and disposal of solid waste will be developed in the camp area. For solid waste collection, 2 numbers of vats (1 for each bio-degradable and non-biodegradable) should be provided at appropriate locations in labour camps. These vats should be emptied at regular intervals (every alternate day). The collected bio-degradable waste will be used for composting. A portion of non bio-degradable wastes can be sold and rest can then be transported to disposal site. Thus, volume of waste to be transported will be less. One small covered truck to collect the solid waste from common collection point and transfer it to the disposal site should be put to service.

5.1.4 Provision of Fuel

The necessary fuel wood requirement will have to be met through supply of fossil fuel or other alternatives to avoid impinging on traditional rights of the local community during construction phase. It is estimated that on an average about 400 people will be there at construction site for 3 years. Asuming 0.25 LPG cylinder required per person per month for cooking, total requirement of LPG will be about 1,260 cylinders per annum for 400 people. The total LPG requirement in project construction would be about 3,780 cylinders, which would cost to about Rs. 1.58 million. It would be economical if cooking of the food is done collectively. Hence, the project promoter may provide a canteen facility to its worker and should maintain it in an efficient manner. The use of non-renewable energy resources such as bio-gas, solar energy, or mini-hydro electricity projects may also be considered as alternative fuel source to reduce the load on conventional energy sources.

The cost for establishment and management of basic infrastructure in the labour camp has been earmarked Rs.9.53 million. The details are given in **Table 5.1** and a typical layout for various facilities is given in ***Annexure XII.***

Table 5:1 Cost required for establishment and management of various measures for environmental management in labour camps

S.No.	Activity	Amount (Rs. million)
1	Establishment of Dwelling Units for work labours	3.42
2	Sanitary facilities in labour camps	0.98
3	Supply of water with chlorination unit	0.23
4	Canteen block	1.75
5	Fuel supply	1.58
6	Solid-waste management	1.57
Total		**9.53**

[39] CPHEEO guideline on *composition and quantity of solid waste*

5.2 ENVIRONMENTAL MANAGEMENT FOR ROAD CONSTRUCTION

Nafra dam site is approachable through PWD road from Bomdila and Power house site is approachable through same road leading to Bichom. However access roads to work sites will have to be constructed as a part of the access to the construction site. In a hilly environment, landslides are often triggered due to road construction because of the loosening of rocks by water trickling from various streams.

In hilly terrain, road construction often generates significant quantity of wastes (muck) due to the stripping of the rocks to make way for the roads. It is recommended that 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. After disposal operation is complete at the dump site, dump yard should be contoured and vegetated. Various aspects to be considered while making the project roads are briefly described in the following paragraphs.

5.2.1 Construction

- The method of balanced cut and fill formation shall be adopted to avoid large difference in cut and fill quantities.
- Where rock blasting is involved, controlled blasting techniques adopted to avoid over-shattering of hill faces.
- Excavated material should not be thrown haphazardly but dumped duly in a suitable form at appropriate places where it cannot get easily washed away by rain, and such spoil deposits should be provided with some vegetative cover.

5.2.2 Drainage

- Drainage of the water from hill slopes and road surface is very important. All artificial drains shall be linked with the existing natural drainage system.
- Surface drains shall have gentle slopes. Where falls in levels are to be negotiate, check dams with silting basins shall be constructed and that soil is not eroded and carried away by high velocity flows.

5.2.3 Grassing and Planting

- Tree felling for road construction/ works will be kept bare minimum and strict control must be exercised in consultation with the concerned Forest Department. New trees will be planted in consultation with the concern forest department as an integral part of the project.
- Depending on the availability of land and other resources, afforestation on roadside land will be carried out to a sufficient distance.

An amount of Rs. 76.9 million can be earmarked for this purpose. This include cost for construction of 5.0 / 7.5M wide project road for approx 5.35 km and Improvement of exiting project road for approx 2.0 km, provision of breast walls, construction of catch water and interceptor drains, provision of drainage system along roads, planting and grassing works, roadside plantation, sprinkling of water through tankers on roads etc . The cost for this aspect has already been included in the project cost. Hence, the same has not been included in the cost required for implementation of EMP.

5.3 QUARRY STABILISATION AND MUCK DISPOSAL PLAN

Muck generated from excavation is required to be disposed in a planned manner, so that it does not lead to adverse impacts on environment. The muck disposal plan is outlined in the following paragraphs:

5.3.1 Quarry Sites

It is proposed to remove the vegetative cover and overburden from the quarry and stored separately in the same order they were extracted. This will help in reuse of the same at a later stage. After excavation of the material, the overburden should be backfilled to moderate the gradient. The soil can then be spread over and the area can then be planted with grass and tree species.

No restoration measures are necessary for river bed excavation, as it get filled up naturally with silt and sand with due time (e.g. during subsequent monsoon season).

5.3.2 Muck Generation, Reuse and Disposal

The muck generated will be 4.78 lacs cum of which approximately 60-80 % (i.e. 2.87- 3.82 lacs cum) shall be reused in the other works of development or in ground/stony waste filling areas, filling of plinth areas / floors of camp buildings, wire crates, soling, retaining wall, embankment protection works in other projects, landscaping etc. Also, the reuse percentage shall be more in the first and last year of construction phase for the obvious reasons of more landscaping and filling works. In order to make maximum use of muck, it is proposed to use suitable material for other projects, which would otherwise require to be taken from borrow areas. This ensures beneficial use of otherwise waste materials. The balance 20-40 % (i.e. 0.96- 1.91 lacs cum approx.) will be disposed off at designated sites. The quantity of excavated material from various structures of proposed Project has been provided in **Table 5.2**.

Table 5:2 The quantity of excavated material from various structures

Sl. No.	Project Component	Approximately Muck Quantity Cum (Lacs)
1	Upstream Structures i.e. Dam works, river diversion, intake, upstream stretch of HRT upto 0.8 Km	2.50
2	Surge Shaft ,D/s HRT, Adits, Part penstock	0.61
3	Pressure Tunnel, Power house, Tail race channel etc.	1.67
Total		**4.78**

5.3.3 Selection of Muck Disposal Sites

The muck disposal sites are selected based on site inspections and available best conditions of the land availability, land stability, accessibility from the portals, sloping pattern, minimum vegetative and tree cover, presence of ecological sensitive areas, river bed conditions and high flood levels of the Bichom River. Their dumping areas and capacity is given in **Table 5.3** and their locations are presented in ***Annexure XI***. The total area earmarked for dumping is 8.28 ha the general layout of identified muck disposal site is given in ***Annexure –XIII.***

Most of the total unused excavated material (approx 20 - 40%) would be piled at an angle of repose (<27°) at the proposed dumping sites. This will be done to provide stability to the slopes and also to

provide ample space for planting of trees which would further help in holding and consolidating the material stacked at different sites. The efforts will be made to relocate and rehabilitate the material within short distances from sites of its generation.

Table 5:3 Details of muck dumping areas

Label in Index Map	Disposal area	Description	Area (Ha)
M1	Muck Dump Area-1	Adjacent to the proposed Facility Area (Q1) at the right bank of the river	4.60
M2	Muck Dump Area-2	Near the approach road to surge shaft (E) at the right bank of the river	3.68
Total Area For Muck Disposal			**8.28**

The protection structures at the edges of the dumping area shall be in cement concrete and masonry and shall be of adequate strength to withstand the pressure of the dumped material. The dumping areas are located at a safe distance form the High Flood Level.

5.3.4 Restoration works

The muck disposal sites after dumping will be restored. Preserving topsoil from the quarry compound will be done by stripping and stacking aside separately at corners. Following civil works are proposed:

- Retaining wall varying from 2 to 7 m of height will be provided to prevent the dumped material from sliding.
- One meter terracing along the contour at 5 m interval along the slope in staggered manner will be done.

The uphill side of the terraces will be provided with the walls/ edging of 50 cm height and 50 cm thicknesses to protect the uphill side of the terraces from slipping

5.3.5 Fencing and Planting

After the completion of civil works, dumping sites will be fenced with the barbed wire in strands with two diagonal strands using wooden fence posts 3 m apart and planting will be done by adopting various vegetative measure.

5.3.6 Vegetative measures

The work plan formulated for re-vegetation of the dumping sites through 'Integrated Biotechnological Approach' is based on following parameters:

- Evaluation of dumped material for their physical and chemical properties to assess the nutrient status to support vegetation.
- Formulation of appropriate blends of organic waste and soil to enhance the nutrient status of rhizosphere.
- Isolation and screening of specialized strains of mycorrhizal fungi, rhizobium, azotobacter and phosphate solubilizers (biofertilizers inoculum) suitable for the dumped material.
- Mass culture of plant specific biofertilizer and mycorrhizal fungi.

- Plantation of dumping sites/areas using identified blend and biofertilizer inoculum.
- Suitable tree and shrub species should be planted after fencing the area.
- Grass can also be distributed

5.3.7 Choice of Species for planting

The tree species and grasses to be planted will be done in consultation with the concerned Forest Department. The afforestation with suitable plant species of high ecological and economic value and which can adapt to local habitat will be undertaken @ 1100 plants per hectare[40] depending upon the canopy cover required. The common tree found in the area is given in table below:

Table 5:4 Species to be planted at muck disposal site (s)

Scientific Name	Family Name
Lyonia ovalifolia (Wall.) Drude	Ericaceae
Urena lobata L.	Malvaceae
Bombax ceiba L.	Bombacaceae
Oxyspora paniculata (D.Don) DC.	Melastomaceae
Cannabis sativa L.	Cannabaceae
Streblus asper Loureiro.	Moraceae
Boehmeria penduliflora Long.	Urticaceae
Milletia pachycarpa Benth.	Fabaceae
Emblica officinalis Gaertner.	*Euphorbiaceae*
Pinus roxburghii Sargent.	Pinaceae

5.3.8 Environmental Mitigation Measures

- As describe in the previous chapter, the identified mucking locations are on the right bank of river Bichom (refer Annexure XII). This site is environmentally the most preferable as the site is essentially of minimal land use value and least environmental impact is anticipated.
- The muck disposal carrier/ transportation will be covered with water resistant sheets such as tarpaulin proof material during transportation of muck construction material to disposal sites.
- The haul road at the construction site should be inspected regularly and the debris left by the trucks should be removed to the muck retention sites as early as possible.
- Provision for water sprinkling on haul roads will be made to suppress the fugitive dust.
- During loading and unloading activities the workers will be provided with ear muff, hand gloves, safety shoes, gumboots and helmets for safety purposes.
- Ambient air quality and noise levels shall be monitored during construction and muck disposal.
- Mechanical device, such as chain roller will be used for proper compaction of disposal material.
- On completion, entire muck disposal area will be provided with good earth on the top and dressed neatly and suitable grass species will be broadcast.

[40] Operational Guidelines For The Tenth Five-Year Plan, Moef

- Afforestation of suitable trees and shrubs of native species will be carried out after muck disposals. Combination of trees, shrubs and grasses suited to the project site will be planted. Species to be planted are given in **Table 5.4**. This would reduce the pollutants levels by 30% of the concentration of pollutants at ground levels. This will also control the soil erosion.

The forest land diverted for muck dumping sites are only of temporary nature and shall be returned to Arunachal Pradesh Forest Department after proper reclamation and rehabilitation

5.3.9 Maintenance

Possibility for watering the plants at least for early two years of planting shall be explored. Maintenance of the plants shall be for three years. The dead plants will be replaced, fenced and be repaired if damaged. A provision of Rs 6.76 million has been earmarked for stabilization and restoration of muck disposal site. The details are given in **Table 5.5.**

Table 5:5 Cost for stabilization and restoration of Muck Disposal

Sl. No.	Item	Amount (Rs. million)
1	Construction of check dams along periphery of muck disposal sites	1.00
2	Site Clearance for dumping area and compaction for different layers	2.23
3	Provision of 15 cm soil layer over an area of 10 ha and Stabilisation and re-vegetation of dumped material	3.53
Total		**6.76**

5.4 CONTROL OF WATER POLLUTION

During Construction:

Sufficient measures need to be implemented to ameliorate the problem of water pollution from various sources. The construction activities would require a crusher to crush large lumps of rocks to the requisite size for coarse as well as fine aggregates. The effluent generated from these crushers will have high suspended solids. The effluent shall be treated before disposal. Settling tanks of appropriate size for treatment of effluent from various crushers shall be provided.

During tunneling work the ground water flows into the tunnel along with construction water which is used for various works like drilling, etc. The effluent thus generated in the tunnel contains high suspended solids. Normally, water is collected in the side drains and drained off into the nearest water body without treatment. It is recommended to construct a settling tank of adequate size to settle the suspended impurities. The sludge from the various settling tanks can be collected once in 15 days and disposed at the site designed for disposal of municipal solid wastes from the labour camps. The sludge after drying will also be used as cover material for landfill disposal site. A total of Rs.0.5 million shall be earmarked for construction of settling tanks for treatment of effluents from crusher and tunneling and a total amount of Rs. 0.23 million has been kept for water quality monitoring, the details has been given in Chapter 5- Environmental Monitoring Programme.

During Operation:

A project colony with about 40 quarters has been proposed to be set up. It is recommended to commission suitable treatment facilities to treat the sewage generated from the colony to avoid

deterioration of water quality of the receiving water body. The cost required for construction of these facilities in the project colony has already been covered in the budget earmarked for construction of the project colony. Hence, cost for the same has not been included in the cost for implementing the Environmental Management Plan (EMP).

5.5 CONTROL OF AIR POLLUTION

The air pollution is basically generated due to primary crushing and fugitive dust originating from the heap of crushed material. It should be mandatory for the contractor involved in crushing activities to install cyclone precipitator in the crusher to control the dust generated while primary crushing of the stone aggregates. The fine aggregates after crushing needs to be stacked till the time it is consumed. It is suggested that these stacks should be regularly sprayed with water to prevent the entrainment of fugitive emissions.

In addition, fugitive emissions are also likely to be entrained as a result of movement of earth movers, excavation of earth, vehicular traffic on unpaved roads, etc. It is recommended to spray water over such areas to prevent entrainment of fugitive emissions on regular basis. As well as complying with the terms and conditions laid down in the CFE and CFO by the state pollution control board, which generally include providing metallic road inside plant campus for movement of vehicles, plantation, periodic (monthly) pollution monitoring i.e. ambient air, noise and stack emission should be strictly followed during operation of plants. A total amount of Rs. 2.77 million has been kept for ambient air quality monitoring, the details has been given in Chapter 5- Environmental Monitoring Programme and cost for Provision for water spray has been kept in civil cost.

5.6 NOISE CONTROL MEASURES

Noise pollution can be mitigated at the source itself. The ambient noise levels would increase marginally up to about 1 km from the major construction sites. The effect of high noise levels on the construction labour is to be considered. It is known that continuous exposure to noise levels above 90 dB (A) affects the hearing of the workers/ operators and hence has to be avoided. Other physiological and psychological effects have also been reported in literature, but the effect on hearing acuity has been specially stressed. To prevent these effects, it has been recommended by international specialist organizations, i.e. Occupational Safety and Health Association (OSHA), that the exposure period of affected persons be limited as specified in **Table 5.6**.

Table 5:6 Maximum Exposure Periods specified by OSHA

Maximum equivalent continuous noise level dB(A)	Unprotected exposure period per day for 8 hrs/day and 5 days/ week
90	8
95	4
100	2
105	1
110	1/2
115	1/4
120	No exposure permitted at or above this level

The contractor will be required to maintain properly functioning equipment and comply with occupational safety and health standards. The construction equipment will be required to use available noise suppression devices and properly maintained mufflers. Use of personal protective

equipment will mitigate the adverse impacts of noise generated by the construction equipment on personnel. During excavation of earth, cutting of rock, crushing, loading and transportation activities, the noise generated will be in the range of 90 -130 dB (A), if all the above activities are carried out simultaneously. Hence, it is suggested that they should be provided with effective personal protective measures such as ear muffs or ear plugs to be worn during periods of exposure. The other measures to control noise could be as follows:

- Equipment and machineries should be maintained regularly to keep the noise generation at the design level;
- Silencers and mufflers of the individual machineries to be regularly checked.
- Effective traffic management to be undertaken to avoid significant delays in and around the project area

A total amount of Rs 0.72 has been kept for ambient noise monitoring, the details has been given in Chapter 5 - Environmental Monitoring Programme.

5.7 RESERVOIR RIM TREATMENT & SOIL EROSION CONTROL

A reservoir of gross storage capacity of 5.267 MCM and length of approx 2448 meter in upstream of the dam has been proposed. An area of about 32.67 ha. including riverbed will submerge in the reservoir. Keeping in view the physiography, drainage pattern, slope aspect, land use / land cover etc., the landslide and related studies of reservoir has been carried out using LANDSAT imagery (IRS-P6, LISS-III) and survey of India topographic sheet (No. 83 A/11). The outcome of the studies has been used to assess and evaluate the possibility of any potential danger to the project and any unforeseen eventuality in the reservoir area. The result topographic and geotechnical studies of the reservoir show that:

- Studies based on LANDSAT imagery with limited field checks indicate that there is no possibility of danger from any major land slide into the reservoir and in its catchment.
- Most of the landslides noticed in the area are in a stable state and as such will not pose any danger to the reservoir. Occasional rock falls of local nature can be occurred which also will not have any impact to the structures.

Based on the outcome; for mitigation of the adverse affects of the natural processes and anthropogenic activities envisaged during and after the project construction around the dam site, following things have been taken into consideration:

1. Proper muck disposal sites have been identified to avoid muck going into the river. Faces of open excavation and filled up areas as a result of the construction activities will accelerate the soil erosion, which may obstruct the natural drainage if not prevented.
2. Creation of a green belt around the reservoir periphery is recommended. Green belt around the reservoir will be created to avoid erosion of soil and prevention of land slips from the direct draining catchment into the reservoir. The creation of green belt on either side of the reservoir will ensure protection of the reservoir rim area from any minor slips due to fluctuation in the water level.
3. The slopes on both the banks will also be planted with suitable tree species for creation of a green belt around the reservoir rim. In areas with moderately steep slopes indigenous,

economically important, soil binding tree species will be planted, which are able to thrive well under high humidity and flood conditions. The reservoir area will give an aesthetically look and can cater the recreation needs of the local population and attract tourists.

4. Soil erosion control measures will include bio-engineering measures, vegetative measures, reduction in use of fuel wood and management measures. These measures are used to improve slope stabilization by breaking the slopes and covering them with vegetation.

   Bio-engineering measures consist of intercepting ditches, check dams retaining walls, debris basins, and construction of bench terraces. These structures should be designed for safe runoff disposal.

   Vegetative control measures include mixed plantation of coniferous and broadleaf trees, in combination with bushes and grasses. The main factors determining vegetative growth are soil and moisture, which are closely related to the slope and its orientation. A combination of trees, shrubs and grasses suited to the characteristics of a particular site should be planted.

A provision of Rs.0.50 million including the cost of nursery, plantation and fencing has been made. The plantation for this purpose will be carried out with the participation of the State Forest Department.

5.8 ENHANCEMENT OF TERRESTRIAL ECOLOGY

The local population is now dependent on fuel wood for their energy requirement. The requirements of fuel wood for heating and cooking can be replaced by cheap electricity generated by hydropower project. This wills ultimately reduce deforestation. In addition to this, compensatory afforestation has been suggested in lieu of acquisition of this land as a part of Environment Management Plan.

A reservoir of an area of about 32.67 ha will be created with the damming of river. The reservoir banks will have wet environment throughout the year leading to propagation of vegetation e.g. grass, etc. along the reservoir banks. Such conditions are generally ideal and expected to increase the population of various kinds of birds, especially water birds. For qualitative & quantitative assessment of flora and fauna and monitoring of restoration of muck disposal area in the project area, a survey will be conducted once every year for the entire construction period. A provision of Rs.1.5 million per study will be earmarked for this purpose. The monitoring can be done by external agency to be finalized in consultation with the state forest department.

5.9 MANAGEMENT OF AQUATIC ECOLOGY

5.9.1 Release of minimum flow

The construction of the proposed project will lead to reduction in flow, especially during dry months, in the intervening stretch between the Head Race Tunnel (HRT) site and the discharge point of Tail Race Tunnel (TRT). Such a situation will affect the benthic communities and fish especially in the above stretch (3.68 km). The natural flow in river is available just after the confluence point of TRT and the river Bichom. A minimum flow of approx 0.913 cumec during lean season will always be available in that stretch, which can be justified as follows:

- Bichom River is perennial as well as snow fed; thus total volume of water with natural flow will be sufficient.

- Apart from that, other adjoining perennial tributaries such as Divya Nallah (major) and two more minor tributaries (just downstream of dam site one after another) with average flow of 15.97 cumecs are joining the river Bichom on the left bank of the river in between the stretch of 3.68 km, which in turn would increase the flow to some extent.
- The water current in the river Bichom is 50 cm/ sec (as studied during ecological study), which is ecologically considered to be fast. Algae have been identified during the baseline study, which is the main food of Trout Fishes available in the river.
- Due to the above velocity in river Bichom available in all the season; no spawning habitat for fish has been found in the river.
- After the discharge point of TRT in the River Bichom, natural flow in river will again be available.

However, it is assumed that river biodiversity in the modified stretch will become the habitat for a number of plant and animal species. In this both flora and fauna will occupy the stretch (a) some will expand the distributional range (b) some for breeding. The flow study has been carried out using HEC-RAS 4.0 Beta software, detail has been provided in ***Annexure VI.***

Proposed Activity in the ecologically changed river stretch due to diversion of water:

- The fish spawn of selected species can be generated in the sites by establishing the "fish breeding center". The fingerling, thus produced can then very well be released in the lower stream and upper stream of the river Bichom to maintain the fish diversity in the river. The technical expertise is available with the Fishery Department, Arunachal Pradesh.
- The water pool can be created artificially by removing few big boulders and converted that into natural breeding pools for insects and amphibians.
- A biodiversity research and monitoring centre, including a museum, can be established to over see the actual positive and negative changes in terms of biodiversity

5.9.2 Reservoir & River Fish Management Plan

The proposed reservoir will be as per general expectation, a fishery and site of high aesthetic value. Fisheries are not well developed in the project area and large scale fishing is not being practiced. Only few individuals catch fish for their own consumption (observed during field study). The proposed reservoir with its large volume of water storage will provide opportunity for commercial fishery development. This will even supplement the subsistence fishing activities in upstream and downstream of the dam site. Overall, this would improve the availability of fish for local population and may play an important role in the growth of local economy. On the basis of the discussion with the locals, fishery department, fishery experts, **Table 5.7** on feasibility of fishery development has been prepared.

Table 5:7 Assessment of feasibility of fishery development in the project area

Questions	Answers	Assessment
Is the fishery for Local consumption only?	Not only for local consumption.	Due to the non availability of the wild animals in the region, fish demand has increased
Is the fishery will be for commercial purpose?	Yes. A part will be commercial, after covering the local demand	Some fishes are being imported in the township including Nafra township

Questions	Answers	Assessment
Is that for both local consumption and commercial purpose?	A commercial angle is expected for the benefit of the local entrepreneurs	It is expected that efficient land communication and storage facilities will increase the chances of commercial venture
Does the local population have preference of fishes for consumption?	Generally there is no specific fish preference, but large sized fishes are easy to eat, high price (if sold), can be kept for longer duration through smoking.	In fast flowing water, it is the luck and chance that dictates the availability of fish species. Hence, identification of specific preference is difficult.
Will the local people accept large scale production for commercial purpose?	Local will prefer large sized fishes for mass production. Of course there will be very less chance of increase the shelf life through refrigeration at present. Uninterrupted supply of electricity may offer a better chace of strage..	At present there is no exercise in this regard and local people cannot visualize the opportunities
Should the fishes be selected for production that can be used as “dry fish”?	Large sized fishes are preferred for dry preservation. This is economical, as both processes of smoke drying and refrigeration (if initiated). Though commercial dry fish production has not been seen and the expertise is also not available.	People take dry fishes, which are brought from outside. Local scientific dry fish production is almost non existence
Will the preferred fishes; both for taste and commercial production can be introduced in the dam reservoir?	Yes. Chocolate mahseer, Snow trout, and Golden mahseer and some carps can be introduced.	Fishery department of Arunachal Pradesh has already initiated cold water fishery in a number of areas
Are the technologies available?	Cold water fishery Technology is available. Already practiced in Arunachal Pradesh.	In the near future cold water fisheries will be vigorously pursued in Arunachal Pradesh
Are there any success stories in such a venture at the state?	Yes. Umium Hydro-electric project reservoir. Meo wetlands at Arunachal Pradesh	Govt of India, under the leadership of the Institute of Cold water fisheries at Bhimtal, has initiated massive cold water fishery in various states of high altitude including Arunachal Pradesh.

Any fish, locally available will be acceptable to the people. They do not have any idea or experience about the commercial fishery and the prospects and the benefit to the locals. They used excess catch as “*smoked fish”* and other dry fishes available in the market which are brought from Assam.

The protein source for the people is mainly from wild meat. The poultry and piggery is not reached to all the people and particularly the poorer section of the society. Hence, any form of protein supplement will be well accepted. Population of the area is meat or fish eater.

Prospect:

The Chocolate mahseer (*Neolissocheilus hexagonolepis*) has a very wide temperature tolerance, hence, could be cultivated in an wider altitudinal range. In the reservoir of Umium Hydro-electric

project (Barapani), at Meghalaya, it was being successfully introduced during seventies. Still are being used by the local people. The chocolate mahseer has been successful introduced in the 2000 feet altitude, in Arunachal Pradesh, at the natural wetlands at Mao. This was initiated on the basis of the earlier studies (Boni Amin Laskar, *et al.* 2009)[41]. The brood stock production can very well be done in earthen pods and release to the reservoir.

The migration against the current by the migratory fishes during spawning is an essential characteristic. In the receiver, the hill stream fishes like chocolate mahseer, during breeding is expected to migrate toward the inflow sites, and find suitable locations for spawning. Hence the construction of fish ladders would not be successful.

As per discussion, it is expected that the Department of Fishery, Itanagar, Arunachal Pradesh and expertise available in Rajiv Gandhi University, Itanagar, Arunachal Pradesh fishery development can be successfully implemented at the project site.

Fish Spawning and Stocking of Fingerlings

It is proposed that the reservoir and river stretches down stream and upstream of the proposed dam be stocked with fingerlings. A very small population of fish has been reported in the river water. To keep them alive a minimum perennial flow would have to be maintained by providing an opening in the dam body at crest level. A fish ladder or fishway on dam structure would facilitate movement of migratory fish across the dam. Aquaculture is likely to flourish in the reservoir water. Fish spawning in flowing water depends on the velocity of water as under:

Sl. No	Spawning Features	Velocity (Km/hr)
1.	Span dispersed irregularly	0.0
2.	All spawning stationary	0.09
3.	Spawning migrate upstream and some taking shelters	0.14 - 0.21
4.	Spawn carried downstream	0.36 - 0.42

The anticipated time to establish fish stocks would depend on the species selected for introduction. In a stocking programme, a rapid increase in abundance is expected in those portions of the reservoir, where stocking is introduced as compared to the other areas of the reservoir. Thus, it is expected that in areas where fish is stocked, significant stocks might develop in 2 to 3 years. The length of time required to achieve quicker results could be reduced considerably by multiple stocking.

At present, due to very steep bed slope, velocity of flow in river Bichom is higher than 0.42 km/hr in all the seasons hence no spawning habitat for fish is found in the river.

5.9.3 Sustenance of Endemic Fisheries

Snow trout (*Schizothorax richardsonii*) is the endemic species. The dam constructed as a part of Nafra HE project puts a barrier to the free movement of fish species. Thus, scientific management of the existing stock needs be adopted.

It is proposed to implement supplementary stocking programme for the project area. It is proposed to stock the river on the upstream and the downstream sides of the TRT discharge point. The rate of

[41] Boni Amin Laskar, D. N. Das and B. C.Tyagi 2009. "Growth performance of the Chocolate mahseer *Neolissocheilus hexagonolepis* (Mc Clelland) in the pond system in Arunachal Pradesh". *Indian J. Fish, 56 (1) :55-59*

stocking is proposed as 100 fingerlings of about 30 mm size per km. The stocking can be done annually by the Fisheries Department, State Government of Arunachal Pradesh. To achieve this objective, facilities to produce seed of trout need to be developed at suitable sites.

The above facility can be developed and implemented by Fisheries Department, State Government of Arunachal Pradesh at an appropriate site. Seeds can be transported from this hatchery. The supply of seeds can be augmented by collecting them from natural sources. Since production, transportation and stocking of fish material is a highly technical subject for which project proponent may not have the required expertise. Thus, implementation of this proposal may be done by the Fisheries Department, Arunachal Pradesh. The management plan for sustenance of riverine fisheries will also be reviewed by the Fisheries Department. The cost required for non-recurring expenditure i.e. developing of hatcheries, office complex, laboratory etc. shall be Rs. 2.11 million. The dimension of the hatching nurseries and rearing unit and their approximate cost is given in **Table 5.8**. The recurring expenditure for hatchery will be Rs. 1.62 million/year. The total recurring expenditure for 3 years including 10% escalation will be Rs. 5.35 million. Thus total cost for fish Hatcheries farm will be Rs.7.46 million.

Table 5:8 Cost required for development of Hatcheries

Sl. No.	Particulars	Area / Rate (Rs. in Lakh)	Amount (Rs. in Million)
A	**Non recurring Expenditure**		
1	Construction of Hatchery (Hatchery building (one concrete hall with provision of hatching troughs each with 4 trays) for production of fingrines-1 No.	15x6x5 m	0.73
2	Nursery ponds -10 No.	5x2x1m	0.12
3	Rearing Ponds -4 No.	10x5x2m	0.21
4	Stocking Ponds -2 No.	30x10x3m	0.47
5	Office Complex, with all infrastructure and separate provision for store and two laboratories and fish feed room etc. -1 No.	8x6 m	0.38
6	Watchmen hut -1 No.	4x4 m	0.10
7	Other items like Dragnet, wide mouth earthen pots, bucket, bamboo patches etc.	Lump Sum	0.10
Sub Total (A)			**2.11**
B	**Recurring Expenditures**		
1	Salaries		
i	Farm Manager -1 No.	0.25/ month	0.30
ii	Farm cum Reservoir Assistant-1 No.	0.20/ month	0.24
iii	Farm Attendants-2 No.	0.08 / month	0.19
iv	Chowkidar-1 No.	0.07 / month	0.08
2	Fish seed (carried over seed with A V. Weight 25 gm each 10,000 nos.)	Lump Sum	0.022
3	Fish food(rice bran oil cake)1:1	Lump Sum	0.100
4	Nursery and Rearing tanks management (Lime, natural fertilizer, wages nursery and etc.)	Lump Sum	0.180
5	Brooders tank management (Lime, fertilizer, artificial food, prophylactic measures, netting and etc.)	Lump Sum	0.100
6	Training and research	Lump Sum	0.100

Sl. No.	Particulars	Area / Rate (Rs. in Lakh)	Amount (Rs. in Million)
7	Maintenance	Lump Sum	0.100
8	Travel	Lump Sum	0.100
9	Contingency & miscellaneous expenditure	Lump Sum	0.100
Sub Total (B)			**1.62**
Total Recurring expenditure for three-year including 10% escalation (B)			**5.35**
Total cost (A+B)			**7.46**

5.10 PUBLIC HEALTH DELIVERY SYSTEM

5.10.1 Development of medical facilities

A population of about 400 is likely to congregate during the construction phase. There is Primary Health Centre (PHC) in Nafra Village. During the construction of dam burgeoning human population (as workers), vehicular movements, sound level, dust (SPM and RSPM), gases like NO_2, SO_2, CO etc. are expected in this region. The sudden increase of the population in the locality could affect the physical and mental health of people involved in the project. The migrant population may introduce new disease carrying agents into the local environment. As the migrant population would be sharing the public service infrastructures such as road, transport, and market places they would come in close interaction with the local population. Through this intermingling, both the migrant population and the local population would get exposed to diseases hitherto unknown to them. Precaution should be taken to monitor the contagious and viral diseases that could have serious impact. The local population engaged as wage labors may not have earlier experience of working in construction activities. They would thus be exposed to a range of chemical and mechanical processes, increasing the risk of health hazards. In addition to this, the accidents in the construction site causing both minor and fatal injuries to the workforce needs medical attention too.

The migrant population would come from a very different eco-zone and climatic condition. Hence, they would face problem in getting adjusted to the new eco-climatic condition. They would surely be prone to seasonal common ailments that would be requiring medical attention. The children migrating with their parents would be required to be vaccinated and provided medical care and services. Addition to this, It is possible that during the construction work, the technical staff operating different equipment is not only exposed to the physical strain of work but also to the physical effects of the environment in which they are working. The workers and other technical staff may come up with common manifestations such as insect bites, fever, diarrhoea, work exhaustion and other diseases, which they are suffering. In addition they may invariably come up with injuries caused by accidents at work site. Under all circumstances, workers need immediate medical care. Therefore, it will be the responsibility of the project authorities to make provisions upgrading at 1 primary health centre (at Nafra); which is easily accessible from these sites and at least two first aid posts are to be provided at each of the major construction sites, so that workers are immediately attended to in case of an injury or accident. This upgraded PHC will not only cater to the workers and labourers engaged in the project construction work but will also provide medical services to the population of surrounding villages as there is an acute shortage as well as urgent need of these facilities. In addition one ambulance shall also be stationed at a suitable place to provide emergency medical facilities in the project area and carry patients to the Bomdila District Hospital as the case may be. It

is also proposed to extend these facilities to the local public This first-aid post will have at least the following facilities.:

- First aid box with essential medicines including ORS packets first-aid leaflet issued by directorate general factory advice service & labour institutes ministry of labour & employment, Government of India
- Stretcher, wheel chair, etc.

The first aid post can be housed in temporarily erected structure and should be managed by one Health Assistant and assisted by one dresser/first aid attendant. Doctors from the upgraded PHC can attend First Aid post regularly every day at a fixed time. There should be communication to establish link between the PHC and first-aid post, so as to enable doctors from PHC to reach the work site in case of an emergency. The first aid post should have facilities such as firefighting equipment and telephone connection.

5.10.2 Health & Safety of Labour

The health extension activities will have to be carried out in the villages situated in the nearby areas. It is important to inculcate hygienic habits of environmental sanitation especially with respect to water pollution by domestic wastes. There will be possibility of the transmission of communicable diseases due to migration of labour population from other areas at the construction site. The doctors from the dispensary should make regular visits to these villages and organize health promotional activities with the active participation of the local village Panchayat, NGOs and available local health functionaries. The health functionaries will undertake the following tasks as a part of health promotional activities:

- Collect water samples to ascertain the potability of water from different sources so as to monitor regular disinfection of drinking water sources.
- Maintain close surveillance on incidence of communicable diseases in these villages.
- Maintain close liaison with the community leaders and health functionaries of different departments, so that they can be mobilized in case of an emergency.

The estimated cost for establishing First-aid posts and up-gradation of the PHC is 13.24 million. It is assumed that initially all the running and maintenance of expenditure would be borne by the project proponent for a period of at least 3 years; thereafter it will be taken over by the state medical department. The cost estimate for development of medical facilities is given in **Table 5.9**.

Table 5:9 Cost estimate for development of medical facilities

Sl. No.	Particular	Number	Amount (in million Rs.)
A: Non-recurring Expenditure			
1	Up-gradation of PHC	1	1.50
2	Construction of First Aid Posts	2	0.40
3	Cost for ambulance*	1	0.00
4	Equipment, laboratory facility, furniture etc.	Lump sum	0.30
Sub-total (A)			**2.20**
B: Recurring Expenditure			
1	salary & wages		
i.	Doctor	1 @30,000 per month	0.36
ii.	Health Assistant	2 @16,000 per month	0.38
iii.	Nurse	1 @ 12,000 per month	0.14
iv.	Male Multi-purpose Health Workers	2 @ 12,000 per month	0.29
v.	Dressers	5 @ 7,000 per month	0.42
vi.	Drivers	2 @ 6000 per month	0.14
2	Medicine and miscellaneous expenditure	Lump sum	0.50
3	Maintenance & fuel of ambulance	Rs.8000 per month	0.10
4	Training on HIV/AIDs awareness and Safety issue	Lump sum	0.50
5	Contingencies	Lump sum	0.50
Sub-total (B)			**3.34**
considering 10% escalation per yes for three year			11.04
Total Amount			**13.24**

**Cost included in civil cost, hence not included*

5.11 BIODIVERSITY CONSERVATION AND WILDLIFE MANAGEMENT PLAN

The need for conservation, preservation and management of biological diversity arises because of threats to natural terrestrial and aquatic ecosystems by anthropogenic activities. In the present project adverse impacts may arise as a result of construction of dam and other associated activities of proposed Nafra Hydro Electric project. The adverse impacts are likely to arise as a result of project road construction, blasting, excavation for tunnels, quarrying, dumping of excavated material and human population pressure on land and biological resources. In view of the foreseen disturbance and degradation of natural ecosystems, a biodiversity conservation and management plan for proposed project area has been proposed.

5.11.1 Wildlife Conservation

There is no conservation/ preservation area in the form of any wildlife sanctuary, national park etc. in and around the proposed project area. The project, therefore, does not pose any threat to an ecosystem or species of conservational significance. However, increased pressure of labour force can also marginally contribute to the degradation of the existing forest. In the project area, no major wildlife is reported. Incidentally most of the project works are restricted to areas which are under human activities such as community land. Keeping in view the concern for wildlife enhancement in

the region, this project envisages a contribution of Rs. 0.5 million towards any ongoing programme for wildlife enhancement, through the state forest department under the direct administrative control of the Principal Chief Conservator of Forest.

5.11.2 Compensatory afforestation

The Conservator of Forest followed by Range Officer in charge of the area is responsible for conservation and management of forest in the project area. The Forest Conservation Act of 1980 has stipulated strict forest protection measures and outline procedures for compensatory afforestation if the department agrees to diversion of forest for non-forest purposes.

- If non-forest land is not available, compensatory forest plantations are to be established on degraded forest lands, to the extent twice the forest area affected or lost, and
- If non-forest land is available, compensatory forest plantation are to be raised over an area equivalent to the affected or lost forest area.

About 32.12 ha of forest land (29.64 ha permanent and 2.48 ha temporary) is to be acquired for various project appurtenances. As per the Hon'ble Supreme court's order the project area can be classified as Eco-Class-V covering Sub-tropical Broad leaved forest and Sub-tropical Pine forests[42]. As a compensatory measure for loss of forest land, it is proposed to afforest double the amount of forest land being acquired for the project i.e. 59.28 ha of land has to be afforested. The compensatory afforestation work to be done by forest department and state forest research institute (SFRI).

The cost of compensatory afforestation for has been kept Rs. 1.5 million. In addition project proponents will also pay cost of net present value (NPV) of the forest land being diverted for non-forest purpose under the Forest (Conservation) Act, 1980. This cost shall be estimated by Forest Department.

A total provision of Rs. 2.00 million has been embarked for biodiversity conservation measure. The details are given in **Table 5.10**.

Table 5:10 Cost estimate for Biodiversity Conservation Measure

Particular	Amount, in million
Wildlife Conservation	0.50
Compensatory afforestation	1.50
Total	**2.00**

5.12 RESTORATION AND LANDSCAPING OF PROJECT SITES

The construction of the proposed project, including its various appurtenances e.g. power house, approach roads, labour camps, project colony, etc. would disturb the existing topography and physiography. No major alteration of the area is expected as per the layout plan and thus, no major impacts on this account are anticipated. It is proposed to landscape the area, so that it integrates with the natural surroundings and the beauty of the area is restored.

[42] Honorable Supreme Court has issued Order regarding rate of the Net Present Value (NPV) of diverted forest land dated by dated 28th Mar 2008 and 9th May 2008

Garden Complex: A garden with local ornamental plants and trees will be developed near the project colony site, where all plants will be properly labeled with scientific and/or common names to make the project area more attractive in terms of tourism development.

Creation of Scenery View Points: View points are suggested to create in the proposed project area with a shed and plantation of ornamental plants nearby. These view points will be slab type extension above the ground, which will be properly reinforced and fenced to avoid any undesirable incidence.

Landscaping: Various sites in the area will be stabilized by constructing a series of benches. The walls that will be constructed for containing the slope will be embedded with local stones to integrate with the aesthetics of the area.

A provision of Rs.1.0 million has been earmarked for landscaping and beautification of the area.

5.13 MANAGEMENT OF ENVIRONMENTAL DEGRADATION

Construction of the proposed project would increase human activities during construction and operation of the project, which would increase pressure on local natural resources if no adequate measures are provided for. Encroachment on nearby forest reserves and subsequent forest degradation can be avoided by arranging adequate supply of alternative fuels.

5.14 PUBLIC AWARENESS PROGRAMMES

As a part of the overall project development, the project proponent would conduct training and awareness programme for their active participation in the project implementation. Apart from training, such programmes should include guidelines for safety, measures of disaster prevention, action required in case of emergency, fire protection, environmental risk analysis etc. a lump sum provision of Rs.0.50 million has been earmarked for information dissemination and awareness campaign.

5.15 ENVIRONMENTAL MONITORING PROGRAMME

The environmental monitoring programme is a vital process in the Management Plan for sustainability of the river valley project. Hydro power project introduces complex inter-relationships in the project area between people, various natural resources, biota and many developing forces. Thus, a new environment is created. It is very difficult to predict the exact post-project environmental scenario with complete certainty.

Hence, monitoring of critical environmental parameters is essential to maintain a baseline data (actual data) about the overall environment of the project study area. Ambient air, ambient noise, water quality, soil and ecology are the important monitoring parameters for this project. An attempt has been made to establish early warning of indicators of stress on the environment. Thus, monitoring becomes essential to ensure that the mitigation measures planned for environmental protection function effectively during the entire period of project operation.

5.15.1 SUGGESTED ENVIRONMENTAL MONITORING FOR THE PROJECT

The environmental monitoring will be required during construction and operational phases. Suggested monitoring details are outlined in the **Table 5.1**, where as cost for the same been provided in **Table 5.2.**

Table 5:11 Suggested monitoring details for Construction and Operation Phase

Item	Parameters	Frequency	Location
Environmental Monitoring during Construction Phase			
Air quality And Ambient Noise Level	SPM, RPM, SO_2 and NOx 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: • Construction Site • Village Khellong • Village Lower Jung • Village Nafra
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	• At Dam site • At Power House site • Between the tail race discharge point and downstream confluence with Digo river
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	• 1 sample at labour camp water supply
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	• 1 sample near dam site • 1 sample at muck disposal site • 1 sample at labour camp
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
Environmental Monitoring during Operation Phase			
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	▪ Reservoir ▪ Between the tail race discharge point and downstream confluence with Digo river
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	• 1 sample from project colony
Erosion and Siltation	Soil erosion rates and slope stability of embankments of dam, efficacy of soil and conservation measures	As per CAT plan	River bank of Bichom river
Terrestrial	Status of afforestation programme of	As per CAT plan	Study area

Item	Parameters	Frequency	Location
Ecology	green belt development, changes in migration patterns of the terrestrial fauna		
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

5.15.2 ENVIRONMENTAL MONITORING COST

The tentative cost for environmental monitoring for the construction phase has been calculated as per notification of Ministry of Environment & Forest, Central Pollution Control Board (CPCB), dated 15th June, 2008 New Delhi (refer ***Annexure XIV***).

Table 5:12 Cost of Environmental Monitoring during Construction

Parameters	No. of Samples to be monitored	No. of Samples for 3 Years	Unit Rate (Rs.)	Total Cost for 3 Yrs (Rs.)
Air	4 x 2 x 4 x 4 = 128	384	9,600	3,686,400
Noise	4 x 2 x 4 x 4 = 128	384	2,500	960,000
Surface Water	3 x 1 x 4 = 12	36	1,250	45,000
Drinking Water	1 x 1 x 4 = 4	12	6,300	75,600
Soil	3 x 1 x 4 = 12	36	3,500	126,000
Ecology	Lump sum		4,00,000	1,200,000
Medical tests for Public Health	420 x 2 x 1			168,000
Cost for Sampling and Analysis				**6,261,000**
Transportation charges	Lump sum	-	80,000	2,40,000
AQC[43] Participation Fees				**45,000**
Total cost including transportation				**6,306,000**
Contingency @ 10%				**630,600**
Total cost for Environmental Monitoring				**6,936,600**

[43] To be charged by CPCB from respective SPCB's / PCC's or Recognized laboratory for Analytical Quality Control Exercise (AQC) samples.

5.16 SUMMARY ENVIRONMENTAL BUDGET

Total amount to be spent for implementation of Environmental Management Plan (EMP) is estimated to the tune of **Rs. 49.74** million. The cost is exclusive of compensation for acquisition of land for the project (provided in ***Volume II***: ***Social Impact Assessment (SIA) including Land Acquisition & Rehabilitation Plan Report***). The details are given in **Table 5.13**. The total amount is for the entire duration of construction phase.

Table 5:13 Cost for implementing Environmental Management Plan

Sl. No.	Item	Total Amount (Rs. in Million)
1.	Control of pollution from labour camps	9.53
2.	Quarry stabilization and muck disposal plan	6.76
3.	Control of water pollution	0.50
4.	Reservoir rim treatment & soil erosion control	0.50
5.	Management of fishery	7.46
6.	Public health delivery system	13.24
7.	Biodiversity conservation and wildlife management plan	2.00
8.	Restoration and landscaping of project sites	1.00
9.	Management of environmental degradation	1.31
10.	Public awareness programme	0.50
11.	Environmental Monitoring Programme	6.94
Total Environmental Cost		**49.74**

Chapter 6

ADDITIONAL STUDIES

6 ADDITIONAL STUDIES

This chapter deals with additional studies conducted along with the environment impact assessment. A risk assessment and dam break analysis was carried out as part of this EIA study, and is presented here in section 6.1. Considering this to be a tribal region, a detailed social impact assessment study was undertaken by a qualified Anthropologist. The report of the SIA study is submitted along with this EIA report in a separate volume (Volume-II). The local community was involved in this EIA study to keep them informed and use their experience and traditional wisdom in the process of environmental and social impact assessment. Other stakeholder groups such as revenue, health, forest and other line departments were also involved in this study. The process of stakeholder consultation is discussed in section 6.2.

6.1 RISK ASSESSMENT - DAM BREAK ANALYSIS

6.1.1 Introduction

Dam break failures are often caused by overtopping of the dam due to inadequate capacity during large inflows into the reservoir from heavy precipitation run-off. Dam failure may also be caused by seepage or piping through the dam or along internal conduits, earthquake and landslide generated waves within the reservoir. For a cascade of dams, the breaking of one dam may cause subsequent damage to other dams located downstream. Partial or catastrophic failure of a dam leading to the uncontrolled release of water causing severe damages to the lives and properties situated downstream. The effect of such a flood disaster can be mitigated to a great extent, if the resultant magnitude of flood peak and its time of arrival at different locations downstream of the dam can be estimated, facilitating planning of the emergency action measures. The most suitable instruments for analysis and prediction of a dam break flood are mathematical hydrodynamic simulation models. These models can be used for prediction of dam breach flood hydrograph, and routing the same through downstream valley to get the time series of discharge and water level at different locations of the valley.

The present study for the Nafra H.E. Project comprises of the following hydrodynamic simulations to get the maximum water level and resulting inundation maps:

- PMF/SPF discharge without dam in place (virgin condition)
- PMF/SPF without dam break i.e. normal discharge
- Dam break with reservoir at FSL i.e. El. 981.0m

For this analysis, topographical survey of the area / valley downstream of the dam upto 3 km was conducted on the basis of the survey 2m contour internal were prepared with scale of 1 in 15000.

6.1.2 Selection of Dam Break Model

As the valley downstream of the dam is long and narrow, one dimensional modeling was adopted in the present study. There are number of software like HEC-RAS version 4.0 model developed by Hydrologic Engineering Center of U.S. Army Corps of Engineers, Danish Hydraulic Institute's MIKE 11 model, National Weather Service (NWS) model etc. for carrying out dam break modeling. All these software essentially carry out hydrodynamic modeling involving finite difference solution of the energy and momentum equations.

The dam break analysis was carried out on the basis of guidelines used in the United States of America (USA) by Federal Energy Regulatory Commission (FERC) and United States Bureau of Reclamation (USBR). The report on Dam safety procedures of Central Water Commission(CWC) has also been considered. In the instant case, HEC-RAS version 4.0 model and the computer program "NWS DAMBRK MODEL" developed by National Weather Service USA 1991 has been used for the study.

6.1.3 Input data and dam break simulation

Dam break simulation requires a range of data to depict accurately to the extent possible the topography and hydraulic conditions of the river course and dam break phenomenon. The important data used in the study are;

i) Cross sections of the Bichom river, from the Nafra dam site and up to the 3 km downstream.

ii) Salient features like crest level and crest length of the dam,crest level, number and size of gates for spillway.

iii) Design flood, i.e., Probable Maximum Flood (PMF) and standard Project Flood (SPF) hydrograph for dam break simulation for channel routing.

iv) Manning's roughness coefficient for different reaches of the river under study, has been taken as 0.030 considering bouldery bed with grassy banks.

The model set up was completed using the above data and dam break simulation was run for the following three critical set of breach parameters;

Breach parameters considered for dam break simulation

Case No.	Elevation of Breach (m)		Average Breach Width (m)	Side slope of breach	Breach Development Time (Hours)	Remarks
	Initial	Final				
1.	984.0	952.0	120	1:1	0.4	4 spillway blocks considered to breach up to spillway crest level.

In this case, the initial breach level has been considered corresponding to the top of dam at El 984.0m. The final breach level has been taken corresponding to the crest level spillway. The time of failure has been taken as 25 minutes considering the instantaneous failure as applicable in the case of Composite dam.

The critical condition for a dam break study is when the reservoir is at Full Reservoir Level (FRL) and design flood hydrograph (PMF) is impinged. Accordingly, in the present study keeping the reservoir at FRL of 981.0m and restricting the Minimum Draw Down Level (MDDL) at 972.0m the reservoir routing has been carried out by impinging the PMF, keeping all the spillway gates fully open. The maximum water level (stage) reached in the reservoir is around 983.0m, which occurs around 21 hours after the applicating of PMF. As the top of the dam is at El 984.0, no overtopping of the dam will occur. Hence to get the maximum discharge through the breach, it is reasonable to assume that the dam will breach when the water level in the reservoir is at this maximum level, i.e., El. 983.0 m. Hence, for all the dam break simulations carried out for sensitivity analysis, the breach has been assumed to start at after around 21 hours after the impingement of PMF.

6.1.4 Results

Taking the input data, critical conditions and dam breach parameters, the dam break simulations have been simulated. The results of the dam break simulation, maximum discharge (flow) and water level (stage) at different locations of the Bichom river for each of the cases were compared. It has been seen that average breach width 120 m, breach depth 40 m and breach development time 25 minutes has been adopted for preparation of inundation map, flood hydrograph just downstream of dam due to dam break, time series of water levels at different cross-section along the Bichom river. The peak of dam breach flood is 10384 cumec. The rise in water level along the Bichom river reach is about 20 m.

The maximum water level for the dam breach situation has also been compared with occurrence of PMF/SPF without dam breach, occurrence of PMF/SPF in virgin river (no dam).

The flood profile resulting from the above conditions is projected in the figures.

Comparison of maximum water level at different simulations:

i) The rise in water level due to dam breach above the bed level of the river generally varies maximum about 20 m.

ii) The rise in water level along the river reach is case of occurrence of PMF and SPF with non dam breach condition varies maximum 11 to 13 m.

iii) The rise in water level above the river bed due to occurrence of PMF and SPF in virgin condition of the Bichom river varies mximum upto 11 to 13 m.

There are 16 human settlements in the radius of 15 km from the central axis of the proposed dam. The list of these settlements and their height from the mean sea level is provided in the table below:

Sl. No.	Name of the settlement / village	Height frm MSL in meters
1	Nafra	990
2	Lower Jang	1200
3	Dishek dam	1230
4	Magiyang Pan	1721
5	Giji Pan	1700
6	Thaljing Pan / Mashing	1850
7	SingsonPan	1400
8	Magyon Pan	1721
9	Guriang	2255
10	Minzing	1890
11	Gurian	1955
12	Rajang Phu	2291
13	Browjin	1800
14	Khazing Pan	1958
15	Khelong	1270
16	Lacha	1775

The proposed Nafra HEP site falls within the area regulated by lower Jung and Khellong village panchayat under Nafra circle. The affected area in the left bank of the Bichom river falls within the Khellong Gram Panchayat and that of the right bank belongs to the lower Jung Gram Panchayat.

All villages / settlements located within 15 km radius from the dam axis are situated in higher elevation and their dependency on the proposed river is limited. Hence, flood water can not reach Khellong, and Lower Jung Villages. No damage could occur due to the failure of the dam in the downstream.

Limitations

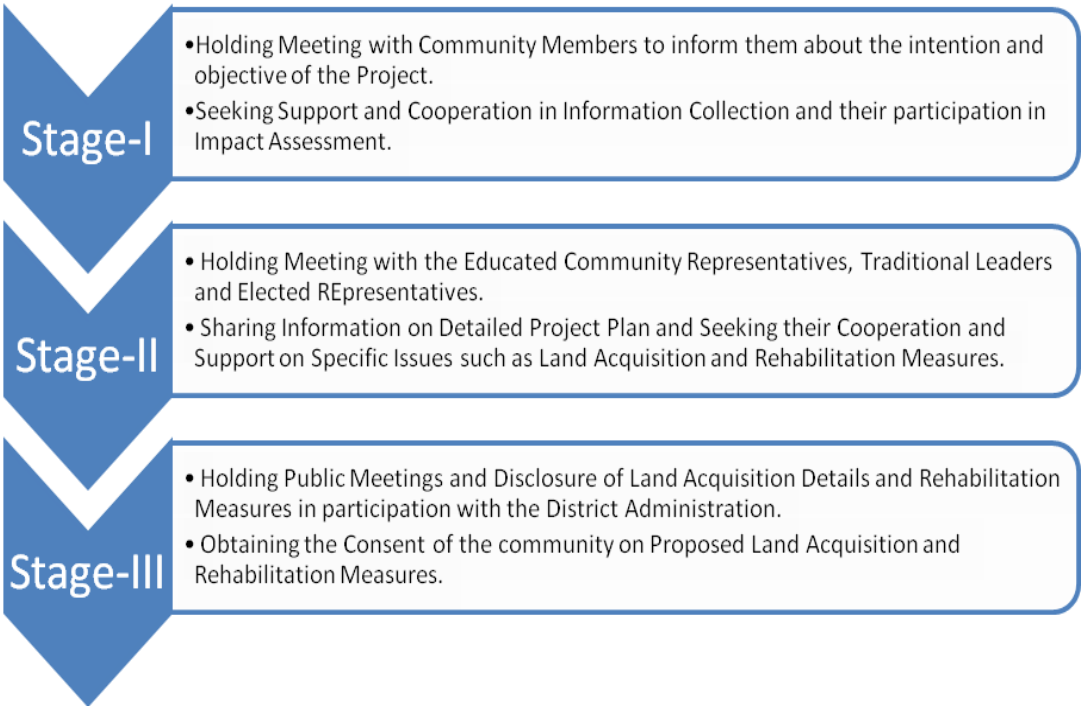
The uncertainties associated with the breach parameters, specially breach width, breach depth and breach development time may cause uncertainty in flood peak and arrival times. Further the high velocity flows associated with dam break floods can cause significant scour of channels. This enlargement in channel cross section is neglected since the equations for sediment transport, sediment continuity, dynamic bed form friction etc. are not included among the governing equations of the model. The narrow channels with minimal flood planes are subject to over estimation of water elevation due to significant channel degradation. The dam breach floods create a large amount of transported debris, which may accumulate at very narrow cross sections, resulting water level variation at downstream locations. This aspect has been neglected due to limitations in modeling of such complicated physical process.

6.1.5 Emergency Action Plan

Emergency Action Plan has been developed as a part of Detailed Project report to meet any emergency situation. Necessary advance actions will need to be taken according to suggested Emergency Action Plan after approval of competent authorities or as amended by them considering local conditions and limitations.

6.2 STAKEHOLDERS CONSULTATION

Meeting with the community members and their representatives were held in each of the project affected villages to share information about the project and to seek their cooperation and support. The community consultations were planned in three stages.



As per this plan, consultations were held in all the project affected villages. We provide a sketch here of these consultations held so far.

6.2.1 Preliminary Consultations with Stakeholders

Following stakeholders were contacted during reconnaissance site survey carried out by a team of Environmental and Social Experts:

S. No.	Name	Designation	Location
1.	Mr. Rinchin Kharu	Ex. MLA	Nafra
2.	Mr. Logyong Rikhong	ZP Member Nafra Block	Nafra
3.	Mr. Leki Dongru	ZP Member Bondila Block	Nafra
4.	Mr. Monjan Kasidu	ZP Member Anchal Samiti Member Khojna village	Nafra
5.	Mr. Ashok	Youth leader Nachiban village	Nafra
6.	Mr. Sanju	Teacher	Nafra
7.	Mr. Hangnu Khanjuju	NGO President	Nafra
8.	Mr. S Miji	Extra Assistance Commissioner	Nafra
9.	Mr. Vijayan	Executive Engineer, PWD	Nafra
10.	Mr. Yohannan	In charge Diversion Cell, Department of Forest	Bomdila

During the preliminary meetings with the above mentioned stakeholders, following key issues have been discussed:

1. The most crucial issue during these preliminary meetings are the willingness of different stakeholders to locate the project at the proposed site close to Nafra Township. The Consultant is happy to receive cordial responses from all the stakeholders. Each one of them held a positive attitude and welcomed the project.

2. The objective of conducting the environmental and social impact study for the proposed Nafra HEP has been shared with the stakeholders. Their queries are suitably answered.

3. Attempt has been made to make preliminary assessment of the nature of the 'stake' each of constituent stakeholder groups and their interrelationship with each other.

4. Their willingness to cooperate in the land acquisition (both forest and private land) process has been assessed. The process of land acquisition applicable for the project has also discussed with the local administration. The local administration provided guidance on this procedure and promised their cooperation and support.

5. The community representatives have assured that due care would be taken to minimize the adverse impact on the local environment and local community. The community leaders also reciprocated with their cooperation and willingness to facilitate this process.

6. The community leaders agreed to provide their support during the primary data collection phase. They appraised of the significance of these information for better planning and executing of the mitigation measures.

6.2.2 Consultation with Institutional Stakeholders

Following institutional stakeholders were consulted during visit to Itanagar, the state capital of Arunachal Pradesh, by a team of Environmental, Ecological and Social Experts:

Sl. No.	Name	Designation	Location
1.	Mr. B. Banerjee	Director Department of Environment and Forest (DoEF) & D.C.F. (P&M)	Itanagar
2.	Dr. R. Kemp, IFS	CF (Cons) and Nodal Officer (FC)	Itanagar
3.	Dr. Pranab Nath	Deputy Director, Department of Fisheries	Itanagar
4.	Mr. Chira Bhan Das	Administrative Officer, Department of Fisheries	Itanagar
5.	Dr. H. N. Sharma	Dean, Department of Science, Rajiv Gandhi University	Itanagar
6.	Dr. Maheswaran	Scientist – C and Officer –in-charge, Zoological Survey of India	Itanagar
7.	Dr. Anil Kumar	Scientist – B, Zoological Survey of India	Itanagar
8.	Dr. Bhatt	State Forest Research Institute	Itanagar
10.	Nodal officer for State Transmission Utility	office of C.E. (Transmission)	
13.	Dr Niranjan Sahoo	State Institute of Rural Development / Panchayatiraj	Itanagar
14.	Prof. Tamo Mibang	Department of Bio-diversity and Arunachal Tribal Research Institute	Itanagar
9.	Chief Secretary / Secretary Power		Itanagar
11.	Directorate of Economics and Statistics		Itanagar
12.	Directorate of Relief and Rehabilitation		

During consultation with these institutional stakeholders, relevant information available with them was collected and their views were sought on issues of their relevance. The photographs of consultation have been provided as ***Annexure XV.***

6.2.3 Public Opinion Survey on Community Perception of likely Impacts

The impact assessment study followed a participatory approach. As part of this approach, community members were involved in the assessment process wherever possible. A public opinion survey was designed covering a range of social and environmental issues. This survey collected responses to these questions from the people living in the project area. The survey process helped

the local community to be exposed to a range of issues connected to this project. It also prodded them to think about the likely impacts on these issues.

The result of this opinion survey is been analyzed and presented in Chapter- 5 of the SIA, LA and Rehabilitation Plan report submitted along with this EIA report, as Volume-II. This helped the expert group for this EIA study to assess the public perception of the project impact. The apprehensions expressed by the community members were later examined by the experts and suitable mitigation measures were developed.

6.2.4 Dissemination of Details of Project Plan

Meetings with representatives of these villages are under progress to share with them the details of the project plan. The impact of the project on them and on the environment is discussed with them and mitigation measures planned to keep the adverse impacts minimum is shared with them. The community representatives are requested to share this information with others in the community and ensure their cooperation and support.

6.2.5 Public Consultation / Public Hearing

The public consultation will be conducted by the Department of Environment & Forest, Govt. of Arunachal Pradesh as it handles the responsibilities of the State Pollution Control Board in the state. Application for public hearing will be submitted to the said department along with this Draft EIA / EMP report. The details of public consultation will be documented and presented along with Final EIA/ EMP report.

Chapter 7

SUMMARY OF PROJECT BENEFITS AND CONCLUSION

7 SUMMARY OF PROJECT BENEFITS AND CONCLUSION

The Nafra HE project is to be perceived as a step towards accomplishing the larger national goal of achieving power for all by 2012. It will also help in providing impetus to economic growth of Arunachal Pradesh. An assurance that the water of the river Bichom, which is the main source of water in the locality, will be valued for power generation rather than exploited for profit. Priority consideration to local needs, with the intent of restoring and improving environmental, public health, economic and employment opportunities; the overall scenario will be enhanced. Major benefits can be described as follows:

1. Employment opportunities
2. Standard of Life
3. Recreation and tourism potential,
4. Additional Habitat for Aquatic Wildlife,
5. Fisheries and Aqua-culture potential,
6. Opportunities & expectations in terms of biodiversity
7. Benefits to economy

7.1 EMPLOYMENT OPPORTUNITIES

The project will provide short and long term employment opportunities. The project is likely to be completed in 42 months. During this period manpower will be needed to take part in various project activities. About 400 people are likely to work during peak period of activity. In operation phase, about 50 people will be employed for operation and maintenance of the project. This employment will be at all levels starting from unskilled worker to plant operator and administrator. Thus, the project would provide substantial direct employment and in addition to these, more people would be indirectly employed for allied activities.

The developer of Nafra hydropower project will reserve the following categories of posts in the project to be filled up by the local tribal people, subject to the incumbents fulfilling the job requirements as stipulated below:

I	Managerial / Professional Post	25 % of the total requirement for the post
II	Ministerial / Clerical Post	50 % of the total requirement for the post
III	Skilled jobs	25 % of the total requirement for the post
IV	Unskilled jobs	75 % of the total requirement for the post

The developers will give preference to the local contractors fulfilling the eligibility criteria in the award of the work except for the specialized jobs (refer ***Annexure XVI***).

7.2 RECREATION AND TOURISM POTENTIAL

Tourism has the potential of contributing significantly to the economy of any region. Therefore, development projects ought to be scanned for the possibility of recreation and tourism, which needs to be exploited to the fullest extent possible. Chin dang festival of Miji tribes is very popular in the district, held in Nafra town in the month of October every year. In addition to this, the proposed dam will increase the potential of tourism development in the district as well.

7.3 ADDITIONAL HABITAT FOR AQUATIC WILDLIFE

Increase in the area covered with water surface will create additional habitat for aquatic wildlife especially in or near the reservoir and the habitat manipulated areas in the downstream. Receding waters will create dry mudflats and shall provide suitable feeding sites for migratory birds in autumn and spring. This will also provide breeding habitat for resident species.

7.4 FISHERIES AND AQUACULTURE POTENTIAL

Fisheries are subjected to a wide variety of positive environmental impacts. The reservoir will create potential for fisheries development. Fish production in reservoir depends upon several parameters such as dissolved oxygen, nutrients and average water depth. Cold water fishery has great potential in this water reservoir.

7.5 OPPORTUNITIES FOR CREATION OF EXPECTED NEW BIODIVERSITY

In the stretch between dam and power house site there will be reduced flow of water as up to 90% of the water will be diverted through HRT. Being located in the "Himalayan biodiversity hotspot" no existing or modified area will remain unoccupied. Hence, the river biodiversity in the modified stretch will become the habitat for a number of plant and animal species. The modified river bed will include new set of biodiversity. This exercise must be viewed as a "*unique research and monitoring opportunities for enhancing biodiversity and in-situ conservation".*

Hence the following changes can be observed.

- Change in the environmental flow will *"offer opportunities"* for a change in the composition of biodiversity in that particular stretch of river.
- It will be almost "*a terrestrial patch in a river bed"*, with assured water supply in the vicinity.
- The riverbed will become a unique habitat as numbers of species are not available in the fast flowing water.
- New habitat conditions will be created for a number of species, both flora and fauna will occupy the stretch.(a) some will expand the distributional range(b) some for breeding
- Some high altitudinal aquatic insect will breed. Some of them may be economical also.
- High altitudinal amphibian and reptiles might occupy the new habitat
- New plankton will occupy who demand less water current hence stagnancy and low water supply
- New pattern of plant- animal interaction will be seen.
- Few bird might select the specific location on the stretch as site of egg laying, particularly the lapwings etc

7.6 BENEFITS TO ECONOMY

Since water is a renewable resource it can be effectively harvested for sustainable socio-economic development purposes. The water development planning based on the sustainable development strategy would be necessary for careful exploration and utilization of these natural resources. The

development strategy would incorporate and maintain balanced harmony with the prevailing ecosystem. Thus augmented water supply would play a vital role in the overall economic, social and industrial development in the region.

The activity will also generate employment during construction and operation phases of the project. This will benefit the economy, both national and local levels (as per MoA between Government of Arunachal Pradesh and M/S SEW Energy Limited).

7.7 SUMMARY & CONCLUSION

The project has been taken up with an objective to exploit the potential of Bichom River in between proposed 125MW Dibbin HEP and ongoing 600 MW Kameng HEP in the Kameng Basin. The project envisaged as a run-off-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 cum. Being a run-of-river scheme, it merits consideration for earning of carbon credit. The proposed project is of 96 MW (2 x 48 MW) capacity, which will afford an annual energy generation of 423.95 MU in a 90% dependable year and 491.60 MU in 50% dependable year. The estimated cost of the project is Rs. 710.46 Crores including escalation during construction and IDC at April 2009 price level.

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.

As a part of any Environmental Impact Assessment study, it is necessary to identify the baseline levels of relevant environmental parameters which are likely to be affected as a result of the construction and operation of the proposed project. A study area of 10 km radius of the project area has been considered for undertaking the EIA study of proposed Nafra HEP.

The total land owned by the village community getting submerged due to the reservoir is 14.50 ha only. Only 2.3 ha of land of this total submerged land is under private possession (5 Families) and used for agriculture/horticulture purpose. No residential land is getting submerged; hence there is no displacement due to reservoir. The details of Project Affected Person (PAP) are reported in Social Impact Assessment (SIA) including Land Acquisition & Rehabilitation Plan Report as Volume-II.

The proposed project envisages acquisition of about 32.12 hectares of forest land; out of which 26.91 ha will be acquired permanently and 5.21 ha temporarily for the construction period.

Based on environmental base line data, prediction of positive and adverse impacts and assessment, it is obvious that the project will bring benefit at local as well as regional level. After incorporation of environmental management plans, the environmental sustainability will be further improved.

In the project area there is no sighting of the wild mammals except some birds, reptiles and butterflies. The literature studies indicate 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. The proposed submergence area is neither potential site for wildlife sanctuary nor offers migration route to any major animal species. No National Park or Sanctuary exists in the vicinity of the project area. The Eaglenest Wildlife Sanctuary is located in the West Kameng district, but located beyond 10 km radius of the project area. No archaeological or cultural heritage site within 10 km radius of the project area comes under the direct or indirect impact of the project.

Due to proposed hydro project, major anticipated environmental impacts during construction phase are degradation due to immigration of labour population, quarrying operations, operation of construction equipment, soil erosion, muck disposal and during construction of roads. The mitigation measures for all individual anticipated impacts have been covered in this report.

The EMP covers labour camp & its facilities, solid waste management at campsite, environmental management in road construction, stabilization of quarry & muck disposal plan, control of water, air & noise pollution, reservoir rim treatment & soil erosion control, enhancement of terrestrial ecology, management of aquatic ecology, biodiversity conservation & wildlife management plan, restoration & land scapping of project sites and management of environmental degradation due to campsite. The additional study includes Risk assessment on dam break analysis & disaster management plan and Social impact assessment & rehabilitation plan.

Impacts, as discussed on natural resources, terrestrial and aquatic ecology of the area will be mitigated with proposed EMP. A detailed environmental monitoring program during construction and operation of the project has been suggested. The proposed EMP cost (***in Rupees million***) for Control of pollution from labour camps ***(9.53)***, Quarry stabilization and muck disposal plan ***(6.76)***, Control of water pollution ***(0.50)***, Reservoir rim treatment & soil erosion control ***(0.50)***, Management of fishery ***(7.46)***, Public health delivery system ***(13.24)***, Biodiversity conservation and wildlife management plan ***(2.00)***, Restoration and landscaping of project sites ***(1.00)***, Management of environmental degradation ***(1.31)***, Public awareness programme ***(0.50)*** and Environmental Monitoring Programme ***(6.94)*** *with total budget* ***in Rupees million is* 49.74** have been covered in EMP and detailed project report.

Chapter 8

DISCLOSURE OF CONSULTANTS ENGAGED

8 DISCLOSURE OF CONSULTANTS ENGAGED

A multi-disciplinary team of experts carried out this EIA and EMP study. The core team of this study included Environmentalist, Geologist, Hydrologist, Anthropologist, Ecologist, GIS/ Remote Sensing Expert and Design Engineers and other support staff. Brief details of the experts involved in this study is given in the table below which is followed by their summary resume that describes their relevant experience.

Sl. No.	Name of the Consultant	Position for the Project	Years of Experience (in years)
1.	Prof P. C. Bhattacharjee	Ecologist	42
2.	Madhusudan Hanumappa	Social Expert	22
3.	Dr. Swayam Shrestha Panda	Anthropologist	12
4.	Mr. Ajay Vatsa	GIS/ Remote Sensing Expert	11
5.	Mr. Saket Verma	Environmentalist	9
6.	Ms. Ritu Khanna	Environmentalist	7
7.	Mr. R. Jeyaseelan	Advisor - Civil	40
8.	Mr. Kultar Sharma	Expert – Civil Engineering (Construction)	44
9.	Mr. G. K. Kaistha	Geotechnical Expert	38
10.	Mr. M. K. Singh	Geotechnical Engineer	16
11.	Dr. D. P. Singh	Geologist	8
12.	Mr. Deepak Jain	Design Engineer	9
13.	Mr. Niranjan Sahoo	Hydrologist	8
14.	Mr. Dhaval Patel	Hydraulics Engineer	4
15.	Ms. Chandrani Mitra	Environmentalist	4
16.	Mr. Santunu Dey	Field Researcher (ecological studies)	6
17.	Mr. Arun Kumar	Design Executive	21

1.	**Name of Staff**	**Dr. PARIMAL CH. BHATTACHARJEE**
2.	**Position for NAFRA HEP**	**Ecology**
3.	**Years of Professional Experience**	**42 years in the field of Ecological studies and Assessment**

4. **Education**
   Ph.D Gauhati University, 1977, Zoology (ecology).
   M.Sc. Gauhati University, 1967, Zoology, Gold Medallist.
   B.Sc. Gauhati University, 1965, Zoology.

5. **Membership of Professional Associations**: Board Member- Wild Life Trust, India.

6. **Involved in following major relevant projects**

- Eco-taxonomic survey of the Water birds of lower Assam, (1987-1989). Sponsored by Assam Science & Technology Council, Govt. of Assam
- Ethno-biological studies of the Boro tribes of Assam. Sponsored by Department of Science & Technology and Environment, Govt. of India.(1989-1992).
- Eco-development of the southern periphery of Manas National Park: A socio-economic survey of the fringe villages (1991-1993) Sponsored by WWF-I: Project No.4638 :
- Conservation of Greater adjutant stork in Assam. (1992-1995).: Sponsored by : WWF-I. Project: 4630
- Kaziranga Bird Survey. (1995-1996).Sponsored by: Oriental Bird Club, UK.
- A study of the scavenger birds and their role in the public health in Greater Guwahati.(1995) Sponsored by: Omio Kumar Das Institute of Social Change and development. Guwahati, Assam
- Biodiversity Conservation Prioritization Project,(BCPP) Year : 1995-1997Location: Assam Client: MoEF.
- An eco-behavioral study of Phyrea's leaf monkey in North East India, 2000-2002 Client: National geographic society (NGS)
- Status evaluation of Phyrea's langur population in fragmented habitats of India, Client: National Geographic Society, USA
- Conservation of White Winged Wood duck .(1996-1998) , Client : Assam valley Wildlife Society, Assam. :
- Status Survey of non-human primates in Namdapha National Park with special reference to an unknown macaque species" Client: Primate Research Center (PRC).
- Survey of the trapped and endangered primates in the neglected habitats in Tinsukia and Dibrugarh districts of Assam, India" Client: Conservation International (USA) (2002-2003).
- Behaviuoral response of Golden langur (Trachypithecus geei) in fragmented forest and its conservation prospective, (July 2002-Dec 2002) Client: People Trust for Endangered Species.
- A community based study for identification of threats in different habitats of Golden langur (Trachypithecus geei) (May2002-Dec.2002). Client: Pittsburgh Zoo.
- Study of the behavioural response of Hoolock Gibbon in fragmented forest and its conservation perspectives, Client: Great Ape Conservation Fund under USFWS . 2003-2004 Location: Assam
- UGC-SAP Programme, Fishery and Biodiversity Year : 2002-2005 Location: AssamClient: UGC, Biodiversity Specialist
- Hoolock Gibbon: Status and conservation perspectives in Tirup and Changlang districts, Arunachal Pradesh Year : 2004-2005 Location: Arunachal Pradesh Client: Great Ape Conservation Fund: US Fish & Wildlife Services, Project Officer
- North Eastern Region Urban Development Project, Asian Development bank, Govt. of India.(Ta.No.4348-IND) Phase-I, Year : 2004-2005, Location: North Eastern States of India Client: ADB , Biodiversity Specialist

1.	**Name of Staff**	**Mr Madhusudan Hanumappa**
2.	**Position for NAFRA HEP**	**Social Expert**
3.	**Years of Professional Experience**	**22 years**

4. Education

Post Graduate Diploma in Environmental Law, National Law School of India University, Bangalore, 2002

M.A. Economics, Shri Venkateshwara University Tirupathi, 1991

B.A. Economics, Political Science & Sociology, St. Josephs College of Arts and Science, Bangalore, 1987

5. Membership of Professional Associations:

Life Member, Indian Society of Ecological Economics, Delhi

6. Involved in following major relevant projects

- Uttarakhand Power Sector Project covering Sub-stations, Transmission Lines (744 kms) and Hydro Power Stations (3 numbers), Uttarakhand, India
- Social Impact Assessment (SIA) and Rehabilitation and Resettlement Action Plan (RRAP) for Cuddalore Power Project
- Assam Power Sector Development Program- Assam State Electricity Board
- Reconstruction of Key Fishery Harbours along the Tamil Nadu Coast at Pazhayar, Nagapattinam, Mallipatnam and Chinamuttom with Modern Facilities
- Madhya Pradesh Water Sector Restructuring Project, Madhya Pradesh
- Environmental and Social Study for the Krishna (Almatti) – Pennar Link canal (587.5kms). National Water Development Authority
- Karnataka Watershed Development Project, Karnataka
- Social Impact Assessment for Solar Based Power Plant at Mathania (Rajasthan) and Feasibility and designing of the Water Carriage System for the Power Plant; Rajasthan State Power Corporation Limited (KfW funding)
- Environmental & Social Impact Assessment for Proposed Oil Pipeline – Offshore and On Terminal at Kutchh, Gujarat
- Preparation of Guidelines for Environmental and Sociological Screening of Projects, Indian Renewable Energy Development Agency
- Environmental Impact Assessment Study for Proposed Thermal Power Plant at Nabinagar
- Rural Water Supply and Sanitation Sector: Coverage, Policy, Financial Aspect and Medium Term Development Program, Swajal Project
- Institutional Strengthening and Restructuring of Uttar Pradesh Irrigation Department under Uttar Pradesh Water Sector Restructuring Project
- Third Party Quality Construction monitoring and review of implementation of civil works and community activities in Tsunami affected areas in Avanigadda, Andhra Pradesh
- Chittagong Port Trade Facilitation Project (RHD Component), Bangladesh

1. **Name of Staff** **Dr. SWAYAM S. PANDA**

2. **Position for NAFRA HEP** **Anthropologist**

3. **Years of Professional Experience** **12 years**

4. **Education**
   LL.B. from ILS, Pune in Second Class, 2004
   Ph.D in Social Anthropology from Deccan College Postgraduate and Research Institute, Pune, 2000
   Post-graduation in AICH&A from Deccan College Post Graduate and Research Institute, Pune, 1996
   Graduation in Political Science and Anthropology (Honors/special) Secured Gold Medal in Anthropology, Utkal University, 1993

5. **Membership of Professional Associations:**
   Life Member of Indian Society of Prehistoric and Quarternary Studies.
   Member, Anthropological Society of India.
   Founder Member and Trustee, LOKDHARA, Pune - An NGO for Rural Development.

6. **Involved in following major relevant projects**

- SIA for Mago Chu HEP (96 MW), Arunachal Pradesh (Ongoing)
- SIA for Nyukcharong Chu HEP (96 MW), Arunachal Pradesh (Ongoing)
- SIA for New Meling HEP (96 MW), Arunachal Pradesh (Ongoing)
- Social & Land Acquisition Survey for NESRIP Tranche 1 Roads
- ESA and Stakeholder Consultation in Consultancy Services for Sind Basin Water Quality Improvement Project
- Capacity Building for Water Users Associations (WUA) in Sindh, Ken, Tons, Chambal and Betwa basin in Mahdya Pradesh
- Uttaranchal Rural Water Supply and Sanitation Project, Planning and Designing Batch-1A. SWAJAL (Dehradun, Tehri and Uttarkashi)
- Building an Eco-community: The viability of a sustainable social movement by the Watershed Development Programme, WOTR-NABARD
- Technical Support and Monitoring of Construction and Community Involvement in APR2D (Andhra Pradesh Relief to Development) Project in Krishna District
- Data Collection and Compilation for Vulnerability Mapping and Disaster Management in Assam.
- Oral traditions of Pastoralists in Maharashtra.
- Consultancy on Traditional wisdom system of Indian Tribal communities
- Ethnographic study of Lamans
- Ethnographic study of Mahadev Kolis in Surgana Taluka, Maharashtra.
- Baseline study of Socio-Economic Conditions of DNTs (De-notified and Nomadic Tribes) in Maharashtra: Perspectives of Development and Protection of Human Rights

1. **Name of Staff** **Mr AJAY KUMAR VATSA**

2. **Position for NAFRA HEP** **GIS / Remote Sensing Expert**

3. **Years of Professional Experience** **11 years**

4. **Education**

- MA in geography from CCS University Meerut
- BE Computer Sciences from Shivaji University Maharashtra
- Geographical Information System and Remote Sensing Course done from Regional Remote Sensing Application Center I.S.R.O Jodhpur Rajasthan.
- Certified ER Mapper Remote Sensing Software's from Earth Resource Mapping Australia.
- Training on AutoCAD Map, ERDAS, and Image Web Server.

5. **GIS/ Remote Sensing Software Knowledge:**

- Remote Sensing Packages : ER Mapper 7.1, Erdas imagine 8.6,
- GIS Packages : Arc Info , Arc GIS, Arc View 3.0, AutoCAD Map, CAD Overlay,

6. **Membership of Professional Associations: Nil**

7. **Involved in following major relevant projects**

- GIS for Senegal Railway network From Dakar to Valengara Total KM 540
- Natural Resources Data Management System (NRDMS) Project; Land Use & Land Cover Mapping for Jodhpur using Ground survey, Merged LISS3 & PAN data for Jodhpur
- Creating integrated GIS data base from Hydro graphic survey, Existing toposheets for Mumbai coastal area (Total KM 120)
- Parcel mapping and GIS creation for Shivani oil & Gas exploration for their upcoming pipe lines for Indian Oil. Total KM 600
- Creating GIS network for Water lines for GK-2 New Delhi Total KM 120
- Creating GIS High tension wires network for new alignment study network Total KM 1200
- Sugar Cane Yield estimation through remote sensing using high end satellite Total SqKM 1300
- Cadastral Parcel Mapping Total SqKM 1500
- Electrical and Consumer Mapping in Mazaffarnagar town of UP India. Total KM 900
- Muzaffarnagar Electrical Network and Consumer GIS using IKONOS Data and Field survey
- CNG Gas Pipeline GIS on 1:10,000 Scale for Delhi
- Village Parcel Mapping for Croton Village of USA
- Image processing for Risk Prone Area Mapping of Kedarnath – Okhimath Region of Higher Himalayas

1.	**Name of Staff**	**Mr SAKET VERMA**
2.	**Position for NAFRA HEP**	**Environmentalist**
3.	**Years of Professional Experience**	**9 years**

4. Education

Master of Science (Environmental Science), Devi Ahilya University, Indore, 1999

Ph.D. (pursuing) from Dept. of Life Sciences, Barkatullah University, Bhopal (MP)

Diploma in Industrial Safety from National Institute of Labor Education & Management (NILEM) in 2004

QMS internal Auditors Course ISO 9001 : 2000, Two Day from Quality Management International, A Division of worldwide Quality Management Network Ltd. UK in 2007

5. Membership of Professional Associations: Nil

6. Involved in following major relevant projects

- Review of EIA/SIA for Pare Hydro Electric Power Project, Arunachal Pradesh
- Consultancy Services for Reconstruction of Key Fishery Harbours along the Tamilnadu Coast at Pazhayar, Nagapattinam, Mallipatnam and Chinamuttom with Modern Facilities (World Bank funded
- Environmental Impact Assessment (EIA) Study of the proposed 800 km. Natural Gas Pipeline Project
- EIA Study of the proposed Thermal Power Plant at Nabinagar in Bihar
- EIA Study of the proposed Thermal Power Plant at Chennai
- Baseline Environmental Monitoring & Analysis in various industries on behalf of Haryana SPCB
- Documentation work for NABL accreditation for Environmental Laboratory, New Delhi
- Environmental Impact Assessment (EIA) studies for Coal Mine project in Orissa

1.	**Name of Staff**	**Mrs. RITU KHANNA**
2.	**Position for NAFRA HEP**	**Environmentalist**
3.	**Years of Professional Experience**	**7 years**

4. Education

- M.Sc. (Environmental Management), Delhi, 2002
- B.Sc. (Biological Sciences), Delhi University, Delhi, 2000

5. Membership of Professional Associations:

6. Involved in following major relevant projects

- EIA for Raigam Hydro Electric Project (96MW), Arunachal Pradesh (Ongoing)
- EIA for Gimliang Hydro Electric Project (99MW), Arunachal Pradesh (Ongoing)
- EIA for Tidding-I Hydro Electric Project (99MW), Arunachal Pradesh (Ongoing)
- EIA for Tidding-II Hydro Electric Project (68MW), Arunachal Pradesh (Ongoing)
- EMP preparation for various Substations and Transmission Lines for Haryana Vidyut Prasaran Nigam Limited
- Environmental Due diligence of a proposed 220 WM Hydroelectric power plant on Teesta River, Sikkim.
- Review of EIA and EMP for 36 MW Rolep Hydroelectric Power Plant Sikkim
- Review of EIA and EMP for 60 MW Chakung Chu Hydroelectric Power Plant Sikkim,
- Review of EIA and EMP for 60 MW Ralang Hydroelectric Power Plant Sikkim,
- Preparation of Environmental Management Framework and Environmental Guidelines for India Rural Energy Access Project, Uttar Pradesh and Rajasthan
- Review of EIA/SIA for Pare Hydro Electric Power Project, Arunachal Pradesh

1. **Name of Staff** **Mr R. JEYASEELAN**
2. **Position for NAFRA HEP** **Advisor - Civil**
3. **Years of Professional Experience** **40 years**
4. **Education**

P.G. Diploma (Hydropower), Norway, Norwegian Institute of Technology, Trondheim, 1979
M.Tech. (Civil - Structural Engineering), Indian Institute of Technology, Madras, Tamil Nadu, 1969
B.E. (Civil Engineering), Govt. College of Technology, Coimbatore, Tamil Nadu, 1967

5. **Membership of Professional Associations:**

INDIA

President, Indian Association of Hydrologists (IAH) : (2002 – 2006)
President, Indian Society for Rock Mechanics & Tunnelling Technology (ISRMTT) : 2002-2006
Member, Indian Geo-Technical Society, Delhi (Since 1974)
Chairman, Water Resources Division Council, Bureau of Indian Standards (2002-2006)
Chairman, ISO TC-113 (Since 2006-2007)
Independent Director, NHPC Ltd., India

INTERNATIONAL

Vice President – International Commission on Irrigation & Drainage (ICID) : (2003 – 2006)

6. **Involved in following major relevant projects**

• Salal Hydro Electric Project (690 MW)	Jammu & Kashmir, India
• Pakal Dul Hydro Electric Project (1000 MW)	Jammu &* Kashmir, India
• Tala Hydro Electric Project (1020 MW)	Bhutan
• 5 Mini Hydel Projects	Bhutan
• Nathpa Jhakri Hydro Electric Project (1500 MW)	Himachal Pradesh, India
• Sardar Sarovar Project (1450 MW)	Gujarat, India
• Srisailam Hydro Electric Project (900 MW)	Andhra Pradesh, India
• Doyang Hydro Electric Project (75 MW)	Nagaland, India
• Subansiri Hydro Electric Project (2000 MW)	Arunachal Pradesh, India
• Upper Kolab Hydro Electric Project (320 MW)	Orissa, India
• Upper Indravati Project (600 MW)	Orissa, India
• Rengali Dam Project (250 MW)	Orissa, India
• Pyokara Ultimate Stage Hydro Electric Project	Tamil Nadu, India
• Rajghat Hydro Electric Project	Madhya Pradesh, India
• Jorethang Hydro Electric Project (96 MW)	Sikkim, India
• Ting Ting Hydro Electric Project (99 MW)	Sikkim, India
• Tashiding Hydro Electric Project (99 MW)	Sikkim, India
• Srinagar Hydro Electric Project (330 MW)	Uttarakhand, India
• Upper Indravati	Orissa, India
• Reugali Dam Project	Orissa, India
• Pyokara Ultimate Stage Hydro Electric Project	Tamil Nadu, India
• Rajghat Hydro Electric Project	Madhya Pradesh, India

1.	**Name of Staff**	**Mr. KULTAR S. SHARMA**
2.	**Position for NAFRA HEP**	**Expert - Civil Engineering (Construction)**
3.	**Years of Professional Experience**	**44 years**

4. Education
B.Sc Engg (Hon's) Civil in 1965

5. Membership of Professional Associations:
Life Membership of the Indian Society of Geological Engineering (Membership No.L -818)

6. Involved in following major relevant projects

- Mago Chu (96 MW) and Nyukcha Rong Chu (96 MW) Hydroelectric Project, Arunachal Pradesh (Ongoing)
- Raigam H.E. Project (2 X 48 MW), Arunachal Pradesh (Ongoing)
- Gimliang H.E. Project (2 X 49.5 MW), Arunachal Pradesh (Ongoing)
- Tidding H.E. Project (2 X 48 MW), Arunachal Pradesh (Ongoing)
- Panan 200 MW Hydro Electric Project(Ongoing)
- Ting Ting Hydroelectric Project, Sikkim
- Tashiding Hydroelectric Project, Sikkim
- Rongni 99 MW Hydro Electric Project
- Tehri Hydroelectric Project (1000 MW)
- Koteshwar Dam Project of (4000 MW)
- Salal Hydro Electric Project 345 MW stage –II
- Baglihar H.E. Project 450 MW
- Sawalkot H.E. Project 600 MW
- Dulhasti H.E. Project 390 MW in Jammu & Kashmir
- Chamera H.E. Project (540 MW) in Himachal Pradesh
- Salal Hydro Electric Project 345 MW stage –I & II,
- Loktak H.E. Project (105 MW)
- Beas Satluj Link Project (660 MW) in the state of Himachal Pradesh

1.	**Name of Staff**	**MR. G. K. KAISTHA**
2.	**Position for NAFRA HEP**	**Geolotechnical Expert**
3.	**Years of Professional Experience**	**38 years**

4. Education

M. Tech. (Applied Geology), 1968, Univ. of Saugar(M.P.)

B.Sc, 1965,Punjab University, Chandigarh

Diploma in Photo Interpretation, 1975, IIRS, Dehradun

5. Membership of Professional Associations:

- Indian Society for Rock Mechanics and Tunneling Technology (ISRMTT)– Life Member
- Institute of Geoscientists (India) – Corporate Member
- Indian Society of Engineering Geology – Life Member
- Indian Society of Remote Sensing – Life Member

6. Involved in following major relevant projects

• Shrinagar Hydro Electric Project (330 MW)	Uttarakhand, India
• Maheshwar Hydro Electric Project (400 MW)	Madhya Pradesh, India
• Rohtang Highway Tunnel	Himachal Pradesh, India
• Jorethang hydro Electric Project (96 MW)	Sikkim, India
• Tamak Lata Hydro Electric Project (280 MW)	Uttarakhand, India
• Kol Dam (330 MW)	India
• Rima Hydro Electric Project (60 MW)	Arunachal Pradesh, India
• Tipang Hydro Electric Project (80 MW)	Arunachal Pradesh
• Tala Hydro Electric Project	Bhutan

- Other projects include Yamuna Hydel Scheme, Kishau, Lakhwar – Biyasi, Tehri, Maneri-Bhali, Larji, Ranganadi-1 & II, Myntdu – Leska, Karbi – Langpi, Kolodyne –I & II.

1.	**Name of Staff**	**MR. M. K. SINGH**
2.	**Position for NAFRA HEP**	**Geotechnical Engineer**
3.	**Years of Professional Experience**	**16 years**

4. Education

M.Tech (Soil Mechanics and Foundation Engineering) REC Kurukshetra, Kurukshetra University

B.Tech. (Civil Engineering) from H.B. Technological Institute, Kanpur University, Kanpur, UP. 1990

5. Membership of Professional Associations: Nil

6. Involved in following major relevant projects

- Erection of 120 MW Rangit Stage – IV, Hydro Electric Power Project
- KOL Dam Hydro Electric Power Project
- Erection of Hydro Electric Power Project in the state of Nagaland, Client- NEEPCO
- Soil investigation works for ONGC, IPCL, NJPC, Jawahar Sagar and Jawai Dam Sites, GACL, NTPC, SAIL etc.
- Erection of Desalter project of M/s ONGC Ltd, for m/s BHPV Ltd.

1.	**Name of Staff**	**Dr. D. P.Singh**
2.	**Position for NAFRA HEP**	**Geologist**
3.	**Years of Professional Experience**	**8 years**

4. Education

M.Sc. (Geo), 2001, DS College, Aligarh

Ph.D, 2005

5. Membership of Professional Associations: Nil

6. Involved in following major relevant projects

- Srinagar Hydro Electric Project, Uttarakhand
- Jorethang Hydro Electric Project, Sikkim
- Tamak Lata Hydro Electric Project, Uttarakhand
- Pala Maneri Hydro Electric Project, Uttarakhand
- Tizu-Zungki Hydro Electric Project, Nagaland
- Kamlang Hydro Electric Project, Arunachal Pradesh
- Ting –Ting Hydro Electric Project, Sikkim
- Tashiding Hydro Electric Project, Sikkim
- Nyaborango Hydro Electric Project, Africa
- Panan Hydro Electric Project, Sikkim
- Tiding Hydro Electric Project, Arunachal Pradesh (Ongoing)
- Gimliyang Hydro Electric Project, Arunachal Pradesh (Ongoing)
- Raigam Hydro Electric Project, Arunachal Pradesh(Ongoing)
- Seli Hydro Electric Project, Himachal Pradesh
- Etabau Hydro Electric Project, Arunachal Pradesh
- Elango Hydro Electric Project, Arunachal Pradesh

1.	**Name of Staff**	**Mr. DEEPAK JAIN**
2.	**Position for NAFRA HEP**	**Design Engineer**
3.	**Years of Professional Experience**	**9 years**

4. Education

M.E. (WRE), REC Jaipur, India (December, 2000)

B.E. (Civil), Nagpur University, India (June, 1999)

5. Membership of Professional Associations: Nil

6. Involved in following major relevant projects

- New Umtru Hydro-Electric Project (2x20 MW), Meghalaya
- Lata Tapovan Hydro-Electric Project (3x57 MW), Uttarakhand
- Kibimba Dam Rising Project, Uganada
- Dam Across River Kurket For 1000 MW Thermal Power Project, Chattisgarh
- Kameng Hydro Electric Project (600MW), Arunachal
- Jorethan Hydro Electric Project (96 MW), Sikkim
- Ting Ting (99 MW), Sikkim
- Tamak Lata (280 MW), Uttaranchal
- Pare Hydro Electric Project (110 MW), Arunachal Pradesh

1.	**Name of Staff**	**Mr. NIRANJAN SAHOO**
2.	**Position for NAFRA HEP**	**Hydrologist**
3.	**Years of Professional Experience**	**8 years**

4. Education

B.E. (Civil), U.C.E. Burla, Sambalpur, India, 2001
M. Tech in Hydraulics, IIT Roorkee, India,2004

5. Membership of Professional Associations:

Life Member, Indian Water Resources Society (IWRS)
Life Member, Association of Hydrologist in India (AHI)

6. Involved in following major relevant projects

- Jorethang Hydro-Electric Project (96) MW, Sikkim
- Pala-Maneri Hydro-Electric Project (480) MW, Uttarkhand
- Shrinagar Hydro Electric Project (4χ82.5) MW, Uttrakhand
- Kameng Hydro Electric Project (4χ82.5) MW, Arunachal Pradesh
- Pare Hydro Electric Project (110) MW, Arunachal Pradesh
- Reoli-Dugli Hydro Electric Project (420) MW, Himachal Pradesh
- Reoli Dugli Hydro Electric Project (420) MW
- Tizu-Zungki Stage-I, II and III Hydro Electric Projects (20MW), Nagaland
- Raigam Hydro Electric Project (96MW), Arunachal Pradesh (Ongoing)
- Gimliang Hydro Electric Project (99MW), Arunachal Pradesh (Ongoing)
- Tidding-I Hydro Electric Project (99MW), Arunachal Pradesh (Ongoing)
- Tidding-II Hydro Electric Project (68MW), Arunachal Pradesh (Ongoing)
- Bajoli-Holi Hydro Electric Project (150) MW, Himachal Pradesh
- Urthing Sobla Hydro Electric Project (4χ70) MW, Uttrakhand
- Tamak-Lata Hydro Electric Project (4χ70) MW, Uttrakhand
- Jorthang Hydro Electric Project (2χ48) MW, Sikkim
- Rongni H. E. Project (2×48) MW, Sikkim
- Panan H. E. Project (4×70) MW, Sikkim
- Sirkari Bhyol Hydro Electric Project (3χ70) MW,Uttrakhand
- Maheshwar H. E. Project (10X40) MW, Madhya Padesh
- Pare H.E. Project (2×55) MW
- Talong H.E. Project (4×40) MW
- Kapak Leyak H.E. Project (4×40)MW
- Flood Control, Drainage & Recharge Salalah, Oman of Salalah Plain
- Design of Dhola Bridge, Arunanchal Pradesh
- EIA Studies for Killing Multi Purpose Project, Meghalaya

1.	**Name of Staff**	**Mr. DHAVAL SURESHBHAI PATEL**
2.	**Position for NAFRA HEP**	**Hydraulics Engineer**
3.	**Years of Professional Experience**	**4 years**

4. Education

M.Tech. (Water Resource Engineering) from National Institute of Technology, Surat, Gujarat

B.E. (Civil) from Gujarat University, Ahmedabad, Gujarat

5. Membership of Professional Associations: Nil

6. Involved in following major relevant projects

- Jorethang Hydro-Electric Project (96) MW, Sikkim
- Ting-Ting Hydro Electric Project (99 MW), Sikkim
- Tashiding Hydro Electric Project (97 MW), Sikkim
- Tidding-I Hydro Electric Project (99MW), Arunachal Pradesh
- Tidding-II Hydro Electric Project (68MW), Arunachal Pradesh
- Multipurpose Projects of Small and Medium Dams, Afghanistan

1.	**Name of Staff**	**Mr. Santunu Dey**
2.	**Position for NAFRA HEP**	**Field Researcher (Ecological Studies)**
3.	**Years of Professional Experience**	**6 years**

4. Education

B.Sc. (Botany) with Zoology and Chemistry, Gauhati University

M. Sc. (Botany), Gauhati University

A 21 days capsule course cum training programme on application of Geographic Information System (GIS) conducted by DST at Cotton College, 2005

5. Membership of Professional Associations:

Aaranyak, a society for biodiversity conservation of North East India.

6. Involved in following major relevant projects / research areas / publications

- Flora of Kamakhya hills. (Thesis)
- Habitat fragmentation and plant diversity in Kanchandzonga BR, Sikkim Himalaya (North Eastern Hill University, Shillong) for eight months sponsored by MoEF (Govt. Of India).
- North Eastern Urban Development Project (Lea Associates South Asia Pvt. Limited) for seven months sponsored by Asian Development Bank.
- Habitat Utilization Pattern of Asian Elephant Elephus maximus and Status of Elephant-Human Conflict in Manas National Park,
- CEPF Manas Landscape Project (Ongoing)

Publications:

- Lahkar, B. P., J. P. Das, N. K. Nath, S, Dey, N. Brahma and P. K. Sarma (2006). Habitat evaluation of Asian elephant Elephas maximus and spatial aspects of human elephant conflict in Manas National Park using Remote Sensing/GIS. (in press) in proceeding of International Elephant Conservation and Research Symposium 2006. Denmark.
- Lahkar, B. P., Das, J. P., Nath, N. K., Dey S., Brahma N. and Sarma, P. K. (2006). A study of habitat utilization patterns of Asian elephant Elephas maximus and current status of human elephant conflict in Manas National park within Chirang-Ripu Elephant Reserve, Assam. Final technical report submitted to US Fish & Wildlife Service.
- Dey,S., Lahakar, B.P., Das, J.P., Nath, N.K., and Brahma N. Orchid Diversity in Manas National Park, Assam. J.Orchid Soc. India,21(1-2):65-68,2007.
- Sarma,P.K., Lahakar, B.P., Ghosh,S., A. Rabha., Das, J.P., Nath, N.K., Dey,S and Brahma, N. Landuse and land-cover change and future implications analysis in Manas National Park, India using multi-temporal satellite data.Current science., 2008,Vol 95,223-227.

1.	**Name of Staff**	**Mrs. CHANDRANI MITRA**
2.	**Position for NAFRA HEP**	**Environmentalist**
3.	**Years of Professional Experience**	**4 years**

4. Education

Post Graduate Diploma in Environment Management, Indian Institute of Social Welfare & Business Management (IISWBM), Kolkata

M. Sc. in Ecology & Environment, Sikkim Manipal University

5. Membership of Professional Associations: Nil

6. Involved in following major relevant projects

- Raigam Hydro Electric Project (96MW), Arunachal Pradesh (Ongoing)
- Gimliang Hydro Electric Project (99MW), Arunachal Pradesh (Ongoing)
- Tidding-I Hydro Electric Project (99MW), Arunachal Pradesh (Ongoing)
- Tidding-II Hydro Electric Project (68MW), Arunachal Pradesh (Ongoing)
- EMP preparation for various Substations and Transmission Lines for Haryana Vidyut Prasaran Nigam Limited
- Socio-economic Impact Assessment studies and Rehabilitation & Resettlement Action Plan for Nabinagar NTPC
- Evaluation of Lai FDA & Lunglei FDA, Mizoram, under National Afforestation Programme (NAP)
- EIA and EMP for setting up Sewerage Facility including Sewerage Treatment Plant in six towns of Sikkim

7.	**Name of Staff**	**Mr. ARUN KUMAR**
8.	**Position for NAFRA HEP**	**Design Executive**
9.	**Years of Professional Experience**	**21 years**

10. Education

Civil Draughtsman course from Pusa Institute, New Delhi
Graduation from Delhi University

11. Membership of Professional Associations: Nil

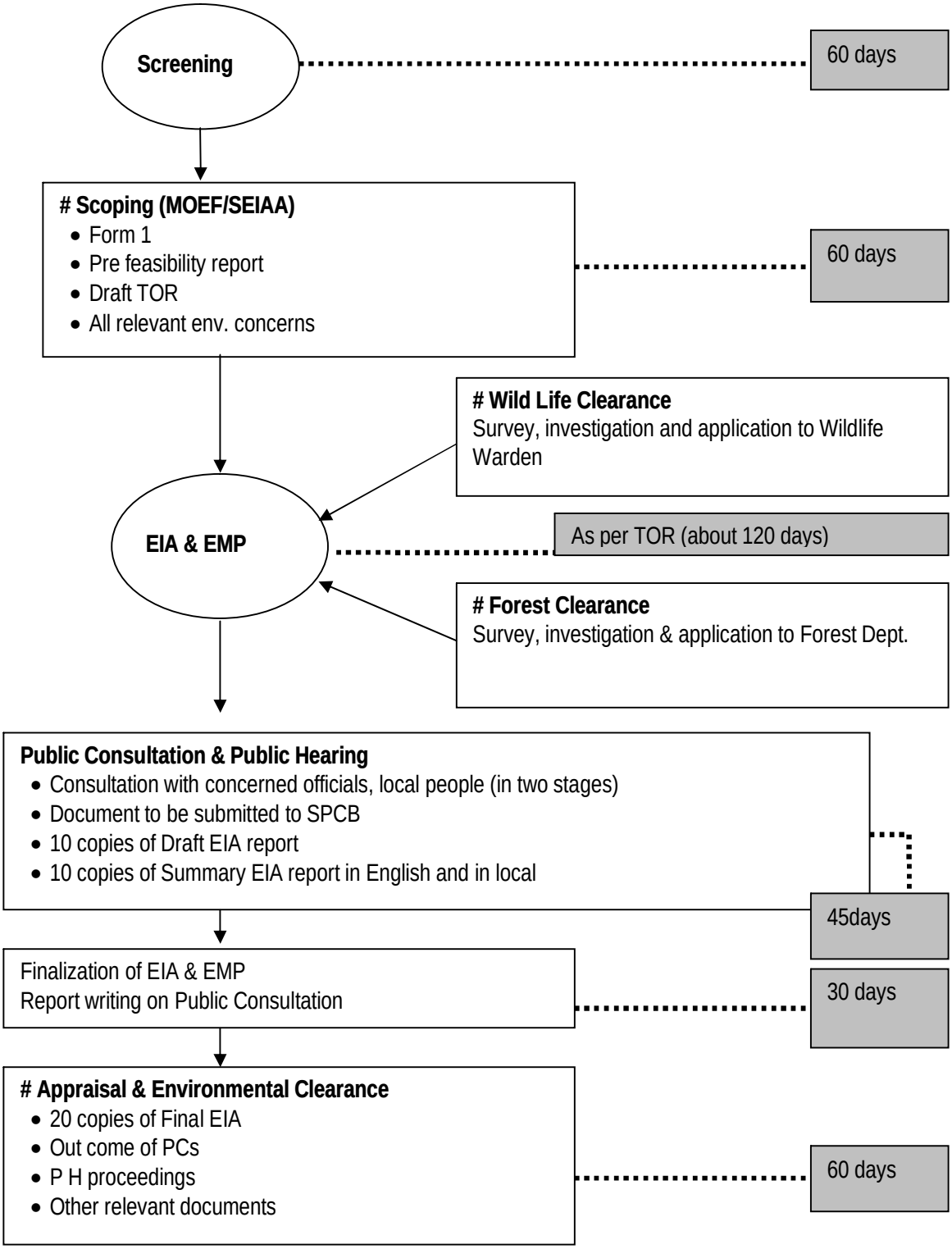
12. Involved in following major relevant projects

- Kameng Hydro Power Project, 600MW (4X150) (NEEPCO), Arunachal Pradesh
- 300 MW Chamera - II Hydro Electric project in Himachal Pradesh
- Srinagar Hydro Electric Project (330MW), Uttarakhand
- Nyaborongo Hydro Electric Project (28 MW), Rwanda
- Raigam Hydro Electric Project (96MW), Arunachal Pradesh (Ongoing)
- Gimliang Hydro Electric Project (99MW), Arunachal Pradesh (Ongoing)
- Tidding-I Hydro Electric Project (99MW), Arunachal Pradesh (Ongoing)
- Tidding-Ii Hydro Electric Project (68MW), Arunachal Pradesh (Ongoing)
- Tizu-Zungki Stage-I Hydro Electric Projects (20MW), Nagaland
- Tizu-Zungki Stage- II Hydro Electric Projects (20MW), Nagaland
- Tizu-Zungki Stage- III Hydro Electric Projects (20MW), Nagaland

Annexure I

EIA PROCESS AND TIME FRAME AS PER MoEF EIA NOTIFICATION, 2006

ANNEXURE – I : EIA PROCESS AND TIME FRAME AS PER MoEF EIA NOTIFICATION, 2006



Clearances to be obtained: #

Annexure II

APPROVED TERMS OF REFERENCE (TOR) FOR EIA STUDY FROM MOEF

तार :
Telegram : PARYAVARAN,
NEW DELHI
दूरभाष :
Telephone : & Fax 24362827
टेलेक्स :
Telex : W-66185 DOE IN
FAX : 4360678

भारत सरकार
पर्यावरण एवं वन मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT & FORESTS
पर्यावरण भवन, सी. जी. ओ. कॉम्प्लेक्स
PARYAVARAN BHAVAN, C.G.O. COMPLEX
लोदी रोड, नई दिल्ली-110003
LODHI ROAD, NEW DELHI-110003

No. J-12011/42/2008-IA.I

Dated : 24.10.2008

Shri Ravi Ramakrishna Paramahamsa
General Manager
SEW Nafra Power Corporation Pvt. Ltd.
6-3-871, 'SNEHALATA'
Greenlands Road,Begumpet
Hyderabad – 500 016

Sub: Nafra HEP (96 MW) in West Kameng District of Arunachal Pradesh by M/s. SEW Nafra Power Corporation Pvt. Ltd.- for Scoping-regarding

Sir,

This has reference to your letters dated 12.8.2008 and 22.10.2008 on above mentioned subject.

2. The project envisages construction of a 53 m. high concrete gravity dam across river Bichom for the generation of 96 MW hydropower. A surface power house is to be located on the right bank of the river at 1.5 km. upstream of Digo river confluence with Bichom. The total land requirement is about 64 ha. Out of which 30 ha is Community Land; 16 ha. is Forest Land and 18 ha. is river bed. Total submergence is about 32.935 ha. The catchment area at the dam site is 834 Sq. kms. The total cost of the project is Rs. 430.24 Crores and will be completed in 6 years.

3. The project was considered by the Expert Appraisal Committee (EAC) at its meetings held on 18.9.2008.

4. The Ministry of Environment and Forests hereby accords clearance for preconstruction activities in the proposed sites as per the provisions of Environmental Impact Assessment Notification, 2006 along with the following Terms of Reference for preparation of EIA report.

SALIENT FEATURES OF THE PROJECT

I. FOR PREPARATION OF EIA REPORT

The Baseline Studies should consist of three seasonal studies (Monsoon, Post-Monsoon and Winter season) and be conducted in the following study area.

A. STUDY AREA

The study area should include the following areas:

- Catchment area
- Submergence area
- Project area to be acquired for various project appurtenances, area within 10 Km from main Project components (i.e. Dam site, Power House etc.)

B. BASELINE DATA

1. Geological, Geophysical Aspects

- Geography & physiography of the project area
- Design discharge & its RI (Recurrence Interval)
- Regional geology and structure of the catchment
- Seismicity, tectonics and history of past earthquakes in the area
- Critical review of the geological features around the project area
- Impact of the project on geological environment
- Justification for location & execution of the project in relation to structural components (dam height).

2. Hydrology of the basin

- Hydro-meteorology, drainage systems
- Catastrophic events like cloud bursts & flash floods, if any should be documented
- Estimation of Sedimentation rate direct sampling of river flow is to be done during EIA to get actual silt flow rate (to be expressed in ha-m km^2 year-1).
- Water availability for the project and the aquatic fauna
- An elementary stream gauging station should be established at a suitable location up-stream to the dam site of the project and record the inflow as well as the sediment concentration of the river water during the 3 seasons of observations particularly during the lean season and during the monsoon season.
- Data on adjoining tributaries (Flow, Velocity and Depth)
- Detailed map depicting all projects on the basin
- Considering the downstream user's requirement & ecological sustainability, estimation of minimum lean season flow should be calculated and based on the release of minimum flow during lean season to maintain the aquatic ecology life should be proposed.

3. Seismo-tectonics:

- Study of Design Earthquake Parameters

4. Biological Resources

i) Flora

- Forests and forest types
- Vegetation profile, no. of species in the project area, etc.
- Community Structure though Vegetation mapping
- Species Diversity Index (Shanon Index) of the biodiversity in the project area as well as plant fossil & phytoplankton
- Importance Value Index (IVI) of the predominant species in the project area
- Inventorisation/ documentation of major groups of Flora with voucher specimen of all the RET species with GPS recording should be provided including economically important plants- medicinal plants NTFP, (MFP) bamboos, rattans (canes), orchids etc.
- Impact of impoundment and construction activities on the vegetation
- Location of any Biosphere Reserve, National Park or Sanctuary in the vicinity of the project, if any
- Collection of data on downstream Flora

ii) Fauna

- Inventorisation/ documentation of major groups of Fauna of all the RET species.
- Zoogeographic distribution/ affinities
- Collection of data on downstream Fauna

iii)Avifauna

- Status
- Resident/ Migratory/ Passage migrants
- Impact of project on threatened/endangered taxa, if any

iv)Aquatic Ecology

- Aqua-fauna like macro-invertebrates, zooplankton, phytoplanktons, etc.
- Conservation Status
- **Fish and fisheries**
  - Fish migrations, if any
  - Breeding grounds
  - Impact of dam building on fish migration and habitat degradation
- Overall ecological impact up to 10 km d/s from the confluence of the TRT with the river and the impact of untreated waste water into the river and the alternatives explored (There is no provision of treating water in the project)

v) Conservation areas and status of threatened/endangered taxa

- Biotic pressures
- Management plan for conservation areas and threatened/endangered taxa

5. Remote Sensing & GIS Studies

- Delineation of critically degraded areas in the directly draining catchment on the basis of Silt Yield Index as per the methodology of AISLUS
- Land use and land cover mapping
- Drainage pattern/ map
- Soil map
- Geomorphological features, slope and relief maps

6. Socio-economic aspects

- Land Details*
- Demographic profile
- Ethnographic profile
- Economic structure
- Literacy profile
- Development profile
- Agricultural practices
- Cultural and aesthetic sites
- Infrastructure facilities: education, health and hygiene, communication network, etc.
- Impact on socio-cultural and ethnographic aspects due to dam building activity

* Report should include list of the entire Project Affected Families (PAFs) with their names, land holdings, other properties, and occupation etc.

7. Environmental Parameters

Baseline information on the following

- Ambient air quality in the project area covering aspects like SPM, RSPM, SO_x, NO_x.
- Water (physico-chemical and biological parameters)
- Noise environment
- Soil quality
- Traffic density in the project area

8. Construction methodology and schedule including the tunnel driving operations, machinery and charge density, etc

C. IMPACT PREDICTION

Impact prediction is a way of 'mapping' the environmental consequences of the significant aspects of the project and its alternatives. Environmental impact can never be predicted with absolute certainty and this is the reason to consider all possible factors and take all possible precautions for reducing the degree of uncertainty.

The following impacts of the project should be assessed:

i. Air

- Changes in ambient levels and ground level concentrations due to total emissions from point, line and area sources
- Effects on soils, materials, vegetation, and human health
- Emissions from DG sets used for construction power (if any) on the vegetation and air environment

ii. Water

- Changes in quality
- Sedimentation of reservoir
- Impact on fish fauna
- Impact of sewage disposal

iii. Noise

- Changes in ambient levels due to noise generated from equipment, blasting operations and movement of vehicles
- Effect on fauna and human health

iv. Land

- Changes in land use and drainage pattern
- Changes in land quality including effects of waste disposal
- Riverbank and their stability
- Impact due to submergence

v. Biological

- Deforestation and shrinkage of animal habitat.
- Impact on fauna and flora (including aquatic species if any) due to decreased flow of water
- Impact on rare and endangered species, endemic species, if any.
- Migratory path / route of animal, if any
- Impact on breeding and nesting grounds , if any
- Impact on animal distribution, migration routes (if any), habitat fragmentation and destruction due to dam building activity

vi. Socio-Economic

- Impact on the local community including demographic changes
- Impact on economic status
- Impact on human health
- Impact of increased traffic
- Impact on holy places and tourism

vii. Overall

- Downstream impact on water, land & human environment due to drying up of the river in the stretch between dam site and powerhouse site.
- Positive as well as negative impacts likely to be accrued due to the project are to be listed

II. ENVIRONMENT MANAGEMENT PLAN (EMP)

On the basis of predicted environment impacts, Environment Management Plans should be formulated with precise action plans incorporating year-wise physical and financial targets. The EMP should include the following **Action Plans:**

a) Catchment Area Treatment Plan

Delineation of micro-watersheds in the river catchment and mapping of critically degraded areas requiring various biological and engineering treatment measures for entire catchment. Identification of areas for treatment based upon Remote Sensing & GIS methodology and Silt Yield Index (SYI) method of AISLUS coupled with ground survey. The prioritization of watershed for treatment based upon SYI. Spatial information in each micro watershed should be earmarked on maps in the scale of 1:50,000. The CAT plan should be prepared with year-wise Physical and Financial details.

b) **Green Belt Development Plan** around the Periphery of the Reservoir and Compensatory Afforestation Scheme in consultation with the State Forest Department

c) **Biodiversity Conservation and Wildlife Management Plan**

For conservation and preservation of endemic, rare and endangered species of flora and fauna (in consultation with the State Wildlife Department)

d) **Fisheries** development, conservation/ management.

e) **Resettlement & Rehabilitation (R&R) Plan along with social/community development plan.**

For Project Affected Families (PAF) who are likely to loose land, the details on the amount of land taken from them and the land remaining (in case 70% of land of any family is taken, then that family should be counted as a fully affected family). R&R plan should be based on NPRR 2007 and the policy of the state government, and should framed in consultation with the Project Affected Persons (PAPs), community, Project authorities and the State Government.

f) **Muck Disposal Plan**

Suitable sites for dumping of excavated materials should be identified in consultation with the State Pollution Control Board and Forest Department.

g) **Restoration and landscaping of Working Areas** - Reclamation of borrow pits (quarry sites) and construction areas.

h) Public Health Delivery System including the provision for drinking water facility for the local community

i) Energy Conservation Measures

j) Management during road construction

k) Sanitation and Solid Waste Management Plan for domestic waste from colonies and labour camps, etc.

l) Water and Air Quality & Noise Environment Management during construction and post-construction periods.

m) Forest Protection Plan

n) Reservoir RIM Treatment Plan

o) Environmental Monitoring Programme (With physical & financial details covering all the aspects from EMP).

p) Dam Break Analysis & Disaster Management Plan.

q) **Option assessment study** to show the options available for fulfilling the needs of the people.

r) **A summary of cost estimate for all the plans**

Cost for implementing all the Environmental Management plans including the cost for implementing Environmental Monitoring Programme.

5. As per the provisions of the EIA Notification of 2006, you are requested to submit draft EIA/EMP report as per the above terms of reference to the State Pollution Control Board/ Committee for conducting the Public Hearing.

6. All the issues discussed in the Public Hearing/ Public Consultations should be addressed to and incorporated in the final EIA/EMP report and submitted to the Ministry for considering the proposal for Environmental Clearance.

7. M/s. KSK Energy Group, project authority of Dibbin HEP on Bichom river has been directed by Expert Appraisal Committee to undertake a basin study for Bichom Basin. Cost of the study to be shared by all the project authorities of HEPs in Bichom Basin on prorate basis per MW.

Yours faithfully,

(Dr. S. Bhowmik)
Additional Director

Copy to :

1. Secretary, Ministry of Power, Shram Shakti Bhawan, Rafi Marg, New Delhi-1
2. Secretary (Power) Govt. of Arunachal Pradesh, Secretariat, Itanagar-791111
3. Secretary (Environment & Forest) Govt. of Arunachal Pradesh, Secretariat, Itanagar-791111, Arunachal Pradesh
4. The chief Engineer, Project Appraisal Directorate, Central Electricity Authority, Sewa Bhawan, R. K. Puram, New Delhi-110066
5. Member Secretary, Arunachal Pradesh State Pollution Control Board, Environment & Forest Office complex, sector-P, Itanagr-791111
6. Regional office, MOEF, Shillong
7. Guard File

(Dr. S. Bhowmik)
Additional Director

Annexure III

PROCEDURE FOR CONDUCTING PUBLIC HEARING

ANNEXURE – III : PROCEDURE FOR CONDUCTING PUBLIC HEARING

1.0 The Public Hearing shall be arranged in a systematic, time bound and transparent manner ensuring widest possible public participation at the project site(s) or in its close proximity District -wise, by the concerned State Pollution Control Board (SPCB) or the Union Territory Pollution Control Committee (UTPCC).

2.0 The Process:

2.1 The Applicant shall make a request through a simple letter to the Member Secretary of the SPCB or Union Territory Pollution Control Committee, in whose jurisdiction the project is located, to arrange the public hearing within the prescribed statutory period. In case the project site is extending beyond a State or Union Territory, the public hearing is mandated in each State or Union Territory in which the project is sited and the Applicant shall make separate requests to each concerned SPCB or UTPCC for holding the public hearing as per this procedure.

2.2 The Applicant shall enclose with the letter of request, at least 10 hard copies and an equivalent number of soft (electronic) copies of the draft EIA Report with the generic structure given in Appendix III including the Summary Environment Impact Assessment report in English and in the local language, prepared strictly in accordance with the Terms of Reference communicated after Scoping (Stage-2). Simultaneously the applicant shall arrange to forward copies, one hard and one soft, of the above draft EIA Report along with the Summary EIA report to the Ministry of Environment and Forests and to the following authorities or offices, within whose jurisdiction the project will be located:

(a) District Magistrate/s

(b) Zila Parishad or Municipal Corporation

(c) District Industries Office

(d) Concerned Regional Office of the Ministry of Environment and Forests

2.3 On receiving the draft Environmental Impact Assessment report, the above-mentioned authorities except the MoEF, shall arrange to widely publicize it within their respective jurisdictions requesting the interested persons to send their comments to the concerned regulatory authorities. They shall also make available the draft EIA Report for inspection electronically or otherwise to the public during normal office hours till the Public Hearing is over. The Ministry of Environment and Forests shall promptly display the Summary of the draft Environmental Impact Assessment report on its website, and also make the full draft EIA available for reference at a notified place during normal office hours in the Ministry at Delhi.

2.4 The SPCB or UTPCC concerned shall also make similar arrangements for giving publicity about the project within the State/Union Territory and make available the Summary of the draft Environmental Impact Assessment report (Appendix III A) for inspection in select offices or public libraries or panchayats etc. They shall also additionally make available a copy of the draft Environmental Impact Assessment report to the above five authorities/ offices viz, Ministry of Environment and Forests, District Magistrate etc.

3.0 Notice of Public Hearing:

3.1 The Member-Secretary of the concerned SPCB or UTPCC shall finalize the date, time and exact venue for conduct the public hearing within 7(seven) days of the date of receipt of the draft Environmental Impact Assessment report from the project proponent, and advertise the same in one major National

Daily and one Regional vernacular Daily. A minimum notice period of 30 (thirty) days shall be provided to the public for furnishing their responses;

3.2 The advertisement shall also inform the public about the places or offices where the public could access the draft Environmental Impact Assessment report and the Summary Environmental Impact Assessment report before the public hearing**.**

3.3 No postponement of the date, time, venue of the public hearing shall be undertaken, unless some untoward emergency situation occurs and only on the recommendation of the concerned District Magistrate the postponement shall be notified to the public through the same National and Regional vernacular dailies and also prominently displayed at all the identified offices by the concerned SPCB or Union Territory Pollution Control Committee;

3.4 In the above exceptional circumstances fresh date, time and venue for the public consultation shall be decided by the Member –Secretary of the concerned SPCB or UTPCC only in consultation with the District Magistrate and notified afresh as per procedure under 3.1 above.

4.0 The Panel

4.1 The District Magistrate or his or her representative not below the rank of an Additional District Magistrate assisted by a representative of SPCB or UTPCC**,** shall supervise and preside over the entire public hearing process.

5.0 Videography

5.1 The SPCB or UTPCC shall arrange to video film the entire proceedings. A copy of the videotape or a CD shall be enclosed with the public hearing proceedings while forwarding it to the Regulatory Authority concerned.

6.0 Proceedings

6.1 The attendance of all those who are present at the venue shall be noted and annexed with the final proceedings.

6.2 There shall be no quorum required for attendance for starting the proceedings.

6.3 A representative of the applicant shall initiate the proceedings with a presentation on the project and the Summary EIA report.

6.4 Every person present at the venue shall be granted the opportunity to seek information or clarifications on the project from the Applicant. The summary of the public hearing proceedings accurately reflecting all the views and concerns expressed shall be recorded by the representative of the SPCB or UTPCC and read over to the audience at the end of the proceedings explaining the contents in the vernacular language and the agreed minutes shall be signed by the District Magistrate or his or her representative on the same day and forwarded to the SPCB/UTPCC concerned**.**

6.5 A Statement of the issues raised by the public and the comments of the Applicant shall also be prepared in the local language and in English and annexed to the proceedings.

6.6 The proceedings of the public hearing shall be conspicuously displayed at the office of the Panchyats within whose jurisdiction the project is located, office of the concerned Zila Parishad, District Magistrate, and the SPCB or UTPCC. The SPCB or UTPCC shall also display the proceedings on its website for general information. Comments, if any, on the proceedings which may be sent directly to the concerned regulatory authorities and the Applicant concerned.

7.0 Time period for completion of public hearing

7.1 The public hearing shall be completed within a period of 45 (forty five) days from date of receipt of the request letter from the Applicant. Therefore the SPCB or UTPCC concerned shall sent the public hearing proceedings to the concerned regulatory authority within 8(eight) days of the completion of the public hearing .The applicant may also directly forward a copy of the approved public hearing proceedings to the regulatory authority concerned along with the final Environmental Impact Assessment report or supplementary report to the draft EIA report prepared after the public hearing and public consultations.

7.2 If the SPCB or UTPCC fails to hold the public hearing within the stipulated 45(forty five) days, the Central Government in Ministry of Environment and Forests for Category 'A' project or activity and the State Government or Union Territory Administration for Category 'B' project or activity at the request of the SEIAA, shall engage any other agency or authority to complete the process, as per procedure laid down in this notification.

(Source: Appendix IV of EIA Notification dated 14th September, 2006)

Annexure IV

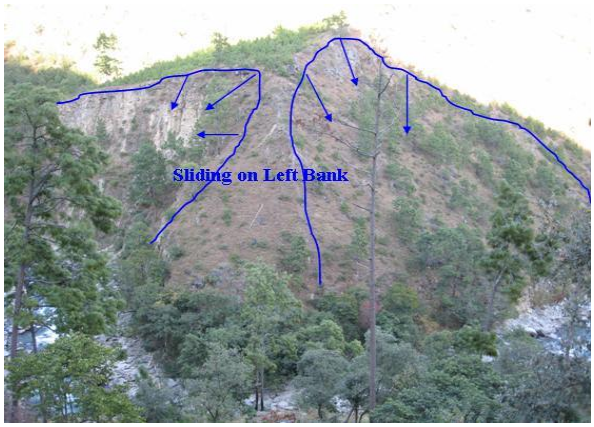
PHOTOGRAPHS OF LANDSLIDES ZONE WITHIN STUDY AREA

ANNEXURE – IV : PHOTOGRAPHS OF LANDSLIDE ZONES WITHIN STUDY AREA

Land slide about 9 km upstream of Dam site

Land slide in middle level of slope

Escarpment due to sliding



Sliding Left Bank

Sliding Left Bank – Downstream of Dam site

Slided Debris

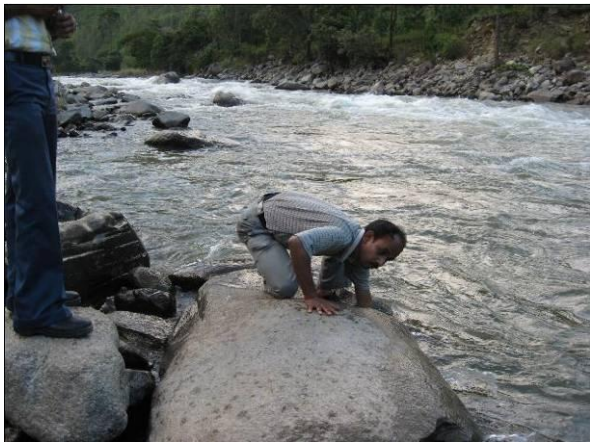
Annexure V

PHOTOGRAPHS OF ENVIRONMENTAL MONITORING

ANNEXURE - V : PHOTOGRAPHS OF ENVIRONMENTAL MONITORING

SURFACE WATER SAMPLING FROM RIVER BICHOM

Surface Water Sampling upstream of Dam Site



Surface Water Sampling downstream of Dam Site

DRINKING WATER SAMPLING FROM TAP

Drinking Water Sampling at Nafra Village

Drinking Water Sampling from Tap

AMBIENT AIR QUALITY MONITORING

Air Quality Monitoring at Nafra Town

Air Quality Monitoring at Lower Jung Village

AMBIENT NOISE LEVEL MONITORING

Ambient Noise Level Monitoring at Nafra village

Ambient Noise Level Monitoring at village Lower Jung

SOIL SAMPLING

Soil Sampling at Nafra village

Soil Sampling at village Lower Jung

ECOLOGICAL SAMPLING AND MONITORING

Collection of plant species for assessment Terrestrial life

Water sampling for assessment of Aquatic life

Annexure VI

SUMMARY TABLE FOR MINIMUM DISCHARGE USING HEC-RAS

ANNEXURE - VI : SUMMARY TABLE FOR MINIMUM DISCHARGE USING HEC-RAS

Reach	Chainage	Bed Level	With Dam				Without Dam				
			Discharge	W.S. Elev	Flow Depth	Velocity	Flow Area	Discharge	W.S. Elev	Flow Depth	Vel Chnl	Flow Area
	(m3/s)	(m)		(m)	(m)	(m/s)	(m2)	(m3/s)	(m)	(m)	(m/s)	(m2)
Up Stream	200	948	0.913	952.07	4.07	0.00	268.31	9.13	948.21	0.21	1.49	6.12
Up Stream	100	946	0.913	952.07	6.07	0.00	471.43	9.13	946.18	0.18	1.31	6.98
Dam Axis	0 (Dam)	944	0.913	952.07	8.07	0.00	506.19	9.13	944.79	0.79	0.84	10.87
Down Stream	-100	944	0.913	944.04	0.04	0.66	1.38	9.13	944.2	0.2	1.39	6.55
Down Stream	-200	942	0.913	942.19	0.19	0.2	4.61	9.13	942.56	0.56	0.64	14.21
Down Stream	-300	942	0.913	942.05	0.05	0.46	1.97	9.13	942.19	0.19	1.27	7.19
Down Stream	-400	940	0.913	940.05	0.05	0.71	1.29	9.13	940.24	0.24	1.49	6.11
Down Stream	-500	938	0.913	938.05	0.05	0.68	1.34	9.13	938.22	0.22	1.46	6.24
Down Stream	-600	934	0.913	934.12	0.12	1.25	0.73	9.13	934.34	0.34	2.89	3.16
Down Stream	-700	928.66	0.913	928.78	0.12	1.1	0.83	9.13	929	0.34	2.3	3.97
Down Stream	-800	926	0.913	926.06	0.06	0.79	1.16	9.13	926.28	0.28	1.66	5.51
Down Stream	-900	921.29	0.913	921.65	0.36	0.21	4.27	9.13	922.1	0.81	0.5	18.36
Down Stream	-1000	921.29	0.913	921.45	0.16	0.91	1	9.13	921.71	0.42	1.58	5.77
Down Stream	-1100	918	0.913	918.07	0.07	0.54	1.69	9.13	918.17	0.17	2.25	4.06
Down Stream	-1200	915.83	0.913	916.02	0.19	0.62	1.47	9.13	916.16	0.33	1.31	6.97
Down Stream	-1300	910.87	0.913	911.07	0.2	0.42	2.19	9.13	911.12	0.25	2.74	3.33
Down Stream	-1400	910	0.913	910.05	0.05	0.69	1.32	9.13	910.22	0.22	1.41	6.47
Down Stream	-1500	904.51	0.913	904.65	0.14	1.36	0.67	9.13	904.76	0.25	3.62	2.52
Down Stream	-1600	900	0.913	900.06	0.06	0.49	1.88	9.13	900.21	0.21	1.38	6.64
Down Stream	-1700	898	0.913	898.04	0.04	0.62	1.48	9.13	898.17	0.17	1.3	7.03
Down Stream	-1800	895.04	0.913	895.15	0.11	0.67	1.36	9.13	895.29	0.25	1.78	5.14
Down Stream	-1900	892	0.913	892.03	0.03	0.58	1.57	9.13	892.14	0.14	1.27	7.18
Down Stream	-2000	888	0.913	888.06	0.06	0.78	1.17	9.13	888.2	0.2	2.11	4.33
Down Stream	-2100	885.92	0.913	886.03	0.11	0.66	1.39	9.13	886.18	0.26	1.35	6.75
Down Stream	-2200	882	0.913	882.03	0.03	0.57	1.61	9.13	882.09	0.09	1.78	5.13
Down Stream	-2300	877.99	0.913	878.09	0.1	0.89	1.02	9.13	878.31	0.32	1.34	6.83

Reach	Chainage	Bed Level	With Dam					Without Dam				
			Discharge	W.S. Elev	Flow Depth	Velocity	Flow Area	Discharge	W.S. Elev	Flow Depth	Vel Chnl	Flow Area
Down Stream	-2400	870.45	0.913	870.77	0.32	0.29	3.19	9.13	870.67	0.22	5.39	1.69
Down Stream	-2500	870.29	0.913	870.44	0.15	0.94	0.98	9.13	870.71	0.42	1.47	6.23
Down Stream	-2600	865.47	0.913	865.54	0.07	1.01	0.9	9.13	865.63	0.16	2.91	3.13
Down Stream	-2700	857.81	0.913	859.89	2.08	0.02	42.97	9.13	860.25	2.44	0.16	58.33
Down Stream	-2800	859.6	0.913	859.82	0.22	1.07	0.85	9.13	860.13	0.53	1.41	6.47
Down Stream	-2900	855.18	0.913	855.51	0.33	2.29	0.4	9.13	855.74	0.56	3.11	2.94
Down Stream	-3000	851.74	0.913	851.9	0.16	0.92	0.99	9.13	852.09	0.35	1.21	7.54
Down Stream	-3100	848	0.913	848.04	0.04	0.86	1.06	9.13	848.15	0.15	2.03	4.49
Down Stream	-3200	846	0.913	846.09	0.09	0.36	2.5	9.13	846.5	0.5	0.64	14.35
Down Stream	-3300	844.9	0.913	845.19	0.29	1.45	0.63	9.13	845.89	0.99	2.32	3.94
Down Stream	-3400	842.16	0.913	842.3	0.14	0.98	0.93	9.13	842.43	0.27	2.52	3.63
Down Stream	-3500	839.9	0.913	840.07	0.17	0.56	1.63	9.13	840.38	0.48	1.03	8.87
Down Stream	-3600	838.3	0.913	838.73	0.43	1.04	0.88	9.13	839.22	0.92	2.38	3.84
Down Stream	-3700	836.58	0.913	836.68	0.1	0.8	1.15	9.13	836.84	0.26	1.84	4.95
Down Stream	-3900	830	0.913	830.05	0.05	0.47	1.96	9.13	830.17	0.17	1.43	6.36
Down Stream	-4000	828	0.913	828.05	0.05	0.69	1.33	9.13	828.5	0.5	0.62	14.7
Down Stream	-4300	826.89	0.913	827.07	0.18	0.96	0.95	9.13	827.35	0.46	1.52	6
Down Stream	-4500	816	0.913	816.04	0.04	1.37	0.66	9.13	816.14	0.14	4.06	2.25
Down Stream	-4600	814	0.913	814.05	0.05	0.73	1.25	9.13	814.25	0.25	1.54	5.92
Down Stream	-5100	805.16	0.913	814.06	8.9	0	710.07	9.13	814.27	9.11	0.01	734.36
Down Stream	-5200	814	0.913	814.04	0.04	0.6	1.52	9.13	814.18	0.18	1.31	6.97
Down Stream	-5300	805	0.913	807.55	2.55	0.01	108.89	9.13	807.74	2.74	0.08	117.87
Down Stream	-5400	806	0.913	807.55	1.55	0.01	85.02	9.13	807.74	1.74	0.1	95.93
Down Stream	-5500	805	0.913	807.55	2.55	0.01	127.67	9.13	807.74	2.74	0.07	138.49
Down Stream	-5600	803	0.913	807.55	4.55	0	248.33	9.13	807.74	4.74	0.03	261.29
Down Stream	-5700	807.5	0.913	807.53	0.03	0.58	1.56	9.13	807.66	0.16	1.24	7.36
Down Stream	-5800	799.07	0.913	799.26	0.19	2.94	0.31	9.13	799.49	0.42	6.47	1.41

Annexure VII

PERMISSIBLE LIMITS FOR WATER QUALITY PARAMETERS

ANNEXURE – VII : PERMISSIBLE LIMITS FOR WATER QUALITY PARAMETERS

Standard for Surface Water Quality Criteria

Designated-Best-Use	Class of water	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	Total Coli forms Organism MPN/100ml shall be 50 or less pH between 6.5 and 8.5 Dissolved Oxygen 6 mg/l or more Biochemical Oxygen Demand 5 days 20°C 2 mg/l or less
Outdoor bathing (Organised)	B	Total Coli forms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 ,Dissolved Oxygen 5mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	Total Coli forms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 ,Dissolved Oxygen 4mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	D	pH between 6.5 to 8.5 Dissolved Oxygen 4mg/l or more Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	pH between 6.0 to 8.5 Electrical Conductivity at 25°C micro mhos/cm Max.2250 Sodium absorption Ratio Max. 26 Boron Max. 2mg/l
	Below-E	Not Meeting A, B, C, D & E Criteria

(***Source:*** *Monitoring of Indian National Aquatic Resource, http//:CPCB.nic.in)*

Indian Standards of Drinking Water Specifications-IS 10500: 1991

Sl. No	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect outside the Desirable Limit	Permissible Limit in the Absence of Alternate Source	Methods of Test (Ref. To IS)	Remarks
Essential Characteristics						
1.	Colour, Hazen units, Max.	5	Above 5, consumer acceptance decreases	25	3025(Part 4) 1983	Extended to 25 only if toxic substances, in absence of alternate sources
2.	Odour	Unobjectionable	-	-	3025 (Parts 5) 1984	a) Test cold and when heated b) Tests at several dilutions
3.	Taste	Agreeable	-	-	3025(Part 7 and 8) 1984	Test to be conducted only after safety has been established
4.	Turbidity NTU, Max.	5	Above 5, consumer acceptance decreases	10	3025 (Part 10) 1984	-
5.	pH Value	6.5 to 8.5	Beyond this range, the water will affect the mucous membrane and /or water supply system	No relaxation	3025 (Part 11) 1984	-
6.	Total hardness (as $CaCO_3$) mg/L. Max.	300	Encrustation in water supply structure and adverse effects on domestic use	600	3025 (Part 21) 1983	-
7.	Iron (as Fe) mg/L. Max.	0.3	Beyond this limit taste/appearance are affected,	1	32 of 3025:1964	-

Sl. No	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect outside the Desirable Limit	Permissible Limit in the Absence of Alternate Source	Methods of Test (Ref. To IS)	Remarks
			has adverse effect on domestic uses and water supply structures, and promotes iron bacteria			
8.	Chlorides (as Cl) mg/L	250	Beyond this limit, taste, corrosion and palatability are affected	1000	3025 (Part 32) 1988	-
9.	Residual, free chlorine, mg/L, Min	-	-	-	3025 (Part 26) 1986	To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be Min 0.5 mg/l.
Desirable Characteristics						
1.	Dissolved solids mg/L, Max	500	Beyond this palatability decreases and may cause gastro intestinal irritation	2000	3025 (Part 16) 1984	-
2.	Calcium (as Ca) mg/L, Max	75	Encrustation in water supply structure and adverse effects on domestic use	200	3025 (Part 40) 1991	-
3.	Magnesium (as Mg) mg/L, Max	30	Encrustation to water supply structure and adverse effects on domestic use	100	16,33,34 of IS 3025: 1964	-

Sl. No	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect outside the Desirable Limit	Permissible Limit in the Absence of Alternate Source	Methods of Test (Ref. To IS)	Remarks
4.	Copper (as Cu) mg/L, Max	0.05	Astringent taste, discoloration and corrosion of pipes, fitting and utensils will be caused beyond this	1.5	36 of 3025: 1964	-
5.	Manganese (as Mn) mg/L, Max	0.1	Beyond this limit taste / appearance are affected, has adverse effects on domestic uses and water supply structures	0.3	35 of 3025:1964	-
6.	Sulphate (as SO4) mg/L, Max	200	Beyond this causes gastro intestinal irritation when magnesium or sodium are present	400	3025 (Part 24) 1986	May be extended up to 400 provided (as Mg) does not exceed 30
7.	Nitrate (as NO2), mg/L, Max	45	Beyond this methaemoglobinemia takes place	100	3025 (Part 34) 1988	-
8.	Fluoride (as F) mg/L, Max	1	Fluoride may be kept as low as possible, high fluoride may cause fluorosis	1.5	23 of 3025: 1964	-
9.	Phenolic compounds (As C5H5OH) mg/L, Max	0.001	Beyond this, it may cause objectionable taste and odour	0.002	54 of 3025: 1964	-
10.	Mercury (as Hg)	0.001	Beyond this, the water	No relaxation	Mercury ion	To be tested when

Sl. No	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect outside the Desirable Limit	Permissible Limit in the Absence of Alternate Source	Methods of Test (Ref. To IS)	Remarks
	mg/L, Max		becomes toxic		analyser	pollution is suspected
11.	Cadmium (as Cd), mg/L, Max	0.01	Beyond this, the water becomes toxic	No relaxation	-	To be tested when pollution is suspected
12.	Selenium (as Se), mg/L, Max	0.01	Beyond this, the water becomes toxic	No relaxation	28 0f 3025: 1964	To be tested when pollution is suspected
13.	Arsenic (as As) mg/L, Max	0.05	Beyond this, the water becomes toxic	No relaxation	3025 (Part 37) 1988	To be tested when pollution is suspected
14.	Cyanide (as CN) mg/L, Max	0.05	Beyond this, the water becomes toxic	No relaxation	3025 (Part 27) 1986	To be tested when pollution is suspected
15.	Lead (as Pb) mg/L, Max	0.05	Beyond this, the water becomes toxic	No relaxation	-	To be tested when pollution is suspected
16.	Zinc (as Zn) mg/L, Max	5	Beyond this limit it can cause astringent taste and an opalescence in water	15	39 0f 3025: 1964	To be tested when pollution is suspected
17.	Amonic detergent (as MBAS) mg/L, Max	0.2	Beyond this limit it can cause a light froth in water	1	Methylene-blue extraction method	To be tested when pollution is suspected
18.	Chromium (as Cr+) mg/L, Max	0.05	May be carcinogenic above this limit	-	38 of 3025: 1964	To be tested when pollution is suspected
19.	Poly nuclear aromatic hydrocarbon (as PAH) g/L, Max	-	May be carcinogenic above this limit	-	-	-

Sl. No	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect outside the Desirable Limit	Permissible Limit in the Absence of Alternate Source	Methods of Test (Ref. To IS)	Remarks
20.	Mineral oil mg/L, Max	0.01	Beyond this limit undesirable taste and odour after chlorination take place	0.03	Gas Chromatograph	-
21.	Pesticides mg/L, Max	Absent	Toxic	0.001	-	-
22.	Radioactive Alpha emitters Bq/L, Max	-	-	0.1	58 of 3025: 01964	-
23.	Radioactive Beta emitters pci/L, Max	-	-	1	58 of 3025: 01964	-
24.	Aluminium (as Al), mg/L Max	200	Beyond this limit taste becomes unpleasant	600	13 of 3025: 1964	-
25.	Aluminium (as Al), mg/L Max	0.03	Cumulative effect is reported to cause dementia	0.2	31 of 3025: 1964	-
26.	Boron, mg/L, Max	1	-	5	29 of 3025: 1964	-

(***Source:*** *Indian Standard Drinking water Specification- IS 10500: 1991)*

Annexure VIII

PLANT SPECIES REPORTED IN THE STUDY AREA

ANNEXURE - VIII : PHOTOGRAPHS OF REPORTED PLANT SPECIES

Castanopsis indica

Bombax ceiba

Tithonia diversifolia

Emblica officinalis

Clematis sp.

Desmodium concinnum

Adenia trilobata

Quercus griffithii

Opuntia dillenii

Indigofera exilis

Solanum sp.

Woodfordia fruticosa

Boehmeria penduliflora

Tolypanthus involucratus

Urena lobata

Calamus spp.

Rubus ellipticus

Milletia pachycarpa

Strobilanthus sp.

Gynocardia odorata

Hymenodictyon excelsum

Annexure IX

CALCULATION OF RELATIVE FREQUENCY, RELATIVE DENSITY AND IMPORTANCE VALUE INDEX (IVI) BY QUADRAT METHOD

ANNEXURE – IX : CALCULATION OF RELATIVE FREQUENCY, RELATIVE DENSITY AND IMPORTANCE VALUE INDEX (IVI) BY QUADRAT METHOD

HERBS

Herbs of the Project Site

Sl. No	Scientific names	Family	Qa-1	Qa-2	Qa-3	Qa-4	Qa-5	Total	mean	RF %	RD %
1	*Ranunculus cantoniensis*	Ranunculaceae		10	3	1		14	2.8	60	6.97
2	*Sida acuta* Burm.	Malvaceae	10	17		6		33	6.6	60	16.42
3	*Urena lobata*	Malvaceae	35	28	16	13		92	18.4	80	45.77
4	*Kalanchoe pinnata*	Crassulaceae	2	15	6	8	3	34	6.8	100	16.92
5	*Clematis buchananiana*	Ranunculaceae	1	3		3	5	12	2.2	80	5.97
6	*Clematis connata*	Ranunculaceae	4	2	6		4	16	3.2	80	7.96

Calculation of different factors of Herbs

Herbs	*Ranunculus cantoniensis*	*Sida acuta* Burm.	*Urena lobata*	*Kalanchoe pinnata*	*Clematis buchananiana*	*Clematis connata*
Mean	2.80	8.25	18.40	6.80	3.00	3.20
Standard Error	1.88	3.57	6.09	2.31	0.82	1.02
Median	1.00	8.00	16.00	6.00	3.00	4.00
Mode	0.00	-	-	-	3.00	4.00
Standard Deviation	4.21	7.14	13.61	5.17	1.63	2.28
Sample Variance	17.70	50.92	185.30	26.70	2.67	5.20
Kurtosis	3.25	0.04	-0.72	1.23	1.50	-0.18
Skewness	1.81	0.19	-0.16	1.17	0.00	-0.40
Range	10.00	17.00	35.00	13.00	4.00	6.00
Minimum	0.00	0.00	0.00	2.00	1.00	0.00
Maximum	10.00	17.00	35.00	15.00	5.00	6.00
Sum	14.00	33.00	92.00	34.00	12.00	16.00
Count	5.00	4.00	5.00	5.00	4.00	5.00
Confidence Level(95.0%)	5.22	11.35	16.90	6.42	2.60	2.83
Relative Frequency %	**60**	**60**	**80**	**100**	**80**	**80**
Relative Density %	**6.97**	**16.42**	**45.77**	**16.92**	**5.97**	**7.96**

SHRUBS

Shrubs of the Project Site (10 m X 10 m) five quadrats

Sl No	Scientific names	Family	Qa-1	Qa-2	Qa-3	Qa-4	Qa-5	Total	mean	RF %	RD %
1	Lyonia ovalifolia	Ericaceae	3	9	7	6	1	26	**5.2**	**100**	**12.81**
2	Gaultheria fragrantissima	Ericaceae	15	11	8			34	**6.8**	**60**	**16.75**
3	Oxyspora paniculata	Melastomaceae	2	3	5	6		16	**3.2**	**80**	**7.88**
4	Cannabis sativa	Cannabaceae	21	17	5	12	2	57	**11.4**	**100**	**28.08**
5	Tolypanthus involucratus	Loranthaceae		1	4		5	10	**2**	**60**	**4.93**
6	Rubus calycinus	Rosaceae	1	1		3	5	10	**2**	**80**	**4.93**
7	Rubus ellipticus	Rosaceae		3			1	4	**0.8**	**40**	**1.97**
8	Cassia mimosoides	Fabaceae	2			3	7	12	**2.4**	**60**	**5.91**
9	Fleminga strobilifera	Fabaceae	2		4	3		9	**1.8**	**60**	**4.43**
10	Woodfordia fruticosa	Lythraceae	1		5			6	**1.2**	**40**	**2.96**
11	Lyonia ovalifolia	Ericaceae	2					2	**0.4**	**20**	**0.99**
12	Urena lobata	Malvaceae	1	3			1	5	**1**	**60**	**2.46**
13	Boehmeria penduliflora	Urticaceae	2			2	4	12	**2.4**	**60**	**5.91**

Calculation of different factors of Shrubs

Shurb	*Lyonia ovalifolia*	*Gaultheria fragrantissima*	*Oxyspora paniculata*	*Cannabis sativa*	*Tolypanthus involucratus*	*Rubus calycinus*	*Rubus ellipticus*	*Cassia mimosoides*	*Fleminga strobilifera*	*Woodfordia fruticosa*	*Lyonia ovalifolia*	*Urena lobata*	*Boehmeria penduliflora*
Mean	8.666667	17	6.4	19	5	4	2.666667	6	4.5	4	2	2.5	5
Standard Error	3.657564	5.845226	2.501999	8.136338	1.870829	1.67332	0.881917	2.27303	1.554563	1.527525	0	0.957427	2.380476
Median	6.5	13	5	14.5	4.5	3	3	5	3.5	5	2	2	3
Mode	-	-	-	-	-	1	-	-	-	-	2	1	2
Standard Deviation	8.959167	11.69045	5.59464	19.92988	3.741657	3.741657	1.527525	4.546061	3.109126	2.645751	0	1.914854	4.760952
Sample Variance	80.26667	136.6667	31.3	397.2	14	14	2.333333	20.66667	9.666667	7	0	3.666667	22.66667
Kurtosis	4.051176	2.810648	3.490594	3.553355	1.5	1.311224	-	-0.74766	2.703924	-	-	-1.28926	3.134948
Skewness	1.898796	1.65238	1.802273	1.776319	0.763604	1.288581	-0.93522	0.894074	1.597078	-1.45786	-	0.854563	1.779179
Range	25	26	14	55	9	9	3	10	7	5	0	4	10
Minimum	1	8	2	2	1	1	1	2	2	1	2	1	2
Maximum	26	34	16	57	10	10	4	12	9	6	2	5	12
Sum	52	68	32	114	20	20	8	24	18	12	4	10	20
Count	6	4	5	6	4	5	3	4	4	3	2	4	4
Confidence Level(95.0%)	9.402069	18.60212	6.946663	20.91512	5.953812	4.645881	3.794583	7.233797	4.947314	6.572411	0	3.04696	7.575738
Relative Frequency %	100.00	60.00	80.00	100.00	60.00	80.00	40.00	60.00	60.00	40.00	20.00	60.00	60.00
Relative Density %	12.81	16.75	7.88	28.08	4.93	4.93	1.97	5.91	4.43	2.96	0.99	2.46	5.91

TREES

Trees of the Project Site in each (50 m X 50 m) quadrats

Sl No	Scientific names	Family	Qa-1	Qa-2	Qa-3	Qa-4	Qa-5	Total	mean	RF %	RD %
1	*Pinus wallichiana*	Pinaceae	6	6	11	9	2	34	**6.8**	100	27.2
2	*Pinus roxburghii*	Pinaceae	5	5	7	3	7	27	**5.4**	100	21.6
3	*Duabanga grandiflora*	Sonneratiaceae				1	1	2	**0.4**	40	1.6
4	*Michelia dotsopa*	Magnoliaceae			1			1	**0.2**	20	0.8
5	*Magnolia caveana*	Magnoliaceae	3	1	4			8	**1.6**	60	6.4
6	*Castanopsis indica*	Fagaceae		1		1	2	4	**0.8**	60	3.2
7	*Quercus griffithii*	Fagaceae	2	2	3			7	**1.4**	60	5.6
8	*Ulmus lanceifolia*	Ulmaceae		1	2		1	4	**0.8**	60	3.2
9	*Engelhardia spicata*	Juglandaceae				1		1	**0.2**	20	0.8
10	*Camellia kissi* Wallich.	Theaceae	1	3		1		5	**1**	60	4
11	*Eurya acuminata*	Theaceae			1			1	**0.2**	20	0.8
12	*Rhododendron arboreum*	Ericaceae	1				1	2	**0.4**	40	1.6
13	*Acer oblongum*	Aceraceae			1			1	**0.2**	20	0.8
14	*Saurauia nepalensis*	Actinidiaceae	1				2	3	**0.6**	40	2.4
15	*Bombax ceiba*	Bombacaceae			1			1	**0.2**	20	0.8
16	*Pterospermum acerifolium*	Sterculiaceae		3			1	4	**0.8**	40	3.2
17	*Rhus javanica*	Anacardiaceae				1		1	**0.2**	20	0.8
18	*Streblus asper*	Moraceae	2					2	**0.4**	20	1.6
19	*Kalanchoe pinnata*	Crassulaceae			1		2	3	**0.6**	40	2.4
20	*Zanthoxylum acanthopodium*	Rutaceae				1			**0.2**	20	0
21	*Zanthoxylum armatum*	Rutaceae	2	2			1	5	**1**	60	4
22	*Desmodium concinnum*	Fabaceae	1		1			2	**0.4**	40	1.6
23	*Bauhinia glauca*	Fabaceae		1				1	**0.2**	20	0.8
24	*Albizia arunachalensis*	Fabaceae		1		1		2	**0.4**	40	1.6
25	*Erythrina variegata*	Fabaceae					1	1	**0.2**	20	0.8
26	*Emblica officinalis*	Euphorbiaceae	1	1			1	3	**0.6**	60	2.4

Calculation of different factors of Trees

Sl No	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Min.	Max.	Sum	Count	Confidence Level (95.0%)
1	6.80	1.53	6.00	6.00	3.42	11.70	-0.09	-0.28	9.00	2.00	11.00	34.00	5.00	4.25
2	5.40	0.75	5.00	5.00	1.67	2.80	-0.61	-0.51	4.00	3.00	7.00	27.00	5.00	2.08
3	1.00	0.00	1.00	1.00	0.00	0.00	-	-	0.00	1.00	1.00	2.00	2.00	0.00
4	1.00	0.00	1.00	-	-	-	-	-	0.00	1.00	1.00	1.00	1.00	-
5	2.67	0.88	3.00	-	1.53	2.33	-	-0.94	3.00	1.00	4.00	8.00	3.00	3.79
6	1.33	0.33	1.00	1.00	0.58	0.33	-	1.73	1.00	1.00	2.00	4.00	3.00	1.43
7	2.33	0.33	2.00	2.00	0.58	0.33	-	1.73	1.00	2.00	3.00	7.00	3.00	1.43
8	1.33	0.33	1.00	1.00	0.58	0.33	-	1.73	1.00	1.00	2.00	4.00	3.00	1.43
9	1.00	0.00	1.00	-	-	-	-	-	0.00	1.00	1.00	1.00	1.00	-
10	1.67	0.67	1.00	1.00	1.15	1.33	-	1.73	2.00	1.00	3.00	5.00	3.00	2.87
11	1.00	0.00	1.00	-	-	-	-	-	0.00	1.00	1.00	1.00	1.00	-
12	1.00	0.00	1.00	1.00	0.00	0.00	-	-	0.00	1.00	1.00	2.00	2.00	0.00
13	1.00	0.00	1.00	-	-	-	-	-	0.00	1.00	1.00	1.00	1.00	-
14	1.50	0.50	1.50	-	0.71	0.50	-	-	1.00	1.00	2.00	3.00	2.00	6.35
15	1.00	0.00	1.00	-	-	-	-	-	0.00	1.00	1.00	1.00	1.00	-
16	2.00	1.00	2.00	-	1.41	2.00	-	-	2.00	1.00	3.00	4.00	2.00	12.71
17	1.00	0.00	1.00	-	-	-	-	-	0.00	1.00	1.00	1.00	1.00	-
18	2.00	0.00	2.00	-	-	-	-	-	0.00	2.00	2.00	2.00	1.00	-
19	1.50	0.50	1.50	-	0.71	0.50	-	-	1.00	1.00	2.00	3.00	2.00	6.35
20	1.00	0.00	1.00	-	-	-	-	-	0.00	1.00	1.00	1.00	1.00	-
21	1.67	0.33	2.00	2.00	0.58	0.33	-	-1.73	1.00	1.00	2.00	5.00	3.00	1.43
22	1.00	0.00	1.00	1.00	0.00	0.00	-	-	0.00	1.00	1.00	2.00	2.00	0.00
23	1.00	0.00	1.00	-	-	-	-	-	0.00	1.00	1.00	1.00	1.00	-
24	1.00	0.00	1.00	1.00	0.00	0.00	-	-	0.00	1.00	1.00	2.00	2.00	0.00
25	1.00	0.00	1.00	-	-	-	-	-	0.00	1.00	1.00	1.00	1.00	-
26	1.00	0.00	1.00	1.00	0.00	0.00	-	-	0.00	1.00	1.00	3.00	3.00	0.00

Species wise ranking to IVI

Sl No	Tree	Relative Frequency %	Relative Density %	Relative Dominance %	IVI	Rank - to IVI
1	*Pinus wallichiana*	100	27.2	2.31	129.51	1
2	*Pinus roxburghii*	100	21.6	3.88	125.48	2
3	*Emblica officinalis*	60	2.4	6.90	69.30	3
4	*Zanthoxylum armatum*	60	4	5.10	69.10	4
5	*Quercus griffithii*	60	5.6	2.72	68.32	5
6	*Magnolia caveana*	60	6.4	1.77	68.17	6
7	*Camellia kissi* Wallich.	60	4	1.99	65.99	7
8	*Castanopsis indica*	60	3.2	2.08	65.28	8
9	*Ulmus lanceifolia*	60	3.2	1.56	64.76	9
10	*Pterospermum acerifolium*	40	3.2	8.59	51.79	10
11	*Kalanchoe pinnata*	40	2.4	7.41	49.81	11
12	*Saurauia nepalensis*	40	2.4	4.14	46.54	12
13	*Rhododendron arboreum*	40	1.6	3.82	45.42	13
14	*Albizia arunachalensis*	40	1.6	2.36	43.96	14
15	*Desmodium concinnum*	40	1.6	2.17	43.77	15
16	*Duabanga grandiflora*	40	1.6	0.45	42.05	16
17	*Bombax ceiba*	20	0.8	11.31	32.11	17
18	*Zanthoxylum acanthopodium*	20	0.8	10.57	31.37	18
19	*Streblus asper*	20	1.6	6.73	28.33	19
20	*Erythrina variegata*	20	0.8	4.40	25.20	20
21	*Rhus javanica*	20	0.8	2.46	23.26	21
22	*Eurya acuminata*	20	0.8	2.22	23.02	22
23	*Acer oblongum*	20	0.8	1.99	22.79	23
24	*Bauhinia glauca*	20	0.8	1.77	22.57	24
25	*Engelhardia spicata*	20	0.8	0.92	21.72	25
26	*Michelia dotsopa*	20	0.8	0.41	21.21	26

Annexure X

PHOTOGRAPHS OF MAJOR FAUNA

ANNEXURE - X : PHOTOGRAPHS OF MAJOR FAUNA

Methun (*Bos frontails)*

Cobra as road kill (*Ophiophagus hannah)*

Snow trout & mahaseer

Viridovipera cf. yunnanensis

Slug

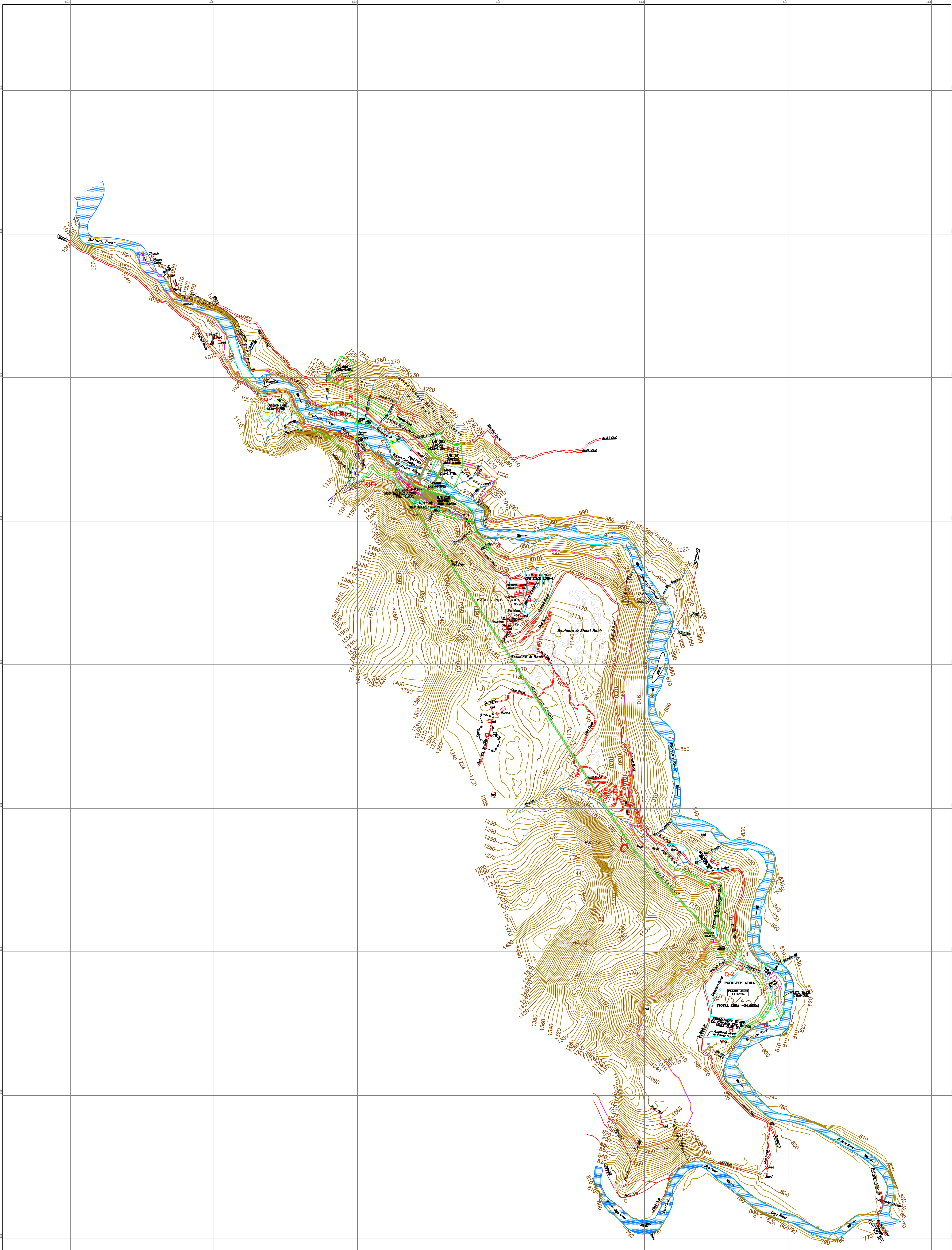
White napped yuhina (*Yuhina bakeri*)

Jungle Cat (*Felis Chaus)*

Indian cricket frog (*Fejervarya limnocharis*)

Annexure XI

PROJECT LAYOUT PLAN INCLUDING FACILITY AREAS

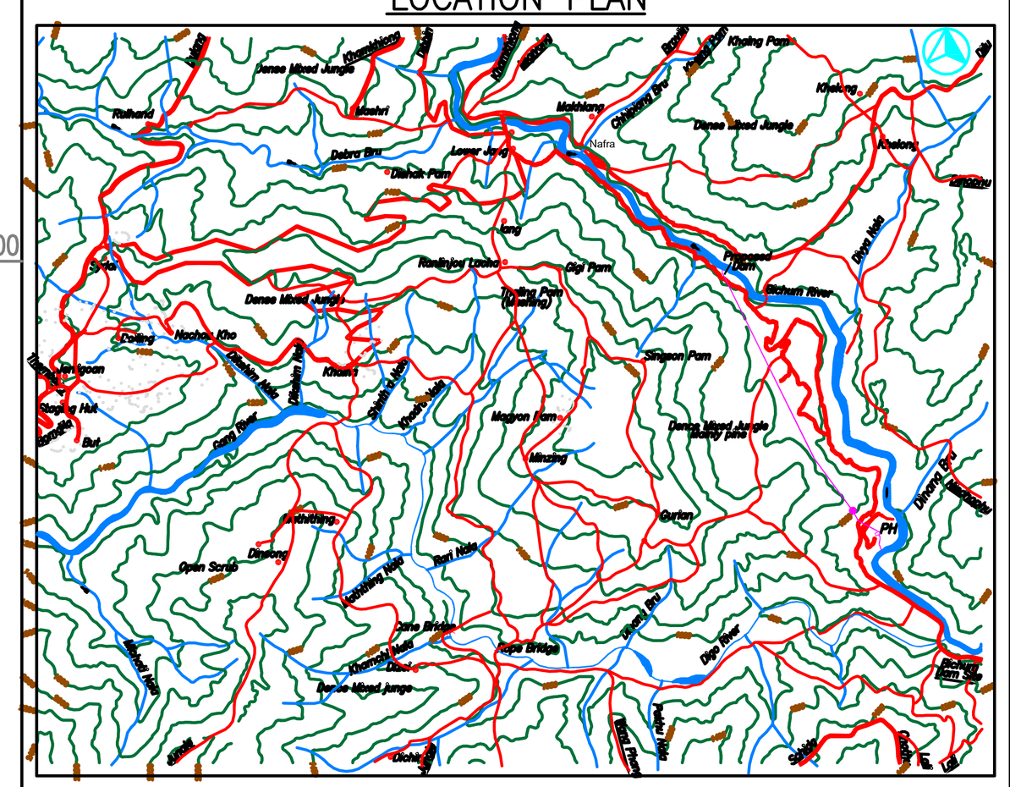


NORTH

L E G E N D

1. BUILTUP AREA: LIMIT
2. Asphalt Road WITH CULVERT, CART TRACK/Metalled Road, - PATH WAY, PROPOSED ROAD
3. HOUSE, HUT, TEMPLE — House, HUT
4. WATER VALVE, BUND, CLIFF
5. RIVER, NALA, STREAM,HRT ALIGNMENT
6. FENCE, BOULDERS, GEOLOGICAL POINT
7. KILOMETER STONE,CONTOURS, ROCK, ALIGNMENT.
8. TRAVERSE POINTS, BENCH MARKS/BM PILLAR — TS 26 1009.552

LOCATION PLAN



LIST OF BENCHMARK POINTS

BM POINT	EASTING	NORTHING	RL
TBM1	459228.308	3022336.789	856.430
TBM2	459287.205	3023031.886	899.065
TBM4	458584.805	3023394.150	959.772
TBM7	458053.484	3025148.349	1111.128
TBM8	457726.967	3024851.087	1078.449
TBM9	457449.592	3025285.748	1033.168
TBM10	456865.382	3025851.069	986.063
TBM11	456215.486	3026174.189	980.955
TBM12	455779.908	3026478.728	1001.114
TBM13	455098.503	3027161.892	1033.770
TBM23	455833.626	3026787.175	1015.368
TBM33	459370.251	3020873.160	778.104
TBM34	458652.490	3020865.770	794.266
TBM41	458563.164	3021232.101	1025.894
TBM42	458640.909	3021295.613	1052.931

LIST OF BENCHMARK PILLAR POINTS

BM POINT	EASTING	NORTHING	RL
BM1	456980.462	3025640.956	1050.182
BM2	457269.776	3026124.407	1149.690
BM3	457013.281	3025786.932	966.566
BM4	457154.309	3025713.878	960.280
BM5	457157.466	3025883.187	952.014
BM6	457839.358	3024998.486	1061.618
BM7	457729.198	3025014.442	1062.555
BM8	459470.003	3022373.213	814.233
BM9	459482.428	3022295.515	811.286
BM10	459084.680	3022602.896	1008.27
BM11	458963.665	3022452.232	1016.737

LIST OF GEOLOGICAL POINTS

GLPOINT	EASTING	NORTHING	RL
GL1	457366.570	3026046.795	1087.548
GL2	457497.438	3025613.408	1005.796
GL3	457518.780	3025604.909	1009.478

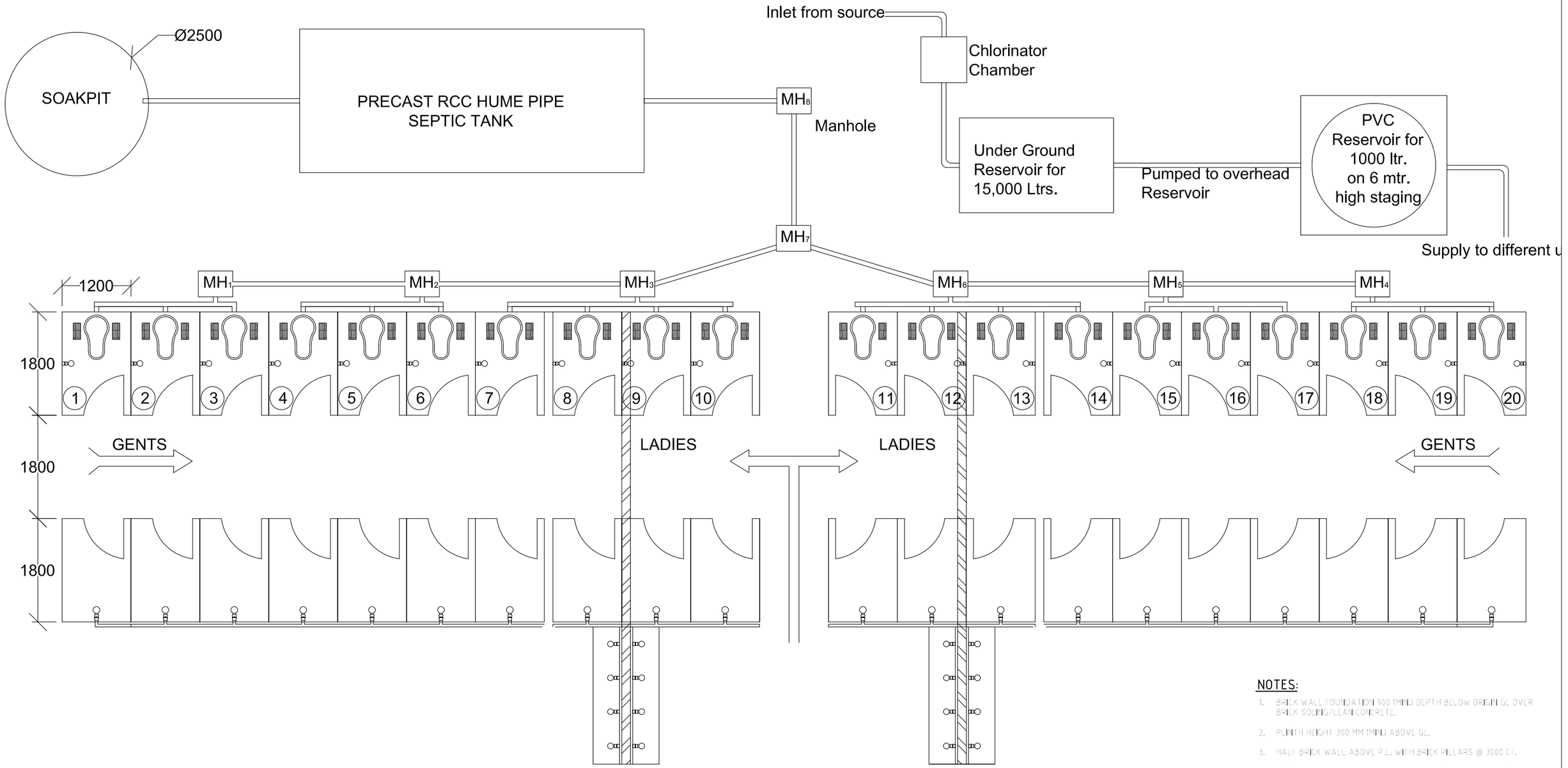
NOTE:-

1. ALL LEVELS ARE WITH REFERENCE TO D.N.T. BM LOCATED ALONG BICHUM DAM AXIS AT ABOUT 300 M SOUTH SIDE. R.L. – 869.169 M.
2. ALL LEVELS ARE IN MTS, UNLESS OTHERWISE MENTIONED.

CLIENT	SEW ENERGY LTD. — SEW ENERGY LIMITED, 6-3-871, Snehalata, Greenlands Road, Begumpet, Hyderabad-500 016, AP, INDIA
TITLE	DETAILED TOPOGRAPHIC SURVEY OF NAFRA HYDRO ELECTRIC PROJECT (2x48MW) IN ARUNACHAL PRADESH.
	INDEX MAP
CAD FILE INDEXMAP	SCALE: 500m 400 300 200 100 0 500m; 1:10000 OR 1CM=100m; CONTOUR INTERVAL = 10.0M
SEASON FEB 2008	DRAWING NO. SEW/CSPL/INDEXMAP — REV 0
SURVEYED & PREPARED BY	CADEN SURVEYS PVT. LTD. Survey & Civil Engineering Project Consultants, #K144/39, 11th Cross, 19th 'A' Main, 1st Block, Rajajinagar, Bangalore - 560 010. Phone: 080 - 23124811 E-mail : info@csplbangalore.com; www.csplbangalore.com

Annexure XII

LAYOUT PLAN FOR LABOUR CAMP FACILITIES



Drinking water tape

NOTES:

1. BRICK WALL FOUNDATION 600 (MIN.) DEPTH BELOW ORIGIN GL OVER BRICK SOLING/LEAN CONCRETE.
2. PLINTH HEIGHT 300 MM (MIN.) ABOVE GL.
3. HALF BRICK WALL ABOVE P.L. WITH BRICK PILLARS @ 3000 C/.
4. MINIMUM HEIGHT OF THE TEMPORARY SHED SHOULD BE 3200
5. INSIDE WALL TO BE PLASTERED & WHITE WASHED AND ALSO THE OUTSIDE SURFACE SHOULD BE NICELY POINTED & WHITE WASHED
6. FLOOR SHOULD BE PLASTERED SMOOTH OVER FLAT BRICK SOLING
7. THE TOILET SHOULD BE WELL VENTILATED & LIGHTED
8. ROOF WITH TUBULAR TRUSSES/WOODEN TRUSSES & PURLINS
9. BAMBOO MAT CEILING SHOULD ALSO TO BE PROVIDED
10. "Z" BATTEN WOODEN DOOR SHUTTERS IN WOODEN FRAMES TO BE PROVIDED
11. STORM WATER DRAIN TO BE PROVIDED AROUND THE BLOCK

TOILET BLOCK

PLINTH AREA:-25.20X5.40

No	Revision	SMEC	Date
A	ISSUED FOR COMMENTS	HM	01.09.2009

CLIENT: SEW ENERGY LTD. — SEW NAFRA POWER CORPORATION LTD., 6-3-871, Snehalata, Greenlands Road, Begumpet, Hyderabad-500 016, AP, INDIA

SCALE: 3.0 0 3.0 6.0 9.0 12.0m

CONSULTANT: SMEC India Pvt. Ltd., 5th Floor, DLF Building No. 8, Tower C, DLF Cyber City, Phase-II, Gurgaon - 122002 (Haryana), Tel: 91124-4376017 Fax: 91124-4376018, Email: smec@vsnl.com, Website: www.smec.com.au

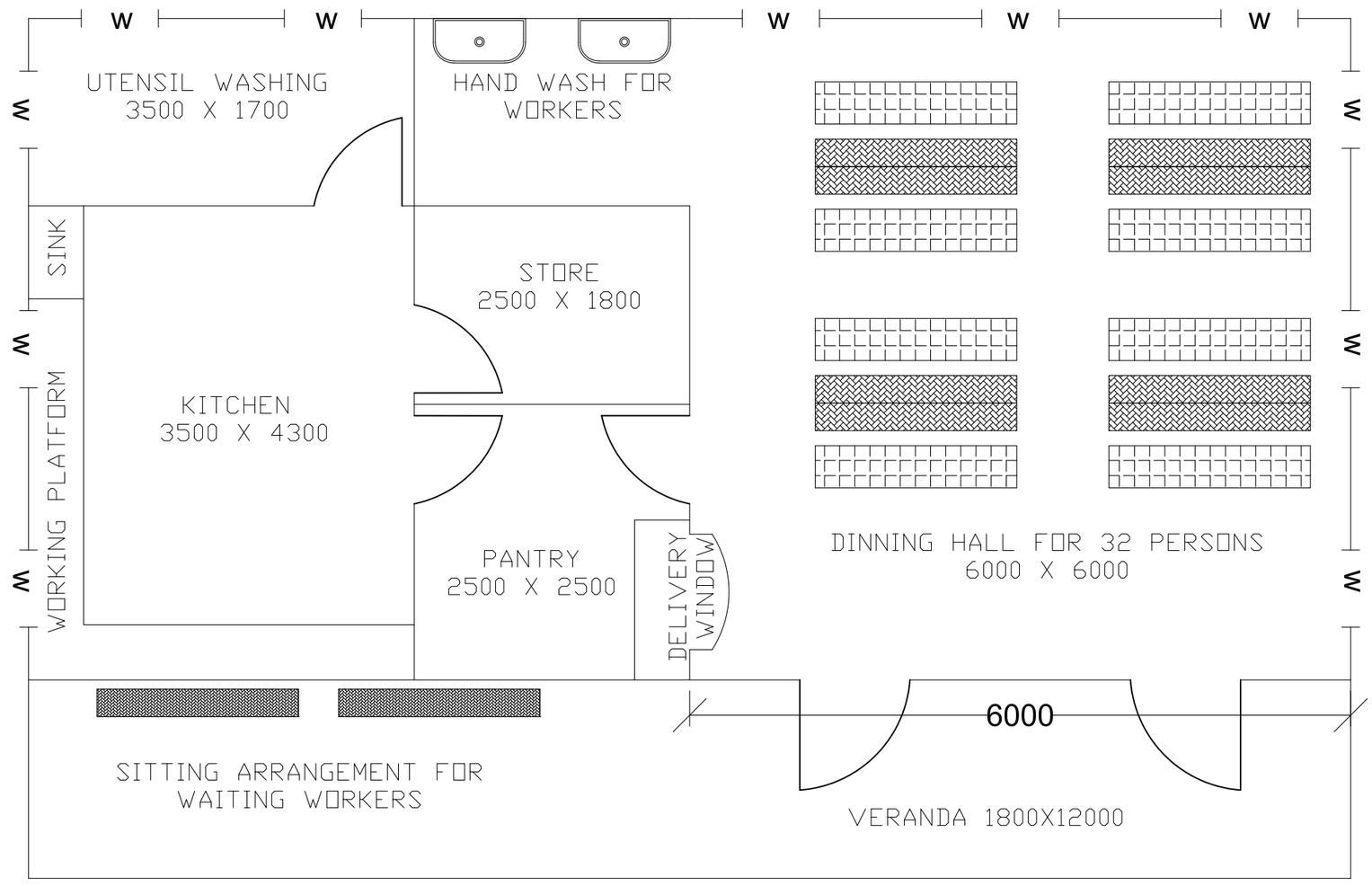
Drawn	Sep-09	Designed	Sep-09
H.SHARMA		A.KUMAR	
Drafting Check	Sep-09	Design Check	Sep-09
A. KUMAR		SAKET	
APPROVED	Sep-09		
H.MEHRA			

Developer: SEW NAFRA POWER CORPORATION LTD.
Project: NAFRA HYDRO ELECTRIC PROJECT, ARUNACHAL PRADESH
Title: TOILET BLOCK LAYOUT PLAN

Original Size	Drawing Status	Drawing No.	Rev
A1	CONCEPTUAL DESIGN	1177-SK-201	A

Cad File No: H:\Projects\Nafra\102 Drawings\Design\SEP 2009\SK-201.dwg

Sep 01, 2009 - 12:03pm



NOTES:

1. BRICK WALL FOUNDATION 900 (MIN.) DEPTH BELOW ORIGIN GL OVER BRICK SOLING/LEAN CONCRETE.
2. PLINTH HEIGHT 300 MM (MIN.) ABOVE GL.
3. HALF BRICK WALL ABOVE P.L. WITH BRICK PILLARS @ 3000 C/.
4. MINIMUM HEIGHT OF THE TEMPORARY SHED SHOULD BE 3200
5. INSIDE WALL TO BE PLASTERED & WHITE WASHED AND ALSO THE OUTSIDE SURFACE SHOULD BE NICELY POINTED & WHITE WASHED
6. FLOOR SHOULD BE PLASTERED SMOOTH OVER FLAT BRICK SOLING
7. THE TOILET SHOULD BE WELL VENTILATED & LIGHTED
8. ROOF WITH TUBULAR TRUSSES/WOODEN TRUSSES & PURLINS
9. BAMBOO MAT CEILING SHOULD ALSO TO BE PROVIDED
10. "Z" BATTEN WOODEN DOOR SHUTTERS IN WOODEN FRAMES TO BE PROVIDED
11. STORM WATER DRAIN TO BE PROVIDED AROUND THE BLOCK

No	Revision	By	Date
A	ISSUED FOR COMMENTS	HM	01.09.2009

CLIENT: SEW ENERGY LTD.
SEW NAFRA POWER CORPORATION LTD.
6-3-871, Snehalata, Greenlands Road
Begumpet, Hyderabad-500 016, AP, INDIA

SCALE: 2.5 0 2.5 5.0 7.5 10.0m

CONSULTANT
SMEC India Pvt. Ltd.
5th Floor, DLF Building No. 8
Tower C, DLF Cyber City, Phase-II
Gurgaon - 122002 (Haryana)
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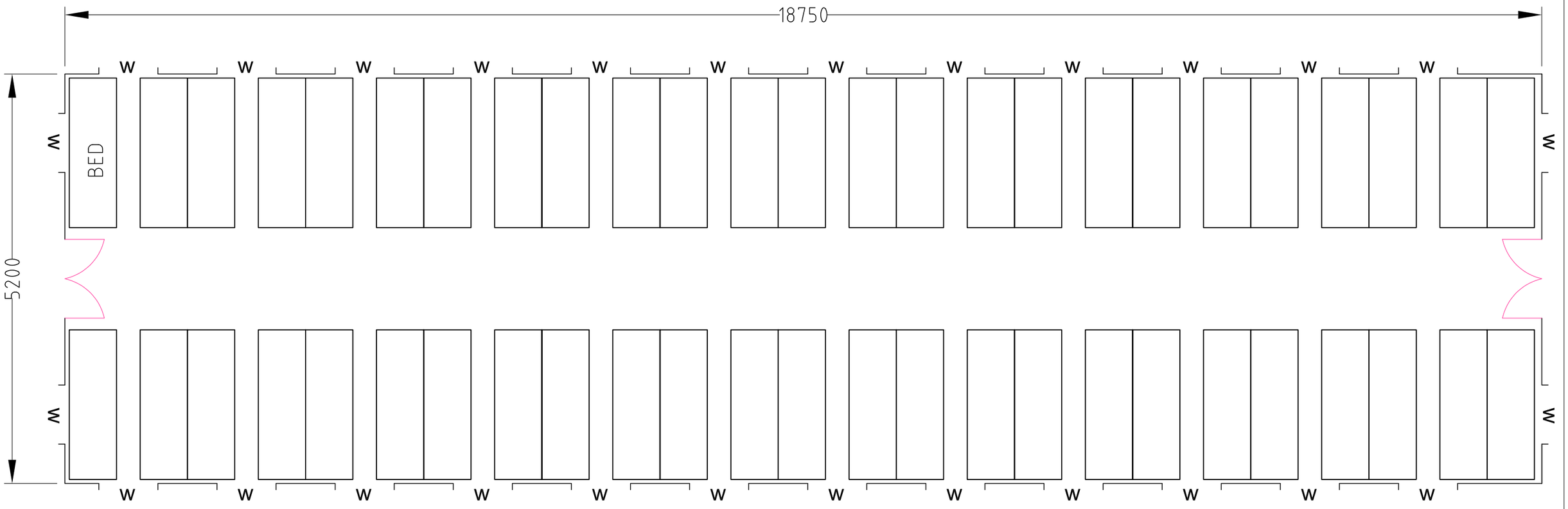
	H.SHARMA		A.KUMAR
Drafting Check	Sep-09	Design Check	Sep-09
	A. KUMAR		SAKET
APPROVED	Sep-09		
	H.MEHRA		

Developer: SEW NAFRA POWER CORPORATION LTD.
Project: NAFRA HYDRO ELECTRIC PROJECT, ARUNACHAL PRADESH

Title: CANTEEN BLOCK
LAYOUT PLAN

Original Size	Drawing Status	Drawing No.	Rev
A1	CONCEPTUAL DESIGN	1177-SK-203	A



NOTES:

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8. ROOF WITH TUBULAR TRUSSES/WOODEN TRUSSES & PURLINS
9. BAMBOO MAT CEILING SHOULD ALSO TO BE PROVIDED
10. "Z" BATTEN WOODEN DOOR SHUTTERS IN WOODEN FRAMES TO BE PROVIDED
11. STORM WATER DRAIN TO BE PROVIDED AROUND THE BLOCK

No	Revision	By	Date
A	ISSUED FOR COMMENTS	HM	01.09.2009

CLIENT
SEW ENERGY LTD.
SEW NAFRA POWER CORPORATION LTD.
6-3-871, Snehalata, Greenlands Road
Begumpet, Hyderabad-500 016, AP, INDIA

SCALE
2.5 0 2.5 5.0 7.5 10.0m

CONSULTANT
SMEC India Pvt. Ltd.
5th Floor, DLF Building No. 8
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H.SHARMA		A.KUMAR	
Drafting Check	Sep-09	Design Check	Sep-09
A. KUMAR		SAKET	
APPROVED	Sep-09		
H.MEHRA			

Developer: SEW NAFRA POWER CORPORATION LTD.
Project: NAFRA HYDRO ELECTRIC PROJECT, ARUNACHAL PRADESH

Title: DORMITORY FOR 50 PERSONS IN 8 BLOCKS
LAYOUT PLAN

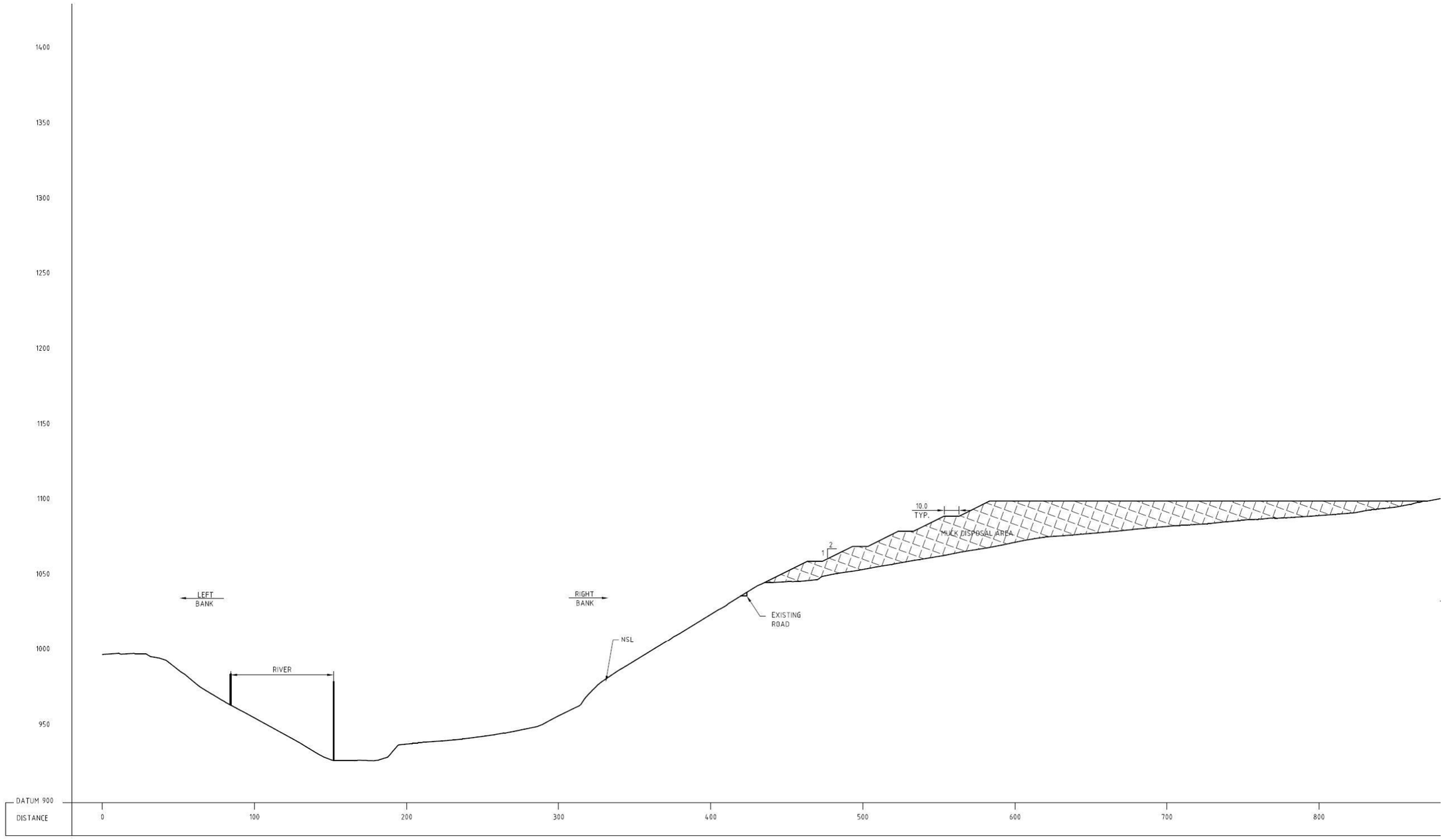
Original Size	Drawing Status	Drawing No.	Rev
A1	CONCEPTUAL DESIGN	1177-SK-202	A

SMEC INDIA

Annexure XIII

GENERAL LAYOUT PLAN FOR IDENTIFIED MUCK DISPOSAL SITES

Annexure XIII : GENERAL LAYOUT FOR IDENTIFIED MUCK DISPOSAL SITE



Annexure XIV

NOTIFICATION OF MoEF, CPCB, DATED 15TH JUNE, 2008

MINISTRY OF ENVIRONMENT AND FORESTS

(CENTRAL POLLUTION CONTROL BOARD)

NOTIFICATION

New Delhi, the 15th June, 2008

No. Legal/42(3)/87.—In exercise of the powers conferred under sub-section (3) of Section 16 and sub-section (2) of Section 17 read with sub-section (4) of Section 4 of the Water (Prevention and Control of Pollution) Act, 1974 (Act 6 of 1974) alongwith rule 28 of the Water (Prevention and Control of Pollution) Rules, 1975, and under sub-section (3) of Section 16 of Air (Prevention and Control of Pollution) Act, 1981 (Act 14 of 1981), the Central Pollution Control Board has established the Board's Laboratories at the places mentioned in Schedule I.

2. The fee payable to the Central Pollution Control Board Laboratories in respect of each report of analysis for various analytical parameters and sampling charges for the water, wastewater, soil, hazardous waste, air/fugitive emissions, source emission, noise monitoring, auto exhaust monitoring and ambient air quality monitoring shall be as per Schedule II : Schedule of sampling and analysis charges for Environmental Samples.

3. The fee prescribed under Schedule II will be subject to revision.

4. This notification shall come into force w.e.f. 1.4.2008

SCHEDULE – I

SCHEDULE OF BOARD'S LABORATORIES

S. No.	Place	Address
1.	Delhi	Parivesh Bhawan, East Arjun Nagar, Shahadra, Delhi – 110032
2.	Kolkata	Zonal Office – Kolkata 247, Deshpran Sheshmal Road CIT Building, 1st Floor Kolkata – 700033
3.	Vododara	Zonal Office – Vadodara Synergy House – II Gorwa Subhanpura Road Vadodara - 390023

4.	Lucknow	Zonal Office – Lucknow Ground Floor, PICUP Bhawan Vibhuti Khand, Gomti Nagar Lucknow – 228010
5.	Bangalore	Zonal Office – Bangalore NISARGA Bhawan, A Block 1 & 2 Floor, Thimmaiah Main Road 7th D Cross, Shivanagar Bangalore – 560086
6.	Bhopal	Zonal Office – Bhopal 3rd Floor, Sahkar Bhawan North TT Nagar Bhopal – 462003
7.	Shillong	Zonal Office – Shillong Tumsir, Lumdiengob Lower Motinagar, Near Fire Brigade H. Q, Lumpyngngad Shillong – 793014

Schedule -II

SCHEDULE OF SAMPLING AND ANALYSIS CHARGES FOR ENVIRONMENTAL SAMPLES

(Applicable w. e. f. April 01, 2008)

Note: (i) This schedule supersedes all schedules of sampling and analysis charges notified earlier as such earlier schedules stand cancelled & withdraw.

(ii) 50% discount on analytical charges shall be applicable for the samples forwarded from North-Eastern States.

A. SAMPLING CHARGES

(I) Sampling charges for Ambient Air/Fugitive emission samples

S. No.	Type of sampling	Charges in Rs.
1.	Air Monitoring	
	(a) Sampling (upto each 8 hrs) for suspended particulate matter and gaseous pollutants	2000.00
	(b) Sampling (24 hrs) for suspended particulate matter and gaseous pollutants	6000.00
	(c) Sampling of Volatile Organic Compounds (VOCs)/ Benzene Toluene Xylene (BTX)	2000.00
	(d) Sampling of Poly Aromatic Hydrocarbons (PAHs)	2500.00

Note: (i) Transportation charges will be separate as per actual basis.
(ii) Sample analysis charges of respective parameters are separate as per list.

2756 GI/08-3

(II) Source Emission Monitoring/Sampling charges

	Type of Sampling	Charges in Rs.
(a)	Sampling/measurement of Velocity, Flow rate, temperature and molecular weight of Flue Gas (each specific location/each sample in duplicate for the mentioned parameter)	5500.00
(b)	Sampling of SO_2/NO_2	2000.00
(c)	Sampling of PAHs	3000.00
(d)	Sampling of VOCs/BTX	3500.00

Note : (i) Transportation charges will be separate as per actual basis.
(ii) Sample analysis charges of respective parameters are separate as per list.

(III) Noise Monitoring

Type of Sampling	Charges in Rs.
First Monitoring	4000.00
Each Subsequent Monitoring within same premises	2000.00
For 08 hours Continuous Monitoring or more	10,000.00

Note : (i) Transportation charges will be separate as per actual basis.

(IV) Sampling charges for water & wastewater samples

S. No.	Type of sampling		Charges in Rs.
1.	GRAB SAMPLING:		
	1) Grab sampling/sample/place		550.00
	2) For every additional Grab sampling/same place		250.00
2.	COMPOSITE SAMPLING:		
	1) Composite sampling/source/place	upto 8 hrs.	1000.00
		- do - upto 16 hrs.	2000.00
		- do - upto 24 hrs.	3000.00
	2) For every additional composite sampling/same place but different source	upto 8 hrs.	550.00
		- do - upto 16 hrs.	1100.00
		- do - upto 24 hrs.	1650.00
3.	Flow Rate measurement/source	- once	400.00
		- do - - every additional	150.00

Note : (i) Transportation charges will be separate as per actual basis.
(ii) Sample analysis charges of respective parameters are separate as per list.

(V) Sampling charges for Soil samples

Type of Sampling	Charges in Rs.
Grab sampling/sample/place	600.00
For additional Grab sampling/same place	300.00

Note : (i) Transportation charges will be separate as per actual basis.
(ii) Sample analysis charges of respective parameters are separate as per list.

(VI) Hazardous Waste Sample collection charges at the premises of Industry/Import site/Disposal site

Type	Charges in Rs.
Integrated sample collection charges	1000.00

Note : (i) Transportation charges will be separate as per actual basis.
(ii) Sample analysis charges of respective parameters are separate as per list.

B. ANALYSIS CHARGES

1. Analysis charges of Ambient Air/ Fugitive Emission Samples

S. No.	Parameters	Analysis charges per sample in Rs.
1.	Ammonia	600.00
2.	Analysis using dragger (per tube)	400.00
3.	Benzene Toluene Xylene (BTX)	1000.00
4.	Carbon Monoxide	600.00
5.	Chlorine	600.00
6.	Fluoride (gaseous)	600.00
7.	Fluoride (particulate)	600.00
8.	Hydrogen Chloride	600.00
9.	Hydrogen Sulphide	As mentioned in respective group at Clause 5.0
10.	Lead & Other metals (per metal)	600.00
11.	NO_2	1000.00
12.	Ozone	As mentioned in respective group at Clause 5.0
13.	Poly Aromatic Hydrocarbons (PAHs)	600.00
14.	Suspended Particulate Matter (SPM)	1000.00
15.	Particulate Matter ($PM_{2.5}$)	600.00
16.	Respirable Suspended Particulate Matter (PM_{10})	600.00
17.	Sulphur Dioxide	2000.00
18.	Volatile Organics Carbon	

S. No.	Parameters	Analysis charges per sample in Rs.
19.	Trace Metals on air filter paper using EDXRF Aluminium, Antimony, Arsenic, Barium, Bromine, Cadmium, Calcium, Cesium, Chlorine, Chromium, Cobalt, Copper, Gallium, Germanium, Gold, Iodine, Iron, Lanthanum, Lead, Magnesium, Manganese, Molybdenum, Nickel, Palladium, Phosphorous, Potassium, Rubidium, Rutherfordium, Selenium, Silicon, Silver, Sodium, Strontium, Sulphur, Tellurium, Tin, Titanium, Tungsten, Vanadium, Ytterbium, and Zinc.	3000.00 Per filter paper
20.	Water Extractable Ions in Air Particulate Matter using Ion Chromatograph (IC) (i). Processing / Pretreatment Charge per Sample (Filter Paper) (ii). Cations (Na^+, NH_4^+, K^+, Ca^{++} & Mg^{++}) and Anions (F^-, Br^-, Cl^-, NO_3^-, NO_2^-, SO_4^{--} & PO_4^{---})	300.00 1200.00 (for 12 Ions)
21.	Organic and Elemental Carbon (OC/EC) on quartz filter paper	2000.00

2. Analysis Charges for Source Emission Parameters

S. No.	Parameters	Analysis Charges per test in Rs.
1.	Acid Mist	600.00
2.	Ammonia	600.00
3.	Carbon Monoxide	600.00
4.	Chlorine	600.00
5.	Fluoride (Gaseous)	600.00
6.	Fluorides (Particulate)	600.00
7.	Hydrogen Chloride	600.00
8.	Hydrogen Sulphide	600.00
9.	Oxides of Nitrogen	600.00
10.	Oxygen	500.00
11.	Polycyclic Aromatic Hydrocarbons (Particulate)	As mentioned in respective group at Clause 5.0
12.	Suspended Particulate Matter	600.00
13.	Sulphur Dioxide	600.00
14.	Benzene Toluene Xylene (BTX)	1500.00
15.	Volatile Organic Compounds (VOCs)	3000.00

3. Ambient Air Quality Monitoring using on-line monitoring instruments by Mobile Van

Parameters	Charges in Rs.
PM_{10}, $PM_{2.5}$, SO_2, NOx, SPM, CO along with Meteorological data viz. temperature, Humidity, Wind speed, Wind direction	Rs.3,500/hour (minimum charges Rs.15,000/-) + Rs.50.00/km run of the van for 24 hours monitoring.

4. Auto Exhaust Monitoring - One time checking of vehicular exhaust

Parameters	Charges in Rs.
Carbon Monoxide %	As per rate notified by Transport Department NCT Delhi
Hydrocarbon, PPM	
Smoke Density, HSU	

5. Analysis charges of Water & Wastewater samples

S. No.	Parameters	Analysis charges per test in Rs.
	PHYSICAL PARAMETERS	
1.	Conductivity	60.00
2.	Odour	60.00
3.	Sludge Volume Index (S.V.I.)	200.00
4.	Solids (dissolved)	100.00
5.	Solids (fixed)	150.00
6.	Solids (volatile)	150.00
7.	Suspended Solids	100.00
8.	Temperature	60.00
9.	Total Solids	100.00
10.	Turbidity	60.00
11.	Velocity of Flow (Current Meter)	200.00
12.	Velocity of Flow (other)	550.00
1.	Acidity	100.00
2.	Alkalinity	100.00
3.	Ammonical Nitrogen	200.00
4.	Bicarbonates	100.00
5.	Biochemical Oxygen Demand (BOD)	600.00
6.	Bromide	100.00
7.	Calcium (titrimetric)	100.00
8.	Carbon Dioxide	100.00
9.	Carbonate	100.00
10.	Chloride	100.00
11.	Chlorine Demand	200.00
12.	Chlorine Residual	100.00
13.	Chemical Oxygen Demand (COD)	350.00
14.	Cyanide	350.00
15.	Detergent	200.00
16.	Dissolved Oxygen	100.00
17.	Fluoride	200.00
18.	H. Acid	350.00
19.	Hardness (calcium)	100.00
20.	Hardness (total)	100.00
21.	Iodide	100.00
22.	Nitrate Nitrogen	200.00
23.	Nitrite Nitrogen	200.00
24.	Percent Sodium	600.00
25.	Permanganate Value	200.00
26.	pH	60.00
27.	Phosphate (ortho)	200.00
28.	Phosphate (total)	350.00

S. No.	Parameters	Analysis charges per test in Rs.
29.	Salinity	100.00
30.	Sodium Absorption Ratio (SAR)	600.00
31.	Settleable Solids	100.00
32.	Silica	200.00
33.	Sulphate	150.00
34.	Sulphide	200.00
35.	Total Kjeldahl Nitrogen (TKN)	350.00
36.	Urea Nitrogen	350.00
37.	Cations (Na^+, NH_4^+, K^+, Ca^{++} & Mg^{++}) and Anions (F^-, Br^-, Cl^-, NO_3^-, NO_2^-, SO_4^{--} & PO_4^{---}) in surface & ground water sample using Ion Chromatograph	1200.00 (for 12 ions)
	Processing / pretreatment Charge per Sample	500.00
1.	Aluminium	300.00
2.	Antimony	300.00
3.	Arsenic	300.00
4.	Barium	300.00
5.	Beryllium	300.00
6.	Boron	300.00
7.	Cadmium	300.00
8.	Chromium Hexavalent	200.00
9.	Chromium Total	300.00
10.	Cobalt	300.00
11.	Copper	300.00
12.	Iron	300.00
13.	Lead	300.00
14.	Magnesium	200.00
15.	Manganese	300.00
16.	Mercury (Processing & Analysis)	800.00
17.	Molybdenum	300.00
18.	Nickel	300.00
19.	Potassium	200.00
20.	Tin	300.00
21.	Selenium	300.00
22.	Silver	300.00
23.	Sodium	200.00
24.	Strontium	300.00
25.	Vanadium	300.00
26.	Zinc	300.00
	Organo Chlorine Pesticides (OCPs)	
	Processing / pretreatment Charge per Sample	1000.00
1.	Aldrin	400.00
2.	Dicofol	400.00
3.	Dieldrin	400.00
4.	Endosulfan-I	400.00
5.	Endosulfan-II	400.00
6.	Endosulfan sulfate	400.00
7.	Heptachlor	400.00
8.	Hexachlorobenzene (HCB)	400.00
9.	Methoxy Chlor	400.00
10.	o,p DDT	400.00
11.	*p,p'*-DDD	400.00
12.	*p,p'*-DDE	400.00
13.	*p,p'*-DDT	400.00
14.	α-HCH	400.00
15.	β-HCH	400.00
17.	γ-HCH	400.00

S. No.	Parameters	Analysis charges per test in Rs.
18.	δ-HCH	400.00
	Organo Phosphorous Pesticides (OPPs)	
	Processing / pretreatment Charge per Sample	1000.00
19.	Chlorpyriphos	400.00
20.	Dimethoate	400.00
21.	Ethion	400.00
22.	Malathion	400.00
23.	Monocrotophos	400.00
24.	Parathion-methyl	400.00
25.	Phorate	400.00
26.	Phosphamidon	400.00
27.	Profenophos	400.00
28.	Quinalphos	400.00
	Synthetic Pyrethroids (SPs)	
	Processing / pretreatment Charge per Sample	1000.00
29.	Deltamethrin	400.00
30.	Fenpropethrin	400.00
31.	Fenvalerate	400.00
32.	α-Cypermethrin	400.00
33.	β-Cyfluthrin	400.00
34.	λ-Cyhalothrin	400.00
	Herbicides	
	Processing / pretreatment Charge per Sample	1000.00
35.	Alachlor	400.00
36.	Butachlor	400.00
37.	Fluchloralin	400.00
38.	Pendimethalin	400.00
	Polycyclic Aromatic Hydrocarbons (PAHs)	750.00
	Processing / pretreatment Charge per Sample	1000.00
39.	Acenaphthene	400.00
40.	Acenaphthylene	400.00
41.	Anthracene	400.00
42.	Benz(a)anthracene	400.00
43.	Benzo(a)pyrene	400.00
44.	Benzo(b)fluoranthene	400.00
45.	Benzo(e)pyrene	400.00
46.	Benzo(g,h,i)perylene	400.00
47.	Benzo(k)fluoranthene	400.00
48.	Chrysene	400.00
49.	Dibenzo(a,h)anthracene	400.00
50.	Fluoranthene	400.00
51.	Fluorene	400.00
52.	Indeno(1,2,3-cd)pyrene	400.00
53.	Naphthalene	400.00
54.	Perylene	400.00
55.	Phenanthrene	400.00
56.	Pyrene	400.00
	Polychlorinated Biphenyls (PCBs)	
	Processing / pretreatment Charge per Sample	1000.00
57.	Aroclor 1232	400.00
58.	Aroclor 1242	400.00
59.	Aroclor 1248	400.00
60.	Aroclor 1254	400.00
61.	Aroclor 1260	400.00
62.	Aroclor 1262	400.00

S No.	Parameters	Analysis charges per test in Rs.
	Trl Halo Methane (THM)	
	Processing / pretreatment Charge per Sample	800.00
63.	Bromo dichloromethane	400.00
64.	Bromoform	400.00
65.	Chloroform	400.00
66.	Dibromo chloromethane	400.00
	Other Organic Parameter	
67.	Adsorbable Organic Halogen (AOX)	2000.00
68.	Tannin / Lignin	350.00
69.	Oil & Grease	200.00
70.	Phenol	200.00
71.	Total Organic Carbon (TOC)	500.00
72.	Volatile Organic Acids	350.00
1.	Bacteriological Sample Collection	200.00
2.	Benthics Organism Identification & Count (each sample)	600.00
3.	Benthics Organism Sample collection	1000.00
4.	Chlorophyll Estimation	600.00
5.	E. Coli (MFT technique)	400.00
6.	E. Coli (MPN technique)	350.00
7.	Faecal Coliform (MFT technique)	400.00
8.	Faecal Coliform (MPN technique)	350.00
9.	Faecal Streptococci (MFT technique)	450.00
10.	Faecal Streptococci (MPN technique)	400.00
11.	Plankton Sample collection	250.00
12.	Plankton (Phytoplankton) count	600.00
13.	Plankton (Zooplankton) count	600.00
14.	Standard Plate Count	200.00
15.	Total Coliform (MFT technique)	400.00
16.	Total Coliform (MPN technique)	350.00
17.	Total Plate Count	350.00
18.	Toxicological - Bio-assay (LC_{50})	2800.00
19.	Toxicological - Dimensionless toxicity Test	1600.00

Note : (i) *Sampling charges for water and waste water samples are separate as specified in clause A (IV), but subject to minimum of Rs.700/- irrespective of number of samples.*

(ii) *Transportation charges are separate on actual basis.*

6. Analysis charges of Soil/Sludge/Sediment/Solid waste samples

S. No.	Soil Parameters	Analysis charges per test in Rs.
1.	Ammonia	300.00
2.	Bicarbonates	200.00
3.	Boron	400.00
4.	Calcium	150.00
5.	Calcium Carbonate	350.00
6.	Cation Exchange Capacity (CEC)	400.00
7.	Chloride	150.00
8.	Colour	100.00
9.	Electrical Conductivity (EC)	100.00
10.	Exchangeable Sodium Percentage (ESP)	550.00

S. No.	Soil Parameters	Analysis charges per test in Rs.
11.	Gypsum Requirement	350.00
12.	H. Acid	400.00
13.	Heavy Metal	As mentioned in respective group at Clause 5.0
14.	Trace Metals using ED-XRF Aluminium, Antimony, Arsenic, Barium, Bromine, Cadmium, Calcium, Cesium, Chlorine, Chromium, Cobalt, Copper, Gallium, Germanium, Gold, Iodine, Iron, Lanthanum, Lead, Magnesium, Manganese, Molybdenum, Nickel, Palladium, Phosphorous, Potassium, Rubidium, Rutherfordium, Selenium, Silicon, Silver, Sodium, Strontium, Sulphur, Tellurium, Tin, Titanium, Tungsten, Vanadium, Ytterbium and Zinc, per sample.	4000.00
15.	Magnesium	300.00
16.	Mechanical soil analysis (soil texture)	150.00
17.	Nitrate	300.00
18.	Nitrite	300.00
19.	Nitrogen available	350.00
20.	Organic Carbon/Matter (chemical method)	350.00
21.	Polycyclic Aromatic Hydrocarbons (PAHs)	As mentioned in respective group at Clause 5.0
22.	Polychlorinated Biphenyls (PCBs)	As mentioned in respective group at Clause 5.0
23.	Pesticides	As mentioned in respective group at Clause 5.0
24.	pH	100.00
25.	Phosphorous (available)	400.00
26.	Phosphate (ortho)	300.00
27.	Phosphate (total)	400.00
28.	Potash (Available)	200.00
29.	Potassium	300.00
30.	Sodium Absorption Ratio (SAR) in Soil extract	650.00
31.	Sodium	300.00
32.	Soil Moisture	100.00
33.	Sulphate	200.00
34.	Sulphur	350.00
35.	Total Kjehldhal Nitrogen (TKN)	400.00
36.	TOC	550.00
37.	Total water soluble salts	200.00
38.	Water Holding capacity	100.00

Note : (i) *Sampling charges for soil samples as specified in clause A(V).*
(ii) *Transportation charges are separate on actual basis.*

7. Analysis charges for Hazardous Waste samples

S. No.	Parameters	Analysis Charges per test in Rs.
1.	Preparation of Leachate (TCLP extract/Water Extract)	1000.00
2.	Determination of various parameters in Leachate	As mentioned in respective group at Clause 5.0
3.	Flash point/Ignitibility	550.00
4.	Reactivity	550.00
5.	Corrosivity	550.00
6.	Measurement of Toxicity	
	- LC_{50}	2800.00
	- Dimensionless Toxicity	1600.00
7.	Total Organic Carbon	500.00
8.	Adsorbable Organic Halogen (AOX)	2000.00

8. AQC Participation Fees:

- to be charged by CPCB from respective SPCB's/PCC's or Recognized laboratory for Analytical Quality Control exercise (AQC) samples.

1.	Laboratories of Govt./Semi Govt./ Public Sector Undertaken/ Autonomous bodies.	10000.00
2.	Private Sector Laboratories.	15000.00

J. M. MAUSKAR, Chairman

[ADVT III/4/Exty./184/08]

Note : The principal notification was published in the Gazette of India *vide* No. S.O. 296(E), dated 31-3-1994, and thereafter amended *vide* No. S.O. 389(E), dated 23-9-1994, No. S.O. 390(E), dated 23-9-1994 and No. S.O. 1218(E), dated 1-9-2001.

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Annexure XV

PHOTOGRAPHS OF STAKEHOLDER CONSULTATION WITH LOCAL COMMUNITY AND INSTITUTION

ANNEXURE - XV: PHOTOGRAPHS OF STAKEHOLDER CONSULTATION WITH LOCAL COMMUNITY AND INSTITUTION

Community Consultation at Khellong Village, West Kameng District, Arunachal Pradesh

Community Consultation at Lower Jung Village, West Kameng District, Arunachal Pradesh

Consultation with Deputy Director, Department of Fishery at Itanagar, Arunachal Pradesh

Consultation with Dean, Department of Science, Rajiv Gandhi University, Itanagar, Arunachal Pradesh

Consultation with Scientist, Zoological Survey of India, Itanagar, Arunachal Pradesh

Annexure XVI

MOA BETWEEN SEW AND GOVT. OF ARUNACHAL PRADESH

अरुणाचल प्रदेश ARUNACHAL PRADESH

006673

MEMORANDUM OF AGREEMENT
BETWEEN GOVERNMENT OF ARUNACHAL PRADESH
AND
M/S SEW ENERGY LIMITED
FOR EXECUTION OF NAFRA HYDRO ELECTRIC PROJECT (96 MW)
ON BOOT BASIS

MEMORANDUM OF AGREEMENT (MoA)

I. This Memorandum of Agreement (MoA) (hereinafter referred to as the "Agreement) is entered on 14th day of September 2007 by and between:

The Governor of Arunachal Pradesh, represented by Secretary (Power) hereinafter referred as "GOAP" which expression shall, unless repugnant to the context or meaning thereof, include its successors and assignees) of the first Part;

AND

M/s SEW Energy Ltd., a Company incorporated under the companies Act 1956 and having its Corporate office at 6-3-871, Snehalatha, Greenlands Road, Begumpet, Hyderabad – 500 016 (hereinafter referred to as "Company" which expression shall, unless repugnant to the context or

For SEW ENERGY LIMITED

(Y. BALAKRISHNA RAO)
DIRECTOR

Secretary (Power)
Govt. of Arunachal Pradesh
Itanagar

meaning thereof, include its successors, nominees and permitted assignees) of the second Part; GOAP and M/s SEW Energy Ltd., shall be individually referred to as "Party" and collectively as "Parties".

WHEREAS

I) The Government of India ("GoI") has launched the "50,000 MW Hydro-electric Initiative" with the objective of increasing the hydro power capacity in India (Country) out of which more than half the capacity has been identified in the State of Arunachal Pradesh ("State") itself.

II) GoAP has earmarked certain projects for allocation to private developers for development of hydropower projects in the State, which will generate economic activity in the State leading to its growth and will also serve as an engine to achieve the objective of promoting all round development of the State and the Country; and

III) M/s SEW Energy Ltd., has expressed its interest in development of Power Generation, Transmission, and Distribution sectors in the State in general; and development of hydro power projects in particular; subject to establishment of feasibility; at their own cost.

IV) Govt. of Arunachal Pradesh has approved the engagement of the Company to execute the Project on Build, Own, Operate and Transfer (BOOT) basis.

NOW THEREFORE, it is agreed by and between the Parties hereto as under:
That

Article 1

INTERPRETATIONS AND DEFINITIONS.

1. INTERPRETATIONS.

1.1.1 The nomenclature of this Agreement, headings and paragraph numbers are only for the convenience of reference and shall be ignored in construing or interpreting this Agreement.

1.1.2 Reference to persons and words denoting natural persons shall include bodies, corporate, partnerships, joint ventures, statutory and other authorities and entities.

1.1.3 Reference to any enactment, ordinance or regulation or any provision thereof shall include any amendment thereof or any replacement in whole or in part.

ENERGY LIMITED ERABAD

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Govt. of Arunachal Pradesh
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1.1.4 Reference to Recitals, Articles, Clauses, or Sub-clauses shall unless the context otherwise requires, be deemed to include the Recitals, Articles, clauses, or Sub-clauses of this Agreement.

1.1.5 The words importing singulars shall include plurals and vice-versa, as the case may be.

1.1.6 Terms beginning with capital letters and defined as per Clause 1.2 of this Agreement shall have the same meaning ascribed thereto.

1.1.7 Any reference at any time to any agreement, deed, instrument license or document of any description shall be construed as reference to that agreement, deed, instrument, license or other document as amended, varied, supplement, modified or suspended at the time of such reference provided that this Clause shall not operate to increase liability or obligations of any Party hereunder or pursuant hereto in any manner whatsoever.

1.1.8 Any agreement, consent, approval, authorization, notice, communication, information or report required under or pursuant to this Agreement from or by any Party shall be valid and effectual only if it is in writing and under the hands of duly authorized representatives of such Party in this behalf and not otherwise.

1.1.9 Any reference to any period commencing "from" a specified day or date and "till" or "until" a specified day or date shall include both such days or dates.

1.2 DEFINITIONS.

In this Agreement the following words and expressions and unless repugnant to the context or meaning thereof, shall have the meanings hereinafter respectively assigned to them :

1.2.1 "Agreement" means this agreement together with any amendments made thereto in accordance with the provisions herein contained;

1.2.2 "Agent" means the authorized representative or such other Authority as may be appointed by the State Government for the purpose of this Agreement;

1.2.3 "PFR" means the pre feasibility report pertaining to the project under this Agreement;

1.2.4 "Agreement period" shall have the meaning as specified in Article 3;

1.2.5 "Company" will mean a company incorporated under the companies Act, 1956 and having its Corporate office at Hyderabad;

1.2.6 "SPV" means a body/organization to be constituted by the Company for implementation of the project while performing the obligations and duties under this agreement

1.2.7 "Central Govt." means the Government of India;

1.2.8 "CEA" means the Central Electricity Authority constituted under Section 3 of the Electricity(Supply) Act 1948 or its successors, administrators or assignees ;

For SEW ENERGY LIMITED

(V. BALAKRISHNA RAO)
DIRECTOR

Secretary (Power)
Govt. of Arunachal Pradesh
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1.2.9 "Detailed Project Report(DPR)" means the Detailed Project Report pertaining to the project under this Agreement to be submitted by the Company and to be approved by the competent authority of the State Government;

1.2.10 "Dispute" shall have the meaning as specified in Article 13;

1.2.11 "Financial closure" means the date on which the Financing Agreements have been duly executed and the Company has access to such funding under the Financing Agreements;

1.2.12 "Financing Agreement" means the loan agreements, notes, indentures, security agreements, letters of credit equity arrangements and other documents relating to the financing(including refinancing) of the project and the capital cost or any part thereof, as amended, supplemented or modified from time to time and approved by the competent authority;

1.2.13 "Force Majeure" shall have the meaning as ascribed thereto in article 11;

1.2.14 "GOI" means the Government of India;

1.2.15 "Evacuation System" means the network of power transmission lines and sub-stations for transmitting the electrical output from the Interconnection Point up to main load centre(s);

1.2.16 "Interconnection Facilities" means all the facilities which shall include without limitation, switching equipment communication, protection, control and metering devices etc. at the Interconnection Point(s) in the switchyard of the generating stations to be installed and maintained at the cost of the Company to enable evacuation of Power output from the Project in accordance with this Agreement;

1.2.17 "Law" means any act rule regulation, notification, order or instruction having the force of Law enacted or issued by any competent legislature. Government or statutory authority in India;

1.2.18 "Month" means the English Calendar month;

1.2.19 "Parties" mean the State Government and the Company collectively;

1.2.20 "Party" means the State Government and / or the Company individually;

1.2.21 "Power Purchase Agreement (PPA)" means a contractual agreement to be signed by the Company with an electricity consumer, trader or any other parties permitted under the statute to purchase the power;

1.2.22 "Project" means the Nafra Hydro Electric Project proposed to be established on Bichom (Kameng) river (located between EL of 990 m to 780m) in West Kameng District of Arunachal Pradesh · including complete hydroelectric power generating facility covering all components such as dam, intake works, water conductor system, power station, generating units, project roads, bridges, offices, residential facilities store, guest houses, security office and other connected facilities including the Interconnection Facilities;

For SEW ENERGY LIMITED

(Y. BALAKRISHNA RAO)
DIRECTOR

Secretary (Power)
Govt. of Arunachal Pradesh
Itanagar

1.2.23 "Commercial Operation" means the state of Unit/Project when Unit/Project is capable of delivering Active power and Reactive Power on a regular basis after having successfully completed the commissioning tests as per Prudent Utility Practices.

1.2.24 "Commercial Operation Date (COD)" means the date on which the commercial operation of Unit/Project as the case may be, is achieved by the Company.

1.2.25 "State Government" means the Govt. of Arunachal Pradesh;

1.2.26 "State" means the State of Arunachal Pradesh.

1.2.27 "Year" means the English Calendar year comprising of 365 days in a non-leap year and 366 days in a leap year.

1.2.28 "Site" means the site of the project appurtenances, generating plant including land, waterways, roads and rights acquired or to be acquired by the Company for the purposes of the project.

1.2.29 "Prudent Utility Practices" means those practices, methods, techniques and standards that are generally accepted internationally from time to time by electric utilities for the purpose of ensuring safe, efficient and economic design, engineering, construction, commissioning, testing, operation and maintenance of various component of the project of the type specified in this agreement and which practices, methods and standards shall be adjusted as necessary to take account of,

I. Installation, operation and maintenance guidelines recommended by the manufacturers of the plant and equipments to be incorporated in the project.

II. The requirement of Indian Law.

III. Physical conditions at the site.

IV. Practices, methods, techniques and standards as changed from time to time that are generally accepted internationally for use in electric utility and for power generation in India.

Article 2

GENERAL TERMS AND CONDITIONS OF THE AGREEMENT.

2.1 The State Govt. hereby grants permission to the Company M/s SEW Energy Ltd.,. to undertake preliminary investigation for preparation of the Pre- feasibility Report, detailed investigation for DPR preparation and subsequent implementation of Nafra HEP (96 MW) in West Kameng Distt., Arunachal Pradesh.

For SEW ENERGY LIMITED

(Y. BALAKRISHNA RAO)
DIRECTOR

Secretary (Power)
Govt. of Arunachal Pradesh
Itanagar

2.2 The project shall be implemented by M/s SEW Energy Ltd., on BOOT basis (Build, Own, Operate and Transfer) for a lease period of 40(forty) years from the Commercial Operation Date(COD). The project shall be reverted to the State Govt. on expiry of 40 years, free of cost, in good working condition. No extension of the lease period will be considered on expiry of the lease period of 40(forty) years.

2.3 The entire cost of investigation, DPR preparation, project implementation and subsequent operation and maintenance of the project will be borne by M/s SEW Energy Ltd.,

2.4 The project shall be developed in tune with the State Govt. policy to develop the project in the most environment, eco, and people friendly manner.

2.5 The PFR and the DPR of the project shall be submitted by M/s SEW Energy Ltd., to the State Govt., prior to commencement of implementation of the project for their consent which shall not be unreasonably withheld.

2.6 All clearances required from the Central Govt. in connection with the project implementation shall be arranged by the Company itself. The State Govt. shall accord necessary clearances under its purview within a reasonable period. The Govt. shall extend all need based assistance in obtaining such clearances including licenses, approvals, sanctions, permits etc. as may be required for the project.

2.7 The Company shall make available information regarding water discharge regularly to the State Govt.

2.8 The State Govt. or its agents or a person authorized by the State Govt. in that behalf shall be free to investigate, survey and implement other projects of any nature either upstream or downstream of the project, provided that it shall not have any adverse impact on implementation, operation and maintenance of the project.

2.9 The Company shall allow the State Govt., its officers/staffs or authorized agents to use the roads and facilities such as Post Office, School and Dispensary etc., that may be provided by the Company as part of the project. The State Govt. and its authorized agents shall be allowed to inspect the project and its site(s) upon advance notice.

For SEW ENERGY LIMITED

(V. BALAKRISHNA RAO)
DIRECTOR

SEW ENERGY LIMITED

Secretary (Power)
Govt. of Arunachal Pradesh
Itanagar

2.10 The Company shall not incur any kind of financial liabilities in the name of the State Govt., in the execution and subsequent operation and maintenance of the project.

2.11 The Company will not be allowed to sell and transfer the power plant to any other party/parties without the prior permission of the State Govt. However, the Company shall be allowed to mortgage the power plant to the Lenders for availing financial assistance to meet the cost of the project with prior consent of the State Govt. Further, the Company shall not be permitted to transfer the project under this agreement to any third party (other than SPV formed by the Company for development of the project as permitted under this agreement) for development without prior concurrence of the State Govt.

2.12 The Company shall make available to the State Govt., for its use free of cost, an additional bay of suitable rating or other mutually acceptable arrangement.

2.13 The Company shall ensure that the execution, operation and maintenance of the project is in conformity with Prudent Utility Practices and the manufacturer's specifications.

2.14 The Company shall ensure proper quality control and safety measures during implementation of the project including any geological study, construction and testing at sites. The State govt. shall have the right to institute an appropriate mechanism to ensure the compliance by the Company in this regard.

2.15 The Company shall make suitable financial provision in the project cost, if required, for the catchments area treatment plans in consultation with the State Forest & Environment and Wild Life Management Department as approved by the Ministry of Environment & Forests, Govt. of India. The cost involved on this account shall be paid by the Company to the concerned authorities of the Govt.

2.16 The Company shall carry out Environmental Impact Assessment (EIA) in association with the State Environment & Forest Department and Wildlife Department as required under the Environment (Protection) Act, 1986 through consultant(s) drawn from a reputed organization and obtain the consent of State Pollution Control Board.

2.17 The Company shall be responsible for maintaining the ecological balance by preventing deforestation, water pollution and defacement of natural landscape in the vicinity of works. The Company shall take all reasonable measures to prevent any unnecessary destruction, scarring

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SEW ENERGY LIMITED HYDERABAD

For SEW ENERGY LIMITED

(V. BALAKRISHNA RAO)
DIRECTOR

Secretary (Power)
Govt. of Arunachal Pradesh
Itanagar

or defacement of the natural surroundings in the vicinity of the works.

2.18 The Company shall ensure such minimum flow of water immediately downstream of the dam/barrage for downstream requirements as shall be specified in the environmental clearance. The Company shall take appropriate steps as may be required for the protection of fish culture as per environmental requirement.

2.19 The Company shall ensure that the water requirement for the construction of the project including potable drinking water shall be generally arranged and harnessed by them from the river source. The local sources of water supply may be utilized by the Company only to the extent it does not adversely affect the local people.

2.20 The Company shall ensure that the materials excavated from the site shall be dumped in the area duly approved by the State Pollution Control Board.

2.21 The Company shall ensure that the land is used only for the project and activities ancillary to the project.

2.22 The Company shall ensure that the taxes as per law are deducted at source from the payments made to the contractors and deposit the same the State Govt.

2.23 As the capacity as well as the reach of the river mentioned in this agreement are tentative, it will be optimized while preparing Pre Feasibility Report / Detailed Project Report. Based on techno-economic consideration, if it is considered to be more economical & more viable to optimize the power potential in the river, for such optimization of the capacity, formal approval of the State Govt. / Central Govt. if required, shall be obtained prior to implementation, if the project capacity exceeds 100 MW.

2.24 The Company shall be permitted to create a Special Purpose Vehicle (SPV) for implementation of this project under this agreement. The State Govt. agrees to transfer / issue all such permission / approvals relating to the project as may be required in the name of such Special Purpose Vehicle.

2.25 Since the project has been identified by the developer, as such the developer shall be totally responsible for proper identification of accurate site of the project, its viability and all other related issues including safety aspects for implementation of the project at the time of formulation of DPR. Further, the change of the site subsequently shall not be permitted.

SEW ENERGY LIMITED * HYDERABAD *

For SEW ENERGY LIMITED

(V. BALAKRISHNA RAO)
DIRECTOR

Secretary (Power)
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Article 3

LAND ACQUISITION AND PERIOD OF AGREEMENT / LEASE

3.1 The Site required for the construction, operation and maintenance of the project and for the associated works as will be assessed by the Company shall be transferred by the State Govt. to the Company on lease basis against payment of land revenue as per approved rate of State Govt. The period of lease will cease with the project getting reverted to the State Govt. on expiry of 40(forty) years. The Company shall be entitled to mortgage the land to the lenders/financers of the project with prior consent of the State Govt. subject to the condition that such period of mortgage shall not exceed the lease period. The State Govt. shall acquire for the Company under the land acquisition Act, 1894 as in force and as per Bengal Eastern Frontier Regulation, 1873 (5 of 1873) at the expense of the Company such private lands within the State of Arunachal Pradesh, as may be required from time to time by the Company for the construction, operation and maintenance of the project.

3.2 This agreement shall automatically expire on completion of 40(forty) years of commercial operation.

Article 4

ADHERENCE TO REGULATIONS OF THE CENTRAL & STATE GOVT.

4.1 The Company shall strictly comply with the following statutory regulations of the Central Govt. and the State Govt. while implementing the project.

4.1.1 The Company shall strictly comply with the provision of the Forest (Conservation) Act, 1980. The Company shall also pay the cost of raising the Compensatory Afforestation including payment of the Net Present Value (NPV) of the forest land being diverted for non-forest purpose under the Forest (Conservation) Act, 1980. The Company shall also pay the royalty on the forest produces such as timber, ballies, and all river bed materials etc as per prescribed rates of the State Govt. in force from time to time. If any precious and semi-precious minerals/stone etc is found from the river beds and/or from the land acquired for and transferred to or leased out to the Company for the purpose of construction and maintenance of the project or in case any object of archeological importance is found by the Company or any of its employees / contractors / sub-contractors during the course of construction/operation of the project, the Company shall hand over the same to the Govt. of Arunachal Pradesh.

SEW ENERGY LIMITED HYDERABAD

For SEW ENERGY LIMITED

(Y. BALAKRISHNA RAO)
DIRECTOR

Secretary (Power)
Govt. of Arunachal Pradesh
Itanagar

4.1.2 The provision relating to labour welfare existing as in force under the labour Laws/Acts shall be strictly adhered to by the Company during the implementation/operation and maintenance of the project.

4.1.3 The provisions of the Electricity Act, 2003 will be diligently adhered to during implementation and subsequent operation and maintenance of Hydro-electric station.

4.2 The fishing, recreational and navigational rights, tourism prospects in the river, water channel, reservoir, lake etc. shall remain vested in the Govt. of Arunachal Pradesh subject only to such restrictions as may be necessary for the operational requirements and safety and security of the project and the general guidelines of the Govt. of Arunachal Pradesh.

4.3 The Company shall comply with the Hydro Electric Power Policy of the Central / State Govt. as would be in force at the relevant point of time, during the course of implementation and subsequent operation and maintenance of the hydel station.

Article 5
FREE POWER TO THE STATE, EVACUATION & TRADING OF POWER

5.1 From the Commercial Operation Date (COD), the State Govt. shall be given free power @ 12 % in lieu of the distress caused. The free power shall be calculated at the bus bar and all taxes, duties, levies and costs in respect of the free power and towards its evacuation shall be borne by the State Government.

5.2 Over and above the free power, the State Govt. will have the first right to purchase the power generated from the project if the State Govt. so desire on mutually agreed terms and conditions. The State Govt. shall exercise its aforesaid right within 90 days of the receipt of such offer from the Company after the DPR is approved from all angles. A separate Power Purchase Agreement (PPA) will be entered into for such purchase of the power between the State Govt. and the Company on mutually agreed terms and conditions. In case the Company and the State Govt. do not arrive at a mutually agreed terms and conditions for the said PPA within 90 days of receipt of the offer, the Company shall be entitled to sell the power from the project to any other party at its discretion.

5.3 The Company shall be responsible for developing evacuation system for the project and liaise with the appropriate authorities for the evacuation of the power from the generating point

SEW ENERGY LIMITED HYDERABAD

For SEW ENERGY LIMITED

M. BALAKRISHNA (AO)
INSPECTOR

Secretary (Power)
Govt. of Arunachal Pradesh
Itanagar

However, in the event of utilizing the infra-structure of the State Govt., necessary charges as mutually agreed shall be paid to the State Govt. The entire cost of grid interfacing, if so required, including cost of maintenance of the evacuation system will be the responsibility of the Company. However, in case the power generated from the project is purchased by the State Govt., the State Govt. shall be responsible for evacuation of power from the bus bar onwards at its own cost.

5.4 The Company shall allow the State Govt. to use its evacuation system and other infrastructures to the extent feasible, after accounting for the Company's requirements for evacuation of power generated from the project(s), if required by the State Govt. on payment of necessary charges by the State Govt. Such charges shall be mutually decided subsequently and a separate agreement entered into.

5.5 It shall be the responsibility of the Company for the trading and sale of the power generated from the project The State Govt. will not be in any manner responsible for the sale and trading of the power on behalf of the Company.

Article 6
SELF IDENTIFICATION OF PROJECT

6.1 The project is identified by the Company on its own. As such, the State Govt. shall not be responsible in any manner if the power potential gets reduced after the DPR is done.

Article 7
RECRUITMENT OF PROJECT PERSONNEL / AWARD OF WORK

7.1 The Company shall reserve the following categories of posts against the project to be filled up by the local tribal people, subject to the incumbents fulfilling the job requirements and considered suitable by the Company as per the criteria given below.

(a) Managerial/Professional post	...	25%
(b) Ministerial/Clerical post.	...	50%
(c) Skilled jobs.	...	25%
(d) Unskilled jobs.	...	75%

For SEW ENERGY LIMITED

(Y. BALAKRISHNA RAO)
DIRECTOR

SEW ENERGY LIMITED HYDERABAD

Secretary (Power)
Govt. of Arunachal Pradesh
Itanagar

7.2 The Company shall give preference to the local contractors fulfilling the eligibility criteria in the award of the work except for the specialized jobs.

Article 8

REHABILITATION & RESETTLEMENT OF PROJECT AFFECTED FAMILIES

8.1 The Company shall earmark a reasonable amount for the social works in accordance with the National Policy on Rehabilitation & Resettlement - 2003 (NPRR - 2003). The Company shall also adhere/conform to the local laws of the State.

8.2 Rehabilitation & Resettlement plan if any, of the oustees from the project/project affected families shall be executed by the State Government as per the approved rehabilitation and re-settlement plan at the cost of the Company, keeping in view the latest guidelines issued by Govt. of India on the subject. The R&R plan shall in any case be not inferior to the National Policy on Rehabilitation & Resettlement-2003 of the Central Govt.

Article 9

LAW & ORDER

9.1 The State Government would make arrangement to maintain general law and order in and around project area for security and safety of properties of the project, protection of life of the workers and experts/ Engineers/Officers during execution, commissioning and subsequent operation and maintenance. However, if any special security arrangement is required by the Company within the project premises, such arrangements shall be made by the State Govt. at the cost of the Company.

Article 10

INDEMNITY

10.1 The Company shall be fully responsible for any damage or loss arising out of the construction, operation or maintenance of the project to any property or person and the Company also undertakes to indemnify the Govt. of Arunachal Pradesh on such account.

SEW ENERGY LIMITED * HYDERABAD *

For SEW ENERGY LIMITED

(Y. BALAKRISHNA RAO)
DIRECTOR

Secretary (Power)
Govt. of Arunachal Pradesh
Itanagar

10.2 The widening, strengthening and construction of the National Highways, State Highways and Bridges and other roads, if required by the Company, shall be executed by the appropriate State Govt. or Central Govt. agency on payment of reasonable cost and departmental charges in advance by the Company as per the estimate to be prepared by the executing State / Central Govt. agency. However, if the Company so desires to do the above activities at its own cost and if permissible under rule, the Company shall be permitted to do so. If any damage to the road and other Govt. and/or public property is done for which only the Company is responsible, it shall be got repaired by the Company at its own cost.

10.3 The Company shall be liable and responsible for all its acts, neglects, omissions and commissions and for the neglects, omissions and commissions of its contractors and employees.

Article 11
FORCE MAJEURE

11.1 Either party shall not be responsible in any manner for the losses arising out of the Force Majeure situation such as earth quake, flood, fire, explosion, epidemic, cyclone, external invasion, civil commotion, riots, landslide etc., which are beyond the reasonable control of the affected party. However, the party so affected, upon serving notice thereof to the other party setting out therein particulars thereof shall be excused from performance of its obligations to the extent prevented, delayed or interfered with for the period Force Majeure conditions persist. The party so affected shall make its best efforts to remove such cause of Force Majeure as expeditiously as possible and shall continue performance hereunder with due dispatch whenever such causers) is removed.

Article 12
TERMINATION OF AGREEMENT AND TAKING OVER OF THE PROJECT

12.1 The Company shall achieve the financial closure within a period of 12 (twelve) months from the date of receipt of the Techno-economic Clearance (TEC), if required, from the Central Electricity Authority(CEA), approvals from Ministry of Environment and Forest (MoEF) and other statutory clearances. In the event that it is confirmed as impossible or impractical to achieve

SEW ENERGY LIMITED * HYDERABAD *

For SEW ENERGY LIMITED

(V. BALAKRISHNA RAO)
DIRECTOR

Secretary (Power)
Govt. of Arunachal Pradesh
Itanagar

Financial Closure or if the Financial Closure is not achieved on or before the expiry of twelve months from the aforesaid date, for the reasons other than those attributable to the Government of Arunachal Pradesh, the Govt. of Arunachal Pradesh reserves the right to terminate the agreement.

12.2 In the event of stoppage of the construction works of the project by the Company, for a period of more than 12(twelve) months for reasons not covered under Force Majeure and for reasons attributable to the Company and/or abandonment of the project by the Company, the State Govt. shall, after giving due opportunity to the Company to resume the work, have the right to terminate the agreement. In the event of termination of the agreement under this clause, the Govt. of Arunachal. Pradesh shall have the right to take over the project on "As is where is" basis and no claim of the Company shall be entertained. The Govt. of Arunachal Pradesh shall also have the exclusive right to re-allot such project to any other developer.

12.3 In case the Company does not commence implementation of the project within a period of 2(two) years from the date of signing of this agreement or within a period of 1 (One) year from the date of receipt of all the statutory clearances, such as Forest & Environment, Techno-economic clearance etc, whichever is earlier, the project shall be reverted to the State Govt. on "As is where is" basis alongwith all the reports, other documents etc., free of cost. However, the above time period shall be automatically extended by the aggregate of the period during which the Company could not take steps to commence implementation by reason of Force Majeure conditions. Thereafter, the State Govt. shall have the exclusive right to re-allot the project to any third party for further development of the project. The Company, if interested, on its own may take necessary steps for reimbursement of its expenditures from such third party without any involvement of the State Govt.

Article 13

RESOLUTION OF DISPUTES & ARBITRATION THEREOF

13.1 In the event of any difference / dispute arising between the Parties, the same shall be resolved in accordance with the provisions of the Arbitration and Conciliation Act, 1996, unless the same has not been resolved amicably by mutual consultations within 90(Ninety) days of the reference of dispute by either Party. The venue of the arbitration shall be Guwahati. The language of arbitration shall be English. The cost of arbitration shall be shared equally. In case

Secretary (Power)
Govt. of Arunachal Pradesh
Itanagar

of any litigation, the Gauhati High Courts shall have the sole jurisdiction.

Article 14

CONFIDENTIALITY

14.1 Each party hereto agrees that it shall not divulge any trade, commercial or technical secrets or confidential matters of one another to any third party, save and except for the purpose of implementation, operation and maintenance of the Project.

Article 15

PROCESSING AND UPFRONT FEES

15.1 The Company has deposited a sum of **Rs. 38,40,000/- (Rupees Thirty eight Lakhs forty thousand) only @ Rs. 40,000/- (Rupees Forty Thousand) per MW** of the proposed installed capacity vide Demand Draft No. 150216 Dtd. 12/09/2007 drawn on State Bank of India, payable at Itanagar towards nonrefundable processing in favour of Secretary (Power), Govt. of Arunachal Pradesh at the time of signing of the Memorandum of Agreement the receipt of which sum the State Govt. hereby acknowledges.

15.2 The Company has deposited the upfront payment of **Rs. 48,96,000/- (Rupees Forty eight Lakhs Ninety Six Thousand) only @ Rs. 51,000/- (Rupees Fifty One Thousand) per MW** of the proposed installed capacity with the Govt. of Arunachal Pradesh at the time of signing of this Memorandum of Agreement vide Demand Draft No. 150215 Dtd. 12/09/2007 drawn on State Bank of India, payable at Itanagar, the receipt of which payment of the State Govt. hereby acknowledges and another installment of same amount i.e. **Rs. 48,96,000/- (Rupees Forty eight Lakhs Ninety six Thousand) only @ Rs. 51,000/- (Rupees Fifty One Thousand)** shall be deposited between the 36th (thirty sixth) and the 37th (thirty seventh) months from the date of signing of the MoA. This upfront payment shall be adjusted from the free power of the State Govt. in the first year of commercial operation which shall be non-interest bearing. The payment shall be made by demand draft drawn in favor of the Secretary (Power), Govt. of Arunachal Pradesh. In the event of the project becoming not viable after the DPR, such upfront payment shall be refunded to the Company without any interest on it but if the project is not taken up due to the fault of the Company, the State Govt. shall have the absolute right to forfeit the upfront payment.

SEW ENERGY LIMITED * HYDERABAD *

For SEW ENERGY LIMITED

(Y. BALAKRISHNA RAO)
DIRECTOR

Secretary (Power)
Govt. of Arunachal Pradesh
Itanagar

15.3 In the event of reduction in the capacity of the project, the State-Govt. shall not be bound to refund the proportionate reduction in the amount of the upfront premium including the processing fee. However, in the event of capacity addition in the installed capacity of the project, the Company shall deposit the processing fee and the upfront premium @ Rs. 40,000/- per MW and Rs. 51,000/- per MW respectively for the increased capacity of the project.

15.4 The upfront premium paid shall not form part of the project cost as the loading of the project will have a direct bearing on the cost of generation.

15.5 The Company shall contribute an amount @ one paisa per unit of electricity sold towards local area development fund. This contribution shall be subject to proportionate enhancement with increase in the rate of tariff.

15.6 The Company shall deposit 0.1% of the Project Cost as Project Monitoring, Evaluation and Coordination (both technical and financial) fee by Demand Draft in favour of the Secretary (Power), Govt. of Arunachal Pradesh, Itanagar within one month of the finalization of the Detailed Project Report

Article 16.
PENALTY.

16.1 The Company shall commission the project within a period of 6 (Six) years from the date of receipt of all statutory clearances from State/Central Govt. agencies/authorities, achieving of Financial Closure and availability of land required for the project. In the event of failure on the part of the Company to commission the project within the targeted period, the Company shall be liable to pay penalty @ Rs. 10,000/- (Rupees Ten Thousand) per MW per month to the Govt. of Arunachal Pradesh for the extended period of commissioning, except when such delay is caused by Force Majeure events.

Article 17
PROJECT MONITORING COMMITTEE

17.1 The State Govt. shall constitute a Project Monitoring Committee with the Secretary (Power), Govt. of Arunachal Pradesh or any other appropriate State Govt. authority as the Chairperson for the purpose of overseeing the progress of the project and sort out the difficulties and issues that could arise with respect to implementation of the project. The

SEW ENERGY LIMITED HYDERABAD

For SEW ENERGY LIMITED

(Y. BALAKRISHNA RAO)
DIRECTOR

Secretary (Power)
Govt. of Arunachal Pradesh
Itanagar

Company shall be represented by a senior executive of the Company or its associate companies.

Article 18
OBLIGATIONS OF THE STATE GOVT.

The Govt. of Arunachal Pradesh hereto recognizes that:

18.1 Nafra HEP shall utilize the flowing water of the river to generate electricity. Such right to utilize water available upstream of the project are granted by the Govt. of Arunachal Pradesh for non-consumptive use only without charging any royalty, duty, cess or levy of any kind of such use of water.

18.2 The tariff/or the energy generated at the project during pre-commissioning stage shall be fixed as per the specific guidelines of Govt. of India for such energy for hydro-electric projects.

18.3 The State Govt. shall provide due assistance to the Company to obtain, in accordance with the prevailing Law and regulations, necessary permits to install and use suitable radio communication systems including satellite communication equipment and walkie-talkies. Any system connecting with the national telecommunication system or any international telecommunication system will be subject to approval / license from the relevant authorities for the issuance of which the State govt. shall assist.

18.4 The State govt. shall provide due assistance to the Company under the Law and regulations, to obtain permission to procure, store and use such explosives which are required for the project; provided that the responsibility of obtaining such a clearance and making the necessary arrangements shall rest with the Company.

18.5 The State govt. shall provide due assistance to the Company in obtaining all necessary import licenses for the project from the relevant Central Govt. authorities to the extent permissible by Law. The Company shall submit a list of such equipments required to be imported for the project to the State govt. for approval. The State Govt. shall provide necessary need based assistance in obtaining the concessions and incentives given by the Central Govt. for setting up of projects in North Eastern States.

SEW ENERGY LIMITED * HYDERABAD *

For SEW ENERGY LIMITED

(Y. BALAKRISHNA RAO)
DIRECTOR

Secretary (Power)
Govt. of Arunachal Pradesh
Itanagar

18.6 The State Govt. can impose an environment cess, according to the Law, which shall not be more than one paisa per unit of electricity sold and shall be collected at the source by the Company and deposited with the State Govt. No other taxes/duties/cess will be levied on the sale of electricity by the Company within the State or outside the State.

19. Save and except as provided aforesaid none of the parties hereto shall assign their respective rights and obligations hereunder without prior consent in writing of the other party hereto.

20. The Company shall be governed and bound by the guidelines as may be notified by the Govt. of India or the State Govt. under the relevant Acts from time to time.

21. The Company hereby covenants that on demand from the Govt. of Arunachal Pradesh, it shall pay the amounts, if any payable hereunder by it to the Govt. of Arunachal Pradesh failing which the Govt. of Arunachal Pradesh may recover the same from the Company in any legal manner or as arrears of land revenue.

22. The Company shall bear the stamp duty on the execution of this agreement.

IN WITNESS WHEREOF THE PARTIES THROUGH THEIR AUTHORISED REPRESENTATIVES HAVE SIGNED THOSE PRESENTS ON THE DAY MONTH AND YEAR MENTIONED ABOVE.

FOR AND ON BEHALF OF THE
GOVERNOR OF ARUNACHAL PRADESH

Office of the Secretary (Power) Govt. Arunachal Pradesh Itanagar

[T. NORBU] 14.9.07
Secretary (Power),
Govt. of Arunachal Pradesh
Itanagar.

Secretary (Power) Govt. of Arunachal Pradesh Itanagar

Signature with seal
Witness

14/09/07

FOR AND ON BEHALF OF
M/s SEW Energy Ltd.,

SEW ENERGY LIMITED HYDERABAD

[Y. BALAKRISHNA RAO]
Director

For SEW ENERGY LIMITED

14/09/07
(Y. BALAKRISHNA RAO)
DIRECTOR

Signature with seal
Witness

14/09/07
Vice President SEW

Annexure XVII

PROFILE AND CERTIFICATES OF ENVIRONMENTAL MONITORING AGENCY

Mitra S. K.

Private Limited

Testing Quality • Winning Trust

Established in 1938 by Late Santosh Kumar Mitra at Barbil, Orissa, Mitra SK has long been one of the foremost names in the independent certification of quality and quantity for international trade. Its network of over 40 offices in major cities, ports, loading stations and industrial centres ensures that the Company can meet any requirement within India. Overseas offices in Japan, China, Korea, Germany and Russia enable the company to reach services beyond the country.

Air :

Test can be conducted on normal and special parameters

- Stack Emission
- Ambient Air
- Fugitive Air
- Workzone Monitoring
- Personal Sampling
- Air Microbiology
- Indoor Air Quality Evaluation
- Meteorological Data using Automatic Monitoring

Environment Studies :

- Impact assessment studies as per MOEF and SPCB requirement
- Environment Management Plan
- Environment Audit
- Hazardous Waste Audit
- Environment base line study studies covering the field of Water, Ambient air, Emission source, Soil, Noise and Ecology.
- Noise Monitoring using automatic data logger

Noise Pollution

It is not often realised that noise is not only an irritant but can affect a person's health, activities and mental abilities. To ensure that critical levels are not breached Mitra SK undertakes decibel studies at and near areas such as airports, factories, hospitals, schools and traffic intersections.

Water:

Test can be conducted on normal and special parameters

- Different sort of water testing can be done as per norms
- Packaged Drinking water
- Surface/Ground water
- Natural Mineral Water
- Feeder/Boiler/Cooling Tower/ Demineralised Water
- Swimming Pool Water
- Laboratory Grade Water
- Bio-medical/ Dialysis Water
- Different Processed Water for Industry

Food, Agriculture & Soil

Test can be conducted on normal and special parameters

- Microbiological Evaluation of different Pathogens
- Pesticides
- Minerals
- Vitamin
- Chemical Composition
- Laboratory out Sourcing
- Food Nutritional Labelling
- Food Safety tests as per PFA

Effluent / solid water:

Test can be conducted on normal and special parameters

- Characterization and analysis of Effluent/ Solid Waste as per norms of Different Industries
- Analysis for Schedule –II
- Analysis of Toxic Elements
- Bioassay Test
- TCLP
- VOC'S, PAH, PCB'S
- Microbiology Evaluation
- Pesticides

Laboratory Outsourcing

(Set up of environmental laboratory as per MOEF and PCB)

LABORATORY FACILITIES

Mitra SK is equipped to undertake analytical surveys at short notice virtually anywhere in India with laboratory facilities across the country. Apart from on-site testing and survey, the Company has its sophisticated Central Laboratory in Calcutta for advanced analysis of samples. Both classical and instrumental methods are undertaken for certifying to national and international standards. ***The lab is accredited by NABL for ISO 17025, MOEF, BIS and is also recognised by the West Bengal and Orissa Pollution Control Board.***

Accredited by the PVA
ISO 9001 : 2000
Certified for H. O., Central Lab & Haldia Site

Mitra S K Private Limited

Head Office :
SHRACHI CENTRE 5th Floor
74B Acharya Jagadish Chandra Bose Road
Kolkata 700 016, West Bengal, India
Ph: 91 33 22172249 / 22441339 /
22445485 / 22177484 / 22177485 / 22177483
Fax: 91 33 22447482
E.mail : info@mitrask.com

http://www.mitrask.com

Overseas Offices :

U.A.E. ● China ● Japan ● Germany ● Russia ● South Korea ● Iran ● Indonesia ● Brazil

Barbil	06767 275209/276069	Bikaner	0151 206863
Bangalore	09341265400	Chennai	044 26413877
Calcutta	033 2244 5485/2244 1339/	Coimbatore	09435551855, 04222645980
	2217 2249/033 2217 9425/	Cochin	09895423189
	2217 9426/0332217 7483/	Cuttack	09777452705
	7484/7485/033 2284 7493/	Dhanbad, Durgapur	0343 2547399/2546839
Goa	0832 2512660	Gandhidham	02836 222648
Guwahati	09864028763	Haldia	03224 2749201276, 772
Hospet	08394 31356	Jaisalmer	02992 50561
Jamshedpur	0657 2303045	Jharsuguda	06645273726
Jodhpur	0291 2638948	Katni	07622 230651
Mangalore	0086 759 2622626	Mumbai	09867592223,02240150415
Nagpur	09423685177	New Delhi	09717067939
Raipur	09179194099	Udaipur	02942451926
Visakhapatnam	09848947733		

रजिस्ट्री सं० डी० एल०-33004/99

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असाधारण

EXTRAORDINARY

भाग II—खण्ड 3—उप-खण्ड (ii)

PART II—Section 3—Sub-section (ii)

प्राधिकार से प्रकाशित

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पर्यावरण एवं वन मंत्रालय

अधिसूचना

नई दिल्ली, 9 जनवरी, 2008

का.आ. 55(अ).—पर्यावरण (सुरक्षा) नियमावली 1986 के नियम 10 के साथ पठित पर्यावरण (सुरक्षा) अधिनियम, 1986 (1986 का 29) की धारा 12 की उप-धारा (1) के खण्ड (ख) और धारा 13 द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए, केन्द्रीय सरकार, उक्त अधिनियम और उसके अंतर्गत बनाये गए नियमों के अंतर्गत ऐसी प्रयोगशालाओं को सौंपे गए कार्यों को करने के लिए नीचे दी गई तालिका के कॉलम (2) में विनिर्दिष्ट की गई प्रयोगशालाओं को, पर्यावरणीय प्रयोगशालाओं के रूप में और केन्द्रीय सरकार अथवा उक्त अधिनियम की धारा 11 के तहत शक्ति प्राप्त अधिकारियों द्वारा वायु, जल, मृदा अथवा अन्य पदार्थों के नमूनों के विश्लेषण के प्रयोजनार्थ कॉलम (3) में विनिर्दिष्ट किए गए नियमों और व्यक्तियों को सरकारी विश्लेषणकर्ता के रूप में उक्त तालिका के कॉलम (4) में विनिर्दिष्ट अवधि के लिए मान्यता प्रदान करती है, और उस प्रयोजन के लिए पर्यावरण एवं वन मंत्रालय की 18 जुलाई, 2007 की भारत सरकार की अधिसूचना संख्या का.आ. 1174(अ) में आगे निम्नलिखित संशोधन करती है नामश:

उक्त अधिसूचना की संलग्न तालिका में, क्रम संख्या 55 और उससे संबंधित प्रविष्टियों के बाद निम्नलिखित क्रम संख्या और प्रविष्टियां जोड़ी जाएं, नामश:

तालिका

क्रम सं.	प्रयोगशाला का नाम	सरकारी विश्लेषणकर्ता का नाम	लागू और कब तक मान्य
(1)	(2)	(3)	(4)
"56	मैसर्ज साई लेबोरेटरीज (साई एनवायरो इंजीनियर्स प्राइवेट लिमिटेड की डिविजन) 210, दूसरा फ्लोर, चाला एस्टेट, मेन रोड, इरगड्डा, हैदराबाद-500018	(1) श्री सुरत्तु हरि कृष्ण (2) श्री आलम सत्यनारायण (3) श्री डी. वी. प्रेम स्वरूप	09-01-2008 से 08-01-2013
57	मैसर्स रामकी एनवायरो इंजीनियर लिमिटेड, रामकी हाउस, गुलमोहर एवेन्यू, राजभवन रोड, सोमाजीगुडा, हैदराबाद-500082	(1) श्री वेमा विजय कुमार (2) श्री मीरा सुभान शेख (3) श्री उलगमगरी प्रवीणी	09-01-2008 से 08-01-2013
58	मैसर्स इंटरनेशनल टेस्टिंग सेंटर, 86, इंडस्ट्रियल एरिया, फेस-I, पंचकूला-134019 (हरियाणा)	(1) डा. प्रकाश कौर (2) डा. आर. के. जैन (3) श्री प्रेम कुमार	09-01-2008 से 08-01-2013

(1)	(2)	(3)	(4)
59	मैसर्स एस. जी. एस. इंडिया प्राईवेट लिमिटेड 1/509ए, ओल्ड महाबलिपुरम रोड, (गवर्नमेंट स्कूल) के सामने, थोराईपक्कम, चेन्नई-600097	(1) श्री एस. सुरेश कुमार (2) श्री आर. रुबन (3) श्री मुथुकुमार (4) श्री पलानीवेलु	09-01-2008 से 08-01-2013
60	मैसर्स सिमाहदरी लैब्स, 25-26-40/1, दूसरा तल, हार्बर अप्रोच रोड, टाउन कोडा रोड, ओपोजिट इलैक्ट्रिकल ऑफिस, विशाखापटनम-530001	(1) डा. जी. मधु गौतम (2) श्री बी रवि प्रसाद	09-01-2008 से 08-01-2013
61	मैसर्स मित्रा एस. के. प्राइवेट लिमिटेड, शराची सैंटर (5वां तल) 74बी, ए. जी. सी. बोस रोड, कोलकाता-700016	(1) डा. नितिश कुंडु (2) सुश्री नौसमी सेनगुप्ता (3) सुश्री नंदिता दास	09-01-2008 से 08-01-2013"

[फा. सं. क्यू. 15018/7/2003-सीपीडब्ल्यू]

नलिनी भट्ट, वैज्ञानिक 'जी'

टिप्पणी : मूल अधिसूचना भारत के राजपत्र, असाधारण में दिनांक 18 जुलाई, 2007 की संख्या का.आ. 1174(अ) और दिनांक 13 सितम्बर, 2007 की अधिसूचना सं. का.आ. 1539(अ) और दिनांक 24 अक्टूबर, 2007 के का.आ. 1811(अ) के तहत संशोधित की गई थी।

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 9th January, 2008

S.O. 55(E).—In exercise of the powers conferred by clause (b) of sub-section (1) of Section 12 and Section 13 of the Environment (Protection) Act, 1986 (29 of 1986) read with rule 10 of the Environment (Protection) Rules, 1986, the Central Government hereby recognises the laboratories specified in column (2) of the Table given below as environmental laboratories to carry out the functions entrusted to such laboratories under the said Act and the rules made thereunder, and the persons specified in column (3) as Government Analysts for the purposes of analysis of samples of air, water, soil or other substances sent for analysis by the Central Government or the officer empowered under Section 11 of the said Act, for a period specified in column (4) of the Table aforesaid, and for that purpose makes the following further amendments in the notification of the Government of India in the Ministry of Environment and Forests, number, S.O. 1174(E), dated the 18th July, 2007, namely :—

In the Table appended to the said notification, after serial number 55 and the entries relating thereto, the following serial number and entries shall be inserted, namely :—

TABLE

Sl. No.	Name of the Laboratory	Name of the Government Analyst	Recognition with effect from and valid up to
(1)	(2)	(3)	(4)
"56	M/s. Sai Laboratories (A Division of Sai Enviro Engineers Private Limited), 210, 2nd Floor, Challa Estates, Main Road, Erragadda, Hyderabad-500 018	(1) Mr. Sussapu Hari Krishna (2) Mr. Allam Satyanarayana (3) Mr. D.V. Prem Swaroop	09/01/2008 to 08/01/2013
57	M/s. Ramky Enviro Engineers Limited, Ramky House, Gulmohar Avenue, Rajbhavan Road, Somajiguda, Hyderabad - 500 082	(1) Mr. Verma Vijay Kumar (2) Mr. Meera Subhan Shaik (3) Mr. Unkamgari Praveeni	09-01-2008 to 08-01-2013

(1)	(2)	(3)	(4)
58	M/s. International Testing Centre 86, Industrial Area, Phase - I, Panchkula - 134 109 (Haryana)	(1) Dr. Parkash Kaur (2) Dr. R. K. Jain (3) Mr. Prem Kumar	09-01-2008 to 08-01-2013
59	M/s. SGS India Private Limited 1/509A, Old Mahabaliputram Road, (Opp. Govt. School), Thoraipakkam, Chennai - 600 097	(1) Mr. S. Suresh Kumar (2) Mr. R. Rubon (3) Mr. Muthukumar (4) Mr. Palanivelu	09-01-2008 to 08-01-2013
60	M/s. Simhadri Labs 25-26-40/1, 2nd Floor, Harbour Approach Road, Town Kotha Road, Opp. Electrical Office, Vishakhapatnam - 530 001	(1) Dr. G.Madhu Gautam (2) Mr. B.Ravi Prasad	09-01-2008 to 08-01-2013
61	M/s. Mitra S. K. Private Limited Shrachi Centre (5th Floor), 74 B, A.J.C. Bose Road, Kolkata- 700 016	(1) Dr. Nitish Kundu (2) Ms. Mousumi Sengupta (3) Ms. Nadita Das	09-01-2008 to 08-01-2013"

[F. No. Q. 15018/7/2003-CPW]

NALINI BHAT, Scientist 'G'

Note : The principal notification was published in the Gazette of India, Extraordinary *vide* number S.O. 1174(E), dated the 18th July, 2007 and subsequently was amended *vide* notification number S.O. 1539(E), dated the 13th September, 2007 and S.O. 1811(E), dated the 24th October, 2007.

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NABL

National Accreditation Board for Testing and Calibration Laboratories

Department of Science & Technology, India

CERTIFICATE OF ACCREDITATION

MITRA S.K. PRIVATE LIMITED

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

KOLKATA

in the field of

CHEMICAL TESTING

Certificate Number T -0148

Issue Date 12/05/2008 **Valid Until** 11/05/2010

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the additional requirements of NABL.

Signed for and on behalf of NABL

Anuja Anand
Convenor

Dr B. Hari Gopal
Director

Dr T. Ramasami
Chairman

NABL

National Accreditation Board for Testing and Calibration Laboratories

Department of Science & Technology, India

CERTIFICATE OF ACCREDITATION

MITRA S.K. PRIVATE LIMITED

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

KOLKATA

in the field of

BIOLOGICAL TESTING

Certificate Number T-1089

Issue Date 12/05/2008 **Valid Until** 11/05/2010

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the additional requirements of NABL.

Signed for and on behalf of NABL

Anuja Anand
Convenor

Dr B. Hari Gopal
Director

Dr T. Ramasami
Chairman

भारतीय मानक ब्यूरो
केन्द्रीय प्रयोगशाला
BUREAU OF INDIAN STANDARDS
Central Laboratory

प्लाट नं 20/9, साईट-IV, साहिबाबाद औद्योगिक क्षेत्र
साहिबाबाद-201010, जिला गाजियाबाद (उ प्र)

Plot No. 20/9, Site IV, Sahibabad Industrial Area,
Sahibabad-201010, Distt. Ghaziabad (U.P.)

दूरभाष Phones 0120-4177100 (EPABX)
फैक्स Fax 0120-2776663
E-mail : cl@bis.org.in
Website : www.bis.org.in

Our Ref: CL/CQAPD/OSL(5120316)

18 Feb. 2009

M/s Mitra S.K. Private Limited,
Yani Sarani, Joka,
P.S. Thakurpukur,
Kolkata 700 104
West Bengal

Sub: Recognition of your lab under BIS Lab Recognition Scheme 2000

Dear Sir,

With reference to your application seeking recognition of your laboratory by BIS and the subsequent assessment(s) / correspondences made in this regard, we are pleased to inform you that, your lab operating at the address given below:

M/s Mitra S.K. Private Limited,
Yani Sarani, Joka,
P.S. Thakurpukur,
Kolkata 700 104 (West Bengal)

has been recognized by BIS for being used, as and when required, for testing of samples of products under **BIS Certification Mark Scheme** as per the Indian Standards given in Annex-I.

The testing charges for product as per relevant Indian Standards, for which your laboratory is recognized, is indicated against each Indian Standard in Annex-I and shall be valid for a period of 3 years effective from **17 Feb. 2009.**

The recognition shall be valid for three years w.e.f. **17 Feb. 2009.** The recognition shall stand automatically withdrawn unless renewed subject to satisfactory performance of your laboratory based on periodic review / surveillance by BIS. The renewal shall also stand withdrawn if renewal is not sought by your laboratory in advance of the expiry date along-with the prescribed fee.

It may be noted that recognition is subject to terms & conditions laid down in BIS Laboratory Recognition Scheme and reproduced in **Annex-II** to this letter and also the Undertaking given by you along with the application form. Your laboratory shall carry out its operations as per the specific instructions contained in **Annex-III** to this letter.

In case your laboratory is found violating any of the provisions of the Scheme or the undertaking given by you, the laboratory may be derecognized by BIS. The conditions under which a laboratory can be de-recognized are given in Annex-IV to this letter.

Please also note that this recognition does not bind BIS to make use of the facilities available in your laboratory; your services will be made use of as and when required, at the discretion of BIS.

Thanking you.

Yours faithfully,

(K. K.Chaudhary)
Director & Head (CQAPD)

DET NORSKE VERITAS

MANAGEMENT SYSTEM CERTIFICATE

Certificate No. 32302-2008-AQ-IND-RvA

This is to certify that
the Quality Management System
of

MITRA S.K. PVT. LTD.

at

Head Office: Shiruchi Centre (5th Floor), 74B, Acharya Jagadish Chandra Bose Road, Kolkata - 700 016, INDIA
Central Laboratory: Behala Industrial Estate, 620 D.H. Road, Kolkata - 700 034, INDIA
Haldia Site: P.O. Khanjanchak, Haldia, Dist. Midnapore (East), Pin - 721 602, INDIA

has been found to conform to the Quality Management System Standard:

ISO 9001:2000

This Certificate is valid for the following product or service ranges:

SAMPLING, ANALYSIS, SUPERVISION, INSPECTION, WEIGHMENT, QUANTITY ASSESSMENT OF MINERALS AND COAL / COKE SAMPLING AND ANALYSIS OF AIR AND WATER

Original Certification date:
2002-07-26

Place and date:
Chennai, 2008-08-28

This Certificate is valid until:
2011-07-26

KGMI. SYS. RvA C 024

for the Accredited Unit:
DNV CERTIFICATION B.V.,
THE NETHERLANDS

Compliance to the Standard in respect to the indicated scope is verified by the DNV appointed registered Team Leader.

Prasenjit Majumder
Lead Auditor

Bhupalam Ajit
Management Representative

Lack of fulfillment of conditions as set out in the Appendix may render this Certificate invalid.

5th Floor, Tower C, Building No. 8,
DFL Cyber City, Phase II, Gurgaon, India, 122 002

Tel : +91 124 4501100/ 4552800
Fax : +91 124 4380043
Web : www.smec.com.au
