

CONTENTS

CHAPTER-1 COMPENSATORY AFFORESTATION AND BIODIVERSITY CONSERVATION PLAN

1.1	Introduction	1-1
1.2	Compensatory Afforestation	1-1
1.3	Biodiversity Conservation	1-6
1.4	Monitoring of Biodiversity Conservation & Management Plan	1-11
1.5	Budget	1-11

CHAPTER-2 CATCHMENT AREA TREATMENT PLAN

2.1	Need for Catchment Area Treatment	2-1
2.2	Approach for the Study	2-2
2.3	Estimation of Soil Loss Using Silt Yield Index (SYI) Method	2-4
2.4	Watershed Management – Available Techniques	2-6
2.5	Catchment Area Treatment Measures	2-7
2.6	Cost Estimates	2-8

CHAPTER-3 FISHERIES MANAGEMENT PLAN

3.1	Introduction	3-1
3.2	Fisheries Status	3-1
3.3	Impacts on Fisheries	3-2
3.4	Management Measures	3-3

CHAPTER-4 PUBLIC HEALTH DELIVERY SYSTEM

4.1	Introduction	4-1
4.2	Impacts on Public Health	4-1
4.3	Public Health Delivery System	4-1
4.4	Cost Estimates	4-4
4.5	Disposal of Bio-medical Waste	4-6
4.6	Budget for Public Health Delivery System	4-9

CHAPTER-5 ENVIRONMENTAL MANAGEMENT IN LABOUR CAMPS

5.1	Introduction	5-1
5.2	Provision of Heating	5-1
5.3	Provision of Water Supply	5-1
5.4	Sanitation & Sewage Treatment Facilities	5-1
5.5	Solid Waste Management from Labour Camps	5-2
5.6	Provision of free fuel	5-3
5.7	Budget	5-5

5.8	Implementing Agency	5-5
-----	---------------------	-----

CHAPTER-6 MUCK MANAGEMENT PLAN

6.1	Introduction	6-1
6.2	Muck Generation	6-1
6.3	Disposal of Muck and Reclamation of Muck Disposal Sites	6-2
6.4	Budget	6-5

CHAPTER-7 RESTORATION AND LANDSCAPING OF CONSTRUCTION SITES

7.1	Introduction	7-1
7.2	Quarrying Operations	7-1
7.3	Restoration Plan for Quarry Site and Borrow Area	7-3
7.4	Landscaping and Restoration Plan	7-5
7.5	Budget	7-5

CHAPTER-8 ENVIRONMENTAL MANAGEMENT IN ROAD CONSTRUCTION

8.1	Introduction	8-1
8.2	Impacts due to Construction of Roads	8-1
8.3	Management Measures	8-2
8.4	Budget	8-4

CHAPTER-9 GREENBELT DEVELOPMENT PLAN

9.1	Introduction	9-1
9.2	Need for Greenbelt Development Plan	9-1
9.3	Scheme for Greenbelt Development	9-1
9.4	Budget	9-1

CHAPTER-10 CONTROL OF AIR POLLUTION

10.1	Impacts on Air Quality	10-1
10.2	Mitigation Measures	10-2
10.3	Implementing Agency	10-4

CHAPTER-11 MEASURES FOR NOISE CONTROL

11.1	Impacts on Noise Levels	11-1
11.2	Mitigation Measures	11-1

CHAPTER-12 WATER POLLUTION CONTROL

12.1	Control of Water Pollution During Construction Phase	12-1
12.2	Control of Water Pollution During Operation Phase	12-1

CHAPTER-13 RESETTLEMENT AND REHABILITATION PLAN

13.1	General	13-1
13.2	Study Objectives	13-1
13.3	Study Approach and Methodology	13-2
13.4	Project Affected Families	13-2
13.5	Resettlement & Rehabilitation Principles	13-3
13.6	Resettlement and Rehabilitation Interventions	13-4
13.7	Estimation of Affected Land & PAFs	13-5
13.8	Resettlement and Rehabilitation Plan	13-6
13.9	Institutional/ Administrative Arrangement for Implementation of the R&R Measures	13-12
13.10	Budget for R&R	13-16

CHAPTER-14 ENERGY CONSERVATION MEASURES

14.1	General	14-1
14.2	Energy Conservation During Construction Phase	14-1
14.3	Energy Conservation During Operation Phase	14-2
14.4	Energy Efficient Equipment	14-2
14.5	Budget	14-3

CHAPTER-15 TRIBAL DEVELOPMENT PLAN

15.1	General	15-1
15.2	Demographic Profile of Study Area Villages	15-1
15.3	Access to Various Social Infrastructures	15-4
15.4	Strategy For Development: The TSP Approach	15-9
15.5	Plans/Programmes of the Ministry	15-10
15.6	Village Grain Bank Scheme	15-10
15.7	Grant-In-Aid to Voluntary Organization Working For Welfare of Scheduled Tribes	15-11
15.8	Tribal Development Plan	15-11
15.9	Budget For Tribal Development Plan	15-14

CHAPTER-16 ENVIRONMENTAL MONITORING PROGRAMME

16.1	The Need	16-1
16.2	Areas of Concern	16-1
16.3	Water Quality	16-1

16.4	Air Quality and Meteorology	16-2
16.5	Noise	16-3
16.6	Soil Erosion and Siltation	16-3
16.7	Ecology	16-3
16.8	Incidence of Water-Related Diseases	16-4
16.9	Landuse Pattern	16-4
16.10	Summary of Environmental Monitoring programme	16-5

CHAPTER-17 COST ESTIMATES

17.1	Cost for Implementing Environmental Management Plan	17-1
17.2	Cost for Implementing Environmental Monitoring Programme	17-1

LIST OF FIGURES

- Figure-1.1 Characteristic features of nest box
- Figure-2.1 Sub-watersheds in the catchment area
- Figure-2.2 Classified land use map of the catchment area
- Figure-2.3 Slope map of the catchment area
- Figure-2.4 Erosion category of various watersheds
- Figure-2.5 Catchment area treatment measures

CHAPTER-1

COMPENSATORY AFFORESTATION AND BIODIVERSITY CONSERVATION PLAN

1.1 INTRODUCTION

Conservation is the sustainable use of natural resources, so that it is preserved for future generation as well. Natural conservation involves proper management of natural wealth, places that sustain these resources besides the human pressure that affect the resources. The need for conservation, preservation and management of biological diversity arises because of threats to natural ecosystems by anthropogenic activities. In view of the foreseen disturbance and degradation of natural ecosystems, a compensatory afforestation plan and biodiversity conservation and management plan has been proposed for Nyamjangchhu hydroelectric project.

1.2 COMPENSATORY AFFORESTATION

The Forest Department of Arunachal Pradesh is responsible for conservation and Management of forests in the state. The objective of the compensatory afforestation is to make up for the loss of forest land proposed to be utilized for construction of the proposed Nyamjangchhu hydroelectric project. The other objectives are to combat soil erosion, afforestation and last but not least to maintain and improve the ecological and environmental balance.

1.2.1 Impacts on Forest

The total land required for the project is 254.5526 ha. The details are given in Tables-1.1 and 1.2.

TABLE-1.1
Land requirement for Nyamjang chhu hydroelectric project

S. No.	Component	Village	Private Land (ha)	Community Land (ha)	Total Land (ha)
1	Submergence Area (Left Bank up to Barriage)	Soksen	4.0454	4.5961	8.6415
2	Submergence Area (Right Bank up to Barriage)	Lumpo	0	2.9707	2.9707
3	Submergence Area (River area up to Barriage)	Soksen and Lumpo (50 - 50)	0	27.7369	27.7369
4	Upstream Headworks	Soksen	0	22.051	22.051

S. No.	Component	Village	Private Land (ha)	Community Land (ha)	Total Land (ha)
5	Head Race Tunnel	Soksen	0	1.079	1.079
6		Kyaley teng	0	2.158	2.158
8		Shakti	0	8.332	8.332
9		Gispu	0	0.981	0.981
10		Sherbang	0	1.054	1.054
11		Kherteng	0	1.168	1.168
12		Phoomang	0	1.168	1.168
13		Bagar	0	1.168	1.168
14	Adits - 1	Kyaley teng	0	0.333	0.333
15	Adits - 2	Shakti	0	0.2382	0.2382
16	Adits - 3	Shakti	0	0.3404	0.3404
17	Adits - 4	Shakti	0	0.484	0.484
18	Adits - 5	Sherbang	0	0.324	0.324
19	Adits - 6 (equally in three villages)	Kherteng/Phoomang/Bagar	0	0.352	0.352
20	Adits - 7	Kherteng/Phoomang/Bagar	0	0.322	0.322
21	Adits - 8	Kungba	0	0.725	0.725
22	Adits - 9	Kherteng	0	0.805	0.805
23	Tail Race Tunnel	Kherteng	0	1.335	1.335
24	G IB	Kherteng	0	0.3261	0.3261
25	MAT	Kherteng	0	0.5152	0.5152
26	Power House	Kherteng	0	15.5618	15.5618
27	Surge Shaft (equally in three villages)	Kherteng, Phoomang, Bagar	0	0.5901	0.5901
28	Pressure Shaft (equally in three villages)	Kherteng, Phoomang, Bagar	0	2.693	2.693
29	Switchyard	Kherteng	0	0.675	0.675
30	Muck disposal Sites M-1	Muchat	0	2.6893	2.6893
31	M-2	Muchat	0	7.459	7.459
32	M-3	Kyaley teng	0	8.659	8.659

S. No.	Component	Village	Private Land (ha)	Community Land (ha)	Total Land (ha)
33	M-4	Shakti	0	1.9571	1.9571
34	M-5	Shakti (BTK)	0	2.9283	2.9283
35	M-6	Shakti (BTK)	0	8.0694	8.0694
36	M-7	BTK	0	4.7789	4.7789
37	M-8	BTK	0	5.767	5.767
38	M-9	Shakti (BTK)	0	2.8847	2.8847
39	M-10	Sherbang	0	3.2569	3.2569
40	M-11	Sherbang	0	4.415	4.415
41	M-12	Sherbang	0	3	3
42	M-13	Kherteng	0	3.9238	3.9238
43	M-14	Kumba	0	6.6	6.6
44	M-15	Kumba	0	2.5898	2.5898
45	Colonies	Sherbang	0	7	7
46	Labour Camps (equally in three villages)	Kyaleyte ng, Kherteng, Sherbang	0	3	3
47	Workshop, Centerlized store and Fabrication yard	Kherteng	0	4	4
48	Explosive Magazines (2 nos) (50 - 50)	Sherbang / Kyaleyte ng	0	1.5	1.5
49	Crusher ,Batching plant and aggregate Storage (2 nos)(50-50)	Kerteng / Shakti	0	12	12
50	Contractor colonies (Temp)equally in three villages	Kherteng/She rbang/Kyaleyte ng	0	4	4
51	Adit Portals (1 to 9),TRT,Cables tunnel Portals (for cover)	respective villages of Adits	0	0.419	0.419
52	Storage area at different works sites	Socks en,resp ective villages of Adits , s.shaft, MAT, GIB &TRT	0	2	2

S. No.	Component	Village	Private Land (ha)	Community Land (ha)	Total Land (ha)
53	Access Roads to Query 3,4,5,6,7 @ 500 mts each	Socksen, Muchat, Shakti, Sherbang, Lumla	0	3.75	3.75
54	Access Roads to Inlet Portal ADIT 1 (15 mtrs RoW)	Kyaleyteing	0	0.15	0.15
55	Access Roads to Adits - 2, 3	Shakti	0	13.5	13.5
56	Access Roads to Adits - 5	Sherbang	0	2.745	2.745
57	Access Roads to Adits - 6	Kherteng/Phomang/Bagar	0	5.625	5.625
58	Access Roads to Adits - 7	Kherteng/Phomang/Bagar	0	1.275	1.275
59	Access Roads to Adits - 8	Kungba	0	1.62	1.62
60	Access Roads to Adits - 9	Kherteng	0	1.65	1.65
61	Access Roads to MuckDumpng 3	Kyaleyteing	0	0.75	0.75
62	Access Roads to MuckDumpng 4	Shakti	0	4.05	4.05
63	Access Roads to Surge Shaft	Kherteng	0	0.375	0.375
64	Access Roads to M.A.T.	Kherteng	1.0875	0	1.0875
65	Access Roads to Cables tunnel	Kherteng	0.75	0	0.75
66	Access Roads to T.R.T	Kherteng	4.2	0	4.2
67	Quarry (Q -2 to Q-7)		0	6	6
	Total		10.0829	244.4697	254.5526

TABLE-1.2
Ownership status of land to be acquired for Nyamjang chhu hydroelectric project

S. No.	Type of land	Area (ha)
1	Private land	10.0829
2	Community land	244.4697
	Total	254.5526

About 244.4697 ha of community land is required for the proposed Nyamjangchhu hydroelectric project. The community land also includes forest

land. The entire community land is considered as forest land for preparation of management plan. The dam construction, clearing of vegetation, movement of earth and rock, widening of road, stocking of construction materials, erection of temporary labour sheds and excavation disturb vegetation and forest area.

During reservoir filling the river and associated wetland become inundated and the vegetation in the submergence area is adversely affected. The species density and diversity in the proposed submergence area indicate that the proposed site is not ecologically sensitive. The tree density in the submergence area is about 270 trees/ha. *Alnus nepalensis* with 70 trees/ha was the dominant species, followed by *Erythrina arborescence* (45 trees/ha) and *Macaranga denticulata* (35 trees/ha). Ten shrubs were recorded from the site. *Eleagnus* sp. and *Rubus ellipticus* were the dominant shrub species. Twenty four species of herbs were recorded during winter and thirty nine species during summer season. *Polygonum capitatum*, *Anaphalis triplinervis* and *Oxalis corniculata* were the dominant herbaceous species.

The project site was not found to have many rare and endangered plants. Plants of other economic importance such as timber, medicinal and edible fruits were common.

1.2.2 Afforestation

The Indian Forest Conservation Act (1980) stipulates:

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

The entire land to be acquired for the project including submergence area and other project appurtenances is about 254.5526 ha. This includes 244.4697 ha of community and 10.0829 ha of community land. It is proposed to afforest double the amount of entire land being acquired for the project including private land. Thus, a total of (254.5526x 2) 509 ha of land needs to be afforested. The afforestation work is to be done by the Forest Department

The total expenditure required for afforestation of 509 ha of area will be Rs. 35.63 million. In addition to above the project proponent will pay NPV and cost of trees to the Forest Department, which shall be estimated by the Forest Department.

1.3 BIODIVERSITY CONSERVATION

The project area did not have any threatened category of species as classified by IUCN.

1.3.1 Habitat Improvement Programme

Habitat improvement programme is an integral part of biodiversity management. This programme consists of bringing into useful association of those condition needed by a species to reproduce and survive. The following activities have been proposed for habitat improvement programme:

Afforestation: Area under forest and tree cover will be expanded through systematic planning and implementation of afforestation and rehabilitation programme in degraded and open forests and available non forest lands.

Regeneration of felled areas will be ensured in a time bound manner and productivity of plantations will be increased through use of improved seeds and planting stock. The indigenous fruit bearing plants, vital from wildlife point of view are proposed to be planted so as to enrich the habitat & ensure the sufficient availability of food. Monoculture will be discouraged and mixed plantations of broad-leaved fodder, fuel wood and wild fruit species will be promoted. This activity will increase forest cover and will provide habitat to the animals. Afforestation programme in the degraded Forest Compartments, is proposed to be carried out and species for this shall be finalized by the Forest Department. An amount of Rs.1.0 million can be earmarked for this purpose.

Avi-fauna : Forests are vital for the survival, foraging, breeding and nesting of avifauna. Natural forests provide a variety of food materials to the birds not only in the form of nectar of flowers, fruits, seeds etc. in the trees, shrubs, herbs and grasses but they also contain a large number of insects eaten by birds. In the forests, food is always available for the faunal component. Although most floral species flower during spring through summer but fruit maturation and seed ripening takes place in them throughout the year. Therefore, first strategy of improvement of habitat for birds is avoiding nest predation or brood parasitism through maintenance of large contiguous forest tract. These areas have the ability to support the largest number of forest interior birds and will also be more likely to provide habitat for area sensitive species. It is more practicable to protect the existing forest area rather than creating new forest area.

Another measure for habitat improvement for avifauna is to be installation of artificial nest boxes in the influence zone and catchment area of the project after consultation with the forest department as well as local NGOs. These nest boxes has been found to be quite beneficial for attracting hole nester birds. The size and capacity of boxes vary from one species to another. Provision for providing the same is given in Table 1.2 along with overall budget estimates.

Feature of a Nest Box:

The characteristic features of nest box are listed below and shown in Figure 1.1.

- Untreated wood (Jamun, mango, pine, cedar or fir)
- Thick walls (at least $\frac{3}{4}$ inches)
- Extended, sloped roof
- Rough or grooved interior walls
- Recessed floor, coated with primer and paint
- Drainage holes
- Ventilation holes
- Easy access for monitoring and cleaning
- Sturdy construction
- No outside perches

The entrance hole should have a 2-inch diameter and 6 inch depth from entrance hole. Nest boxes are placed on trees at height from 10-12 ft. Such nest boxes designs have been used with success.

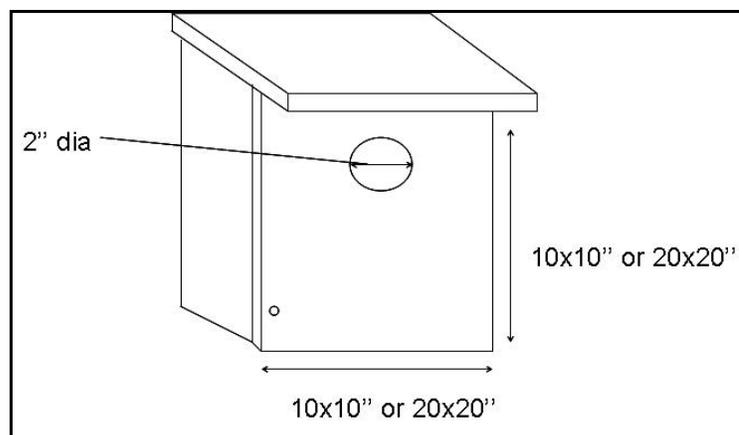


Figure 1.1: Nest Box

It is proposed that one qualified person be hired for a period of five years. An amount of Rs.1.9 million can be earmarked for habitat improvement of avifauna in the study area. The details are given in Table-1.3.

TABLE-1.3
Cost of habitat improvement for avi-fauna in the study area

Sl. No.	Particulars	Amount (Rs. million)
A	Non-recurring Cost	
1	Cost of nests of different sizes (10"x10" to 20"x20"; average cost Rs. 500 per wooden box) and installation in the area along with the green belt (1000)	0.5
2	Repair and maintenance of the nests	0.1
B	Recurring Cost (for 5 years)	
1	Salary for one skilled person @ Rs. 15,000 per month for implementation and data collection including 10% escalation	1.1
2	Contingencies (including avifaunal biodiversity awareness programme for the local inhabitants)	0.2
Total Cost (A+B)		1.9

1.3.2 Conservation and cultivation of Medicinal Plants

It is proposed to develop a Herbal nursery at appropriate location preferably in the Gram Panchayat. Self help groups formed by women should be involved for the promotion of herbal drugs from the kitchen stock and rare medicinal plants. Species of medicinal plants proposed for plantation in the project area is given as below:

- *Artemisia nilagirica*
- *Cannabis sativa*
- *Centella asiatica*
- *Elaeagnus sp.*
- *Houttuynia cordata*
- *Lycopodium clavatum*
- *Lyonia ovalifolia*
- *Plantago major*
- *Rumex nepalensis*
- *Solanum viarum*
- *Zanthoxylum armatum*

For this programme to be undertaken on 5 ha land and creation of at least one herbal garden an amount of Rs. 0.5 million can be earmarked for this purpose.

1.3.3 Eco-Development Works

The Eco-development Committees and Village Conservation Committees (VCCs) can be constituted for this purpose which will help State Forest Department in capacity building and microplanning of the various eco-developmental activities

formulated for community development. The activities under this programme are aimed at improvement of livelihood of people living in the project area. Under this programme, number of activities have been proposed and are described in the following paragraphs.

Compensation: *Ex-gratia* payment to the victims of crop damage, cattle lifting and human life loss/injury:

Ex-gratia payment to the victims of crop damage, cattle lifting and human life loss/injury is also a management tool for conserving the wild animals. The compensation to the owners for loss of their crop / livestock by wildlife, if any, is proposed under this scheme on humanitarian grounds. An amount of Rs. 1.0 million is proposed for victims of the legal heirs.

Publicity and Awareness

- Under this programme, the following activities are proposed:
- Training should be imparted to the school teachers in the project area for introduction of environmental education among the school children and exchange to knowledge on environment and ecology between the monastic and village schools.
- Publishing of research documents, pamphlets, brochures, hoardings
- Opening of biodiversity register in every village
- Advertisement of hazardous effect of fire through press, sign boards and public meetings will form the important activities under this component.

An amount of Rs. 0.5 million is earmarked for this purpose.

1.3.4 Anti-poaching Measures

For the improvement of vigilance and measures to check poaching number of measures described below would be undertaken.

During construction phase in and around the main construction areas, i.e. the barrage site, powerhouse site, etc. where construction workers congregate, some disturbance to the wildlife population may occur. Therefore, marginal impacts may be on wildlife due to various construction activities. In view of this it is recommended that 4 check posts be developed in the major construction area i.e. one near intake and one near power house along the boundary of labour camps to implement anti-poaching measures during project construction

phase. Each check post shall have 3 guards to ensure that poaching does not take place in the area. The guards will be supervised by a range officer. It is also recommended that the staff manning these check posts have adequate communication equipment and other facilities. Apart from inter-linking of check posts, communication link needs to be extended to Divisional Forest Office and the local police station also.

Purchase of anti-poaching kits: To capture and translocate wild animals out of human habitations or agricultural lands, various trapping equipments pertaining to anti-poaching activities are needed. In the absence of these the staff faces difficulties and all efforts made on this behalf are futile. For this an amount of Rs. 0.5 million has been earmarked. The anti-poaching kits will include equipments for self defense of the staff as well.

Infrastructure Development: This includes antipoaching huts, rock shelters development and residential quarters for forest guards. For effective monitoring, one watch tower is also proposed to be established at an identified place having high pressure of biotic interference. These basic amenities for the field staff to enable them to do effective patrolling in the areas. For watch tower and accommodation an amount of Rs. 2.0 million has been earmarked.

Purchase of Survey equipment & Vehicle: In order to improve network and vigilance it is required to procure equipment like V-SAT and to document and develop a database IT infrastructure like laptops, L.C.D. projectors, altimeters, G.P.S., spotoscope, binoculars, video as well as digital still cameras are essential. Purchase of field vehicle will help in increased vigilance.

For better communication and purchase of survey equipment an amount of Rs. 2.0 million has been earmarked.

Construction of Check posts: To improve vigilance for anti-poaching, better protection, enforcement for control grazing practices the construction of control-grazing-cum-anti poaching check posts. An amount of Rs.1.0 million can be earmarked for this purpose.

An amount of Rs. 12.62 million has been earmarked for this purpose. The details are given as below:

a) **Salary**

- Guards (12 nos.) @ Rs.5000 per month Rs. 720,000

▪ One range officer @ Rs.15,000 per month	Rs. 180,000
▪ Total cost for one year	Rs. 900,000
Cost for 6 years (Assuming 10% increase per year)	Rs. 7.12 million
b) Purchase of anti-poaching kits	Rs. 0.5 million
c) Infrastructure development	Rs. 2.0 million
d) Purchase of Survey equipment & Vehicles	Rs. 2.0 million
e) Construction of check posts	Rs. 1.0 million
Total Cost	Rs.1262 million

1.4 MONITORING OF BIODIVERSITY CONSERVATION & MANAGEMENT PLAN

Monitoring is an important part of the Biodiversity Management Plan. All the activities of BMP will be closely and regularly monitored in terms of physical, financial progress and quality by the project proponent and officers of Forest Department.

The State Government shall set up a Biodiversity Conservation Committee (BCC) under the chairmanship of the Principal Chief Conservator of Forests, Govt. of Arunachal Pradesh. The committee shall review and oversee the conservation work to be undertaken.

1.5 BUDGET

A total provision of Rs.53.15 million has been earmarked for biodiversity conservation. The details are given in Table-1.4.

TABLE-1.4
Estimated cost of Biodiversity Conservation and Management Plan implementation

Particulars	Cost (Rs. million)
Compensatory afforestation	35.63
Afforestation	1.00
Habitat improvement for avi-fauna	1.90
Conservation and cultivation of Medicinal Plants	0.50
Eco-Development Works - Compensation	1.00
Eco-Development Works - Publicity & Awareness	0.50
Anti-poaching measures	12.62
Total	53.15

CHAPTER-2

CATCHMENT AREA TREATMENT PLAN

2.1 NEED FOR CATCHMENT AREA TREATMENT

It is a well-established fact that reservoirs formed by dams on rivers are subjected to sedimentation. The process of sedimentation embodies the sequential processes of erosion, entrainment, transportation, deposition and compaction of sediment. The study of erosion and sediment yield from catchments is of utmost importance as the deposition of sediment in reservoir reduces its capacity, and thus affecting the water availability for the designated use. The eroded sediment from catchment when deposited on streambeds and banks causes braiding of river reach. The removal of top fertile soil from catchment adversely affects the agricultural production. Thus, a well-designed Catchment Area Treatment (CAT) Plan is essential to ameliorate the above-mentioned adverse process of soil erosion.

Soil erosion may be defined as the detachment and transportation of soil. Water is the major agent responsible for this erosion. In many locations, winds, glaciers, etc. also cause soil erosion. In a hilly catchment area as in the present case erosion due to water is a common phenomenon and the same has been studied as a part of the Catchment Area Treatment (CAT) Plan.

The Catchment Area Treatment (CAT) plan highlights the management techniques to control erosion in the catchment area. Life span of a reservoir in case of a seasonal storage dams is greatly reduced due to erosion in the catchment area. The catchment area considered for treatment is about 16,661 ha. The sub-watersheds in the catchment area considered for the present study are given in Figure-2.1.

The catchment area treatment involves

- Understanding of the erosion characteristics of the terrain and,
- Suggesting remedial measures to reduce the erosion rate.

In the present study '**Silt Yield Index**' (**SYI**), method has been used. In this method, the terrain is subdivided into various watersheds and the erodibility is determined on relative basis. SYI provides a comparative erodibility criteria of

catchment (low, moderate, high, etc.) and do not provide the absolute silt yield. SYI method is widely used mainly because of the fact that it is easy to use and has lesser data requirement. Moreover, it can be applied to larger areas like sub-watersheds, etc.

2.2 APPROACH FOR THE STUDY

A detailed database on natural resources, terrain conditions, soil type of the catchment area, socio-economic status, etc. is a pre-requisite to prepare treatment plan keeping in view the concept of sustainable development. Various thematic maps have been used in preparation of the CAT plan. Due to the spatial variability of site parameters such as soils, topography, land use and rainfall, not all areas contribute equally to the erosion problem. Several techniques like manual overlay of spatially index-mapped data have been used to estimate soil erosion in complex landscapes.

Geographic Information System (GIS) is a computerized resource data base system, which is referenced to some geographic coordinate system. In the present study, real coordinate system has been used. The GIS is a tool to store, analyze and display various spatial data. In addition, GIS because of its special hardware and software characteristics, has a capacity to perform numerous functions and operations on the various spatial data layers residing in the database. GIS provides the capability to analyze large amounts of data in relation to a set of established criteria.

In order to ensure that latest and accurate data is used for the analysis, satellite data has been used for deriving land use data and ground truth studies too have been conducted.

The various steps covered in the study are as follows:

- Data acquisition
- Data preparation
- Output presentation

The above mentioned steps are briefly described in the following paragraphs.

2.2.1 Data Acquisition

The requirement of the study was first defined and the outputs expected were noted. The various data layers of the catchment area used for the study are as follows:

- Slope Map
- Soil Map
- Land use Classification Map
- Current Management Practices
- Catchment Area Map.

2.2.2 Data Preparation

The data available from various sources was collected. The ground maps, contour information, etc. were scanned, digitized and registered as per the requirement. Data was prepared depending on the level of accuracy required and any corrections required were made. All the layers were geo-referenced and brought to a common scale (real coordinates), so that overlay could be performed. A computer programme was used to estimate the soil loss. The formats of outputs from each layer were firmed up to match the formats of inputs in the program. The grid size to be used was also decided to match the level of accuracy required, the data availability and the software and time limitations. The format of output was finalized. Ground truthing and data collection was also included in the procedure.

For the present study IRS 1C-LISS III digital satellite data was used for interpretation & classification. The classified land use map of the catchment area considered for the study is shown as Figure-2.2. The land use pattern of the catchment is summarized in Table-2.1.

TABLE-2.1
Landuse pattern of the catchment area

Category	Area (ha)	Percentage
Dense Vegetation	8650	51.92
Open Vegetation	3472	20.83
Scrub	2888	16.13
Agriculture land	198	1.19
Rocky outcrops	1591	9.55

Category	Area (ha)	Percentage
Water body	52	0.31
Settlement	12	0.07
Total	16661	100.00

Digitized contours from toposheets were used for preparation of Digital Elevation Model (DEM) of the catchment area and to prepare a slope map. The first step in generation of slope map is to create surface using the elevation values stored in the form of contours or points. After marking the catchment area, all the contours on the toposheet were digitized (100 m interval). The output of the digitization procedure was the contours as well as points contours in form of x, y & z points. (x, y location and their elevation). All this information was in real world coordinates (latitude, longitude and height in meters above sea level).

A Digital Terrain Model (DTM) of the area was then prepared, which was used to derive a slope map. The slope was divided in classes of slope percentages. The slope map is enclosed as Figure-2.3.

Various layers thus prepared were used for Modeling. Software was prepared to calculate the soil loss using input from all the layers.

2.2.3 Output Presentation

The result of the modeling was interpreted in pictorial form to identify the areas with high soil erosion rates. The primary and secondary data collected as a part of the field studies were used as an input for the model.

2.3 ESTIMATION OF SOIL LOSS USING SILT YIELD INDEX (SYI) METHOD

The Silt Yield Index Model (SYI), considering sedimentation as product of erosivity, erodibility and arial extent was conceptualized in the All India Soil and Land Use Survey (AISLUS) as early as 1969 and has been in operational use since then to meet the requirements of prioritization of smaller hydrologic units.

The erosivity determinants are the climatic factors and soil and land attributes that have direct or reciprocal bearing on the unit of the detached soil material. The relationship can be expressed as:

Soil erosivity = f (Climate, physiography, slope, soil parameters, land use/land cover, soil management)

Silt Yield Index

The Silt Yield Index (SYI) is defined as the Yield per unit area and SYI value for hydrologic unit is obtained by taking the weighted arithmetic mean over the entire area of the hydrologic unit by using suitable empirical equation.

Prioritization of Watersheds/Subwatersheds:

The prioritization of smaller hydrologic units within the vast catchments are based on the Silt Yield Indices (SYI) of the smaller units. The boundary values or range of SYI values for different priority categories are arrived at by studying the frequency distribution of SYI values and locating the suitable breaking points. The watersheds/ sub-watersheds are subsequently rated into various categories corresponding to their respective SYI values.

The application of SYI model for prioritization of sub watersheds in the catchment areas involves the evaluation of:

- a) Climatic factors comprising total precipitation, its frequency and intensity,
- b) Geomorphic factors comprising land forms, physiography, slope and drainage characteristics,
- c) Surface cover factors governing the flow hydraulics and
- d) Management factors.

The data on climatic factors can be obtained for different locations in the catchment area from the meteorological stations whereas the field investigations are required for estimating the other attributes.

The various steps involved in the application of model are:

- Preparation of a framework of sub-watersheds through systematic delineation
- Rapid reconnaissance surveys on 1:50,000 scale leading to the generation of a map indicating erosion-intensity mapping units.
- Assignment of weightage values to various mapping units based on relative silt-yield potential.
- Computing Silt Yield Index for individual watersheds/sub watersheds.
- Grading of watersheds/sub watersheds into very high, high medium, low and very low priority categories.

The area of each of the mapping units is computed and silt yield indices of individual sub watersheds are calculated using the following equations:

a. Silt Yield Index

$$SYI = \frac{\sum (A_i \times W_i)}{A_w} \times 100 ; \quad \text{where } i = 1 \text{ to } n$$

Where

A_i	=	Area of ith unit (EIMU)
W_i	=	Weightage value of ith mapping unit
n	=	No. of mapping units
A_w	=	Total area of sub-watershed.

The SYI values for classification of various categories of erosion intensity rates are given in Table-2.2.

TABLE-2.2
Criteria for erosion intensity rate

Priority categories	SYI Values
Very high	> 1300
High	1200-1299
Medium	1100-1199
Low	1000-1099
Very Low	<1000

2.4 WATERSHED MANAGEMENT – AVAILABLE TECHNIQUES

Watershed management is the optimal use of soil and water resources within a given geographical area so as to enable sustainable production. It implies changes in land use, vegetative cover, and other structural and non-structural action that are taken in a watershed to achieve specific watershed management objectives. The overall objectives of watershed management programme are to:

- increase infiltration into soil;
- control excessive runoff;
- Manage & utilize runoff for useful purpose.

Following Engineering and Biological measures have been suggested for the catchment area treatment.

1. Engineering measures

- Step drain
- Angle iron barbed wire fencing
- Stone masonry
- Check dams

2. Biological measures

- Development of nurseries
- Plantation/afforestation
- Pasture development
- Social forestry

The basis of site selection for different biological and engineering treatment measures under CAT are given in Table-2.3.

TABLE-2.3
Basis for selection of catchment area treatment measures

Treatment measure	Basis for selection
Social forestry, fuel wood and fodder grass development	Near settlements to control tree felling
Contour Bunding	Control of soil erosion from agricultural fields.
Pasture Development	Open canopy, barren land, degraded surface
Afforestation	Open canopy, degraded surface, high soil erosion, gentle to moderate slope
Barbed wire fencing	In the vicinity of afforestation work to protect it from grazing etc.
Step drain	To check soil erosion in small streams, steps with concrete base are prepared in sloppy area where silt erosion in the stream and bank erosion is high due to turbidity of current.
Nursery	Centrally located points for better supervision of proposed afforestation, minimize cost of transportation of seedling and ensure better survival.

2.5 CATCHMENT AREA TREATMENT MEASURES

The total catchment area is 16661 ha. The erosion category of various watersheds in the catchment area as per a SYI index is given in Table-2.4. The details are

shown in Figure-2.4. The area under different erosion categories is given in Table-2.5.

TABLE-2.4**Erosion intensity categorization as per SYI classification**

Watershed number	Area	SYI values	Category
W1	1269	930	Very low
W2	590	1211	High
W3	1626	1046	Low
W4	1783	1225	High
W5	1047	1228	High
W6	796	1230	High
W7	794	1081	Low
W8	546	1121	Medium
W9	886	1059	Low
W10	1573	1093	Low
W11	1169	945	Very low
W12	1616	1219	High
W13	1871	1216	High
W14	1124	1117	Medium

TABLE-2.5**Area under different erosion categories**

Category	Area (ha)	Percentage
Very low	2438	14.6
Low	4819	28.9
Medium	1670	10.1
Very High	7734	46.4
High	-	-
Total	16661	100.00

The objective of the SYI method is to prioritize sub-watershed in a catchment area for treatment. The total area under high erosion category is 7734 ha. The various measures suggested for catchment area treatment are mentioned in Figure 2.5, expenses of which have to be borne by the project proponents.

2.6 COST ESTIMATE

The cost required for Catchment Area Treatment is Rs. 70.2 million. The details are given in Tables -2.6 and 2.7.

TABLE-2.6
Cost estimate for Catchment Area Treatment - Biological Measures

S.No.	Item	Rate/unit (Rs.) (including maintenance cost)	Target	
			Physical	Financial (Rs. million)
1.	Gap Plantation	35,000/ha	985 ha	34.48
2.	Pasture Development	15,000/ha	851	12.77
3.	Social forestry	70,000/ha	25	1.75
4.	Nursery development	3,00,000/no.	2 no	0.60
5.	Maintenance of nursery	2,70,000/no	2 no.	0.54
6.	Barbed wire fencing	100,000/km	3 km	0.30
7.	Watch and ward for 3 years for 10 persons	5000/ man- month	360 man months	1.80
	Total (A)			52.24

TABLE-2.7
Cost estimate for Catchment Area Treatment - Engineering Measures

S.No.	Item	Rate (Rs.)	Unit	Target	
				Physical	Financial (Rs. million)
1.	Contour bunding	25000/ha	Ha	137	3.43
2.	Check dam	150,000	No.	32 No.	4.80
	Total (B)				8.23

Total cost for Biological and Engineering measures = Rs. 60.47 million (A)

Administrative expenditure

- Government Expenditure 3% of A (including O&M) Rs. 1.81 million
- Establishment cost 8% of A Rs. 4.84 million
- Contingency 5% of A Rs. 3.03 million

Total

Rs.70.15 million
Say Rs.70.2 million

CHAPTER-3

FISHERIES MANAGEMENT PLAN

3.1 INTRODCUTION

A river valley project may have adverse or beneficial effects on the fish fauna, depending upon the particular situation and the fish fauna inhabiting the concerned river. Similarly it has various impacts on the people, the livelihood of which depends on the fish. The construction of the dam leads the fragmentation of habitat, modification in hydrologic regime and may have adverse effects on indigenous and migratory fish. On the other hand pondage provides a large volume of water, which is beneficial with respect to fish culture and can play an important role in the upliftment of economic growth.

3.2 FISHERIES STATUS

The fishery survey was conducted during (August 2007), winter (December 2007) and summer (April 2008) using cast net. 50 castings each in the upstream and downstream of the dam site were done in different sections of the river. The major fish species observed during fisheries survey is given in Table-3.1.

TABLE-3.1

List of fish species in project area along with their common names

S. No.	Species	Family
1	<i>Barilius barna</i>	Cyprinidae
2	<i>Botia Dario</i>	Balitoridae
3	<i>Chanda nama</i>	Ambassidae
4	<i>Channa orientalis</i>	Channidae
5	<i>Danio aequipinnatus</i>	Cyprinidae
6	<i>Garra gotyla gotyla</i>	Cyprinidae
7	<i>Garra lissorhynchus</i>	Cyprinidae
8	<i>Glyptothorax sp.</i>	Amblycipitidae
9	<i>Hara hara</i>	Amblycipitidae
10	<i>Labeo dero</i>	Cyprinidae
11	<i>Labeo pangusia</i>	Cyprinidae
12	<i>Puntius sarana sarana</i>	Cyprinidae
13	<i>Salmostoma bacaila</i>	Cyprinidae
14	<i>Schizothorax richardsonii</i>	Cyprinidae
15	<i>Tor putitora</i>	Cyprinidae
16	<i>Tor tor</i>	Cyprinidae

Snow trout, a migratory fish species represented by *Schizothorax* sp. are endemic to Himalayas. In winter months, when the water in upper reaches of these rivers touches almost 0°C, snow trouts migrate downstream for a considerable distance and constitute the major fisheries, particularly in the middle and lower stretches.

Mahaseer in the area is represented by Tor species, which is one of the finest group of game fish of lower Himalayas. During months of May and June, they migrate upward and ascend to the smaller tributaries for breeding. The Mahaseer species undertake upstream migration in river Nyamjangchhu during summer and monsoon months for feeding and breeding. As the winter sets in the upper reaches, the species takes a downstream journey.

The proposed barrage may obstruct the migration route of the Mahaseer and Snow trout which can be termed as one of the adverse impacts.

There is no fish landing centre in project area. It was also observed during field visit that no large scale fishing activities are being practiced by the population in and around the project area. During interaction with the locals and Fisheries Department, it was confirmed that there are no fishermen families in the project area. However, few locals are involved in fishing activities to augment their income. No family is fully dependent on fishery for earning his living. The fisheries is done mostly for subsistence.

3.3 IMPACTS ON FISHERIES

3.3.1 Construction phase

The construction of the proposed Nyamjangchhu hydroelectric project would involve large-scale of construction activities at the barrage site, including boulders, stones, gravel, sand, etc. Extraction of gravel and sand causes considerable damage to fish stocks and other aquatic life by destabilizing the sub-stratum, increasing the turbidity of water, silting of the channel bottom and modifying the flow, which in turn may result in erosion of the river channel. These alterations would have a significant impact on the benthic fauna. The increased turbidity during extraction on dredging process will also increase the turbidity which is likely to last during the time dredging is undertaken. The suspended solids in excess of 100 ppm brought by suspended solids chokes the gills of young fish. Fine solids in concentration greater than 25 mg/l, adversely affects the development of fish eggs and fish. Normally, fish species migrate for

the area and return to the site, only after the dredging or extraction activities are ones. This is a phenomenon reported in many projects and is expected in the proposed project.

3.3.2 Operation phase

Among the aquatic animals, it is the fish life, which would be most affected. The migratory fish species, e.g. Snow trout and Maahseer are likely to be adversely affected due to obstruction created by the proposed barrage. With the completion of dam, flow in the downstream stretch (32 km) of the river would be reduced considerably more so during the lean period. Such situation may adversely affect the benthic community and fish. The most important changes, which can be expected are:

- reduced flow rate
- increase in water temperature
- reduction in availability of stano-thermal aquatic animals
- increase in population of euro-thermal species.
- barrier to migration due to construction of barrage.

Unless the desired flow is maintained downstream of the dam, aquatic ecology in general and fisheries in particular would be affected.

3.4 MANAGEMENT MEASURES

3.4.1 Release of minimum flow

The requirement of flow in the downstream is directly related to the water temperature. After construction of barrage on Nyamjangchhu river, water is to be diverted for power generation. The tail race channel will confluence in river Nyamjangchhu at a distance of about 32 km downstream of the barrage site.

A study for Minimum Environmental Flow for the Sustenance of Ecology and Biodiversity for Nyamjang Chhu HEP is under preparation by Central Inland Fisheries Research Institute (CIFRI), Barrackpore, West Bengal.

As per the preliminary report from CIFRI, the minimum flow requirement for the sustenance of ecology and biodiversity in Nyamjang Chhu river can be taken as 20% of the average flow of lean season in 90% dependable year which shall be finalized after three season studies and will be indicated in the final report. The preliminary report from CIFRI is enclosed as Annexure-I.

Based on the preliminary report, average lean season flow (December to March) has been estimated as 14.71 cumec. The minimum flow shall be 20% of 14.71 cumec, i.e. 2.94 cumec. The details are given in Table-3.2.

TABLE-3.2
Estimation of Environmental Flow

Month		90% Dependable Year 1994-95 (cumec)
December	I	19.24
	II	17.52
	III	15.55
January	I	12.92
	II	12.55
	III	12.3
February	I	12.44
	II	13.19
	III	12.13
March	I	12.63
	II	13.18
	III	22.92
Average (A)		14.71
Minimum Flow (20% of A)		2.94

3.4.2 Provision of fish ladder

Mahaseer (*Tor putitora*) is the migratory species. The barrage on river Nyamjangchhu will be a barrier to the free movement of fish species. Therefore, a provision of fish ladder would have been made in the dam.

3.4.3 Sustenance of migratory fish species

Since, migratory fish species are observed in the project area, scientific management of the existing stock needs be adopted. It is proposed to implement reservoir and supplementary stocking programmes for the project. It is proposed to stock the reservoir and river Nyamjangchhu for a length of 10 km upstream and 32 km on the downstream sides. The rate of stocking is proposed as 100 fingerlings of about 30 mm size per km. For reservoir area, stocking shall be 1000 fingerlings/ha of 30 mm size. The migratory fish species namely, mahaseer and snow trout can be stocked. The stocking can be done annually by the Fisheries Department, State Government of Arunachal Pradesh. To achieve this objective, facilities to produce seeds of mahaseer and snow trout would have to be created at suitable sites. The site would be identified in consultation with Fisheries Department.

3.4.4 BUDGET

The total cost required for development of fish seed farm is **Rs. 13.23 million**. The details are given in Table-3.3. Since, separate farms are to be developed for mahaseer and snow trout, an amount of Rs. 26.46 million are proposed to be earmarked.

TABLE-3.3
Component wise cost for development of fish seed farm

S. No.	Particulars	Qty.	Rate (Rs.)	Amount (Rs.million)
A.	Capital cost (Non-recurring expenditure)			
1.	Hatchery (20 troughs and 80 trays)	1	Lumpsum	0.500
2.	Nursery ponds (3.0mx0.75mx0.5m)	9	30,000	0.270
3.	Rearing ponds (10mx1.50mx0.5m)	9	50,000	0.450
4.	Stocking ponds (30m x 6.0m x 1.5m)	2	15000	0.300
5.	Office, store, hut with infrastructure	4	-	0.600
6.	Laboratory	1	-	0.200
7.	Water supply (lumpsum)	-	-	0.100
8.	Other project cost (Drag nets, wide mouth earthen pots, miniature hapa, buckets, bamboo poles etc.) (lumpsum)	-	-	0.100
	Total (A)			2.520
B.	Working Capital /year (Recurring expenditure)			
1.	Salaries			
i)	Farm Manager (one) @ 25000/month			0.300
ii)	Farm Assistants (one) @ Rs. 15000/month			0.180
iii)	Farm Attendants (one) @ Rs.10000/month			0.120
iv)	Chowkidars (one) @ Rs. 10000/month			0.120
2.	Fish food (rice bran, oil cake, etc.) Lumpsum			0.100
3.	Brooders	200 kg	150	0.300
4.	Ponds manuring			
i)	Cow dung	20 tons	200/tons	0.004
ii)	Urea	100 kg	10/kg	0.001
iii)	Potash, phosphate	100 kg	100/kg	0.100
5.	Lime	300 kg	10/kg	0.030
6.	Training and Research		Lumpsum	0.100
7.	Chemical		Lumpsum	0.100
8.	Maintenance		Lumpsum	0.100

S. No.	Particulars	Qty.	Rate (Rs.)	Amount (Rs.million)
9.	Travel		Lumpsum	0.100
10	Miscellaneous		Lumpsum	0.100
	TOTAL (B) Total recurring expenditure for five years including 10% escalation (B)			1.755 10.71
	Grand Total (A+B)			13.23

CHAPTER-4

PUBLIC HEALTH DELIVERY SYSTEM

4.1 INTRODUCTION

As a part of CEIA study, data on public health was collected through local health offices. In addition, information on major diseases in the project area was also collected as a part of socio-economic survey. The prevalent disease in the project area include gastro-enteritis, malaria, etc. The project area has not reported occurrence of major epidemics due to occurrence of vector borne diseases like Malaria are prevalent in the project area, but then incidence is not very high. Water pollution problems are also not likely as the study area is devoid of industries.

4.2 IMPACTS ON PUBLIC HEALTH

The construction of dam may involve many diversified activities and require a large number of labors. The change in population density through immigrants/influx may cause new health problems in this region. People may carry different types of contagious diseases if any spread in locality. Influx of human work force may also bring stress on available drinking water sources and sanitary facilities. The additional domestic sewage generated may cause drinking water contamination resulting in spread of enteric diseases, if not taken proper precautionary measures.

The proposed project would lead to increase in the water spread area with corresponding increase in shoreline. This is expected to increase the incidence of malaria in project area and its surroundings. However, impacts on this account are not expected to be significant.

4.3 PUBLIC HEALTH DELIVERY SYSTEM

4.3.1 Control of malaria

The increase in water fringe area provides suitable habitats for the growth of vectors of various diseases and they are likely to increase the incidence of water-related diseases. Malaria is the water related major vector-borne disease. Thus, malaria control measures which aim at destroying the habitat and interrupting the life cycle by mechanical or biological or chemical means need to be implemented. Various Primary Health Centres in the nearby villages and Hospital at District Head Quarters can coordinate the anti-malarial operations in association with the project authorities.

The suggested measures are given in following paragraphs:

- The site selected for habitation of workers should not be in the path of natural drainage.
- Adequate drainage system to dispose storm water drainage from the labour colonies should be provided.
- Adequate vaccination and immunization facilities should be provided for workers at the construction site.
- The labour camps and resettlement sites should be at least 2 km away from a main water body or quarry areas.

4.3.2 Development of medical facilities

A population of about 11,200 is likely to congregate during the construction phase. The labour population will be concentrated at two or three sites. There is no medical facility in the immediate vicinity of the project area. It is recommended that necessary medical facilities be developed at the project site. It is recommended that the dispensary should be developed during project construction phase itself, so that it can serve the labour population migrating in the area as well as the local population.

The details of manpower, infrastructure requirement for this dispensary are given as below.

Manpower

Doctor : 1

Qualification : M.B.B.S./ M.D

2 doctors can be employed in the dispensary and will reside in the staff quarters adjacent to the dispensary. The para-medical staff required for assistance to these doctors is given in Table-4.1.

TABLE-4.1
Details of Para-medical staff for dispensary

Para medical staff	Number
Auxiliary Nurse	2
Male Multipurpose Health worker	2
Attendants	2
Driver	2
Total	10

Infrastructure

A building shall be constructed to provide basic preventive, promotive and curative services to the labour colony with facilities for maternal and child health services, control of communicable diseases and medical care for minors. The building should have a waiting hall where 30-40 people can sit. The building would have place for the following:

- Two rooms for doctors
- One room for staff
- Two rooms for stores
- One general ward to accommodate 10 beds
- One minor operation theater/ dressing room
- One garrage with space for three vehicle

Residential accommodation is to be provided to the essential staff in the campus.

Proposed Health Facilities at Construction sites and labour camp

It is possible that during the construction work, the technical staffs operating different equipment are 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, diarrhea, work exhaustion and other diseases. In addition they may invariably come up with injuries caused by accidents at work site. Under all circumstances, workers need immediate medical care.

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

- First aid box with essential medicines including ORS packets
- First aid appliances-splints and dressing materials
- Stretcher, wheel chair, etc.

Health Extension Activities

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 specially with respect to water pollution by domestic wastes. There would 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 would undertake the following tasks as a part of health promotional activities:

- Collect water samples to ascertain the portability 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.

4.4 COST ESTIMATES

The cost required for implementation of various public health measures shall be Rs. 22.27 million. The details are given in the following paragraphs:

A. Expenditure on salaries

Dispensary

Post	Number	Monthly Emoluments (Rs.)	Annual Expenditure (Rs.)
Doctors	1	30,000	360,000
Nurse	2	10,000	240,000
Male Multi-purpose Health Workers	2	10,000	240,000
Attendants	2	5,000	120,000
Drivers	2	5,000	120,000
Total			10,80,000

First Aid Posts

Health Assistants	2	10,000	2,40,000
Dressers	2	5,000	2,40,000
Total			4,80,000

Total Expenditure = Rs.15,60,000

B. Expenditure on Material and Supplies**Dispensary****Non-recurring**

i)	1 Vehicle (Closed Jeep) and	}	Rs. 20,00,000
ii)	Furniture, etc.		Rs. 1,50,000
iii)	Hospital equipment		Rs. 10,00,000
iv)	Ambulance 2 No. and their maintenance for five years		Rs.20,00,000

Total **Rs.51,50,000**

Recurring

i)	Drugs and Medicine,	Rs. 3,00,000/yr
ii)	Contingencies	Rs. 50,000/yr
iii)	2 First-Aid Posts at construction sites	Rs. 36,000/yr

Total **Rs. 3,86,000/yr**

Infrastructure

Dispensary: Considering the number of rooms, staff quarters and open space etc., it is estimated that 5000 sq.feet (i.e. 465 sq.meter) of plot will be required for dispensary, out of which about 4000 sq.feet (375 sq.meter) will be the built-up land which includes staff quarters, etc. The construction cost for RCC structure will be Rs.400/sq.feet excluding land cost. The cost of construction of Dispensary will be Rs.1.6 million. The project proponents can purchase the land from the State Government. An amount of Rs.0.3 million can be earmarked for this purpose.

2 First Aid Posts: These are of temporary nature and will be constructed with asbestos sheets, bamboo, etc. It will cost @ Rs.100,000/First Aid Post. The total cost for constructing First Aid Posts will be of the order of Rs.0.2 million.

The total cost for developing the infrastructure will be (Rs.1.6 + Rs.0.3 + Rs.0.2 million) Rs.2.1 million.

A. Recurring Expenditure

* Expenditure on salaries	:	Rs. 15,60,000/yr
* Expenditure on materials & supplies	:	Rs. 3,86,000/yr

Sub-Total **Rs. 19,46,000/yr**

Total expenditure for 6 years (A) : Rs. 15.02 million
(considering 10% escalation per year period)

B. Non-Recurring Expenditure

* Infrastructure (Construction of Dispensary & 2 First aid posts)	:	Rs. 2.10 million
* Expenditure on materials, supplies and: equipment	:	Rs. 5.15 million

Total (B) **Rs. 7.25 million**

Total A + B **Rs.22.27 million**

4.5 DISPOSAL OF BIO-MEDICAL WASTE

Dispensaries use a variety of drugs including antibiotics, cytotoxics, corrosive chemicals etc. a part of which is generated as a solid waste. With greater emphasis on disposables, the quantum of solid waste generated in a hospital is quite high. As per the Bio-Medical Waste (Management and Handling) Rules 1998, the bio-medical waste has been classified into various categories which are outlined in Table-4.2.

TABLE-4.2

Categories of bio-medical waste as per the Bio-Medical Waste (Management and Handling) Rules 1998

Waste Category No.	Waste category type
Category No. 1	Human Anatomical Waste Human tissues, organs, body parts
Category No. 2	Animal Waste Animal tissues, organs, body parts, carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals, colleges, discharge from hospitals, animal houses
Category No. 3	Micro-biology and Biotechnology wastes

Waste Category No.	Waste category type
	Wastes from laboratory cultures, stocks or specimens of micro-organisms, live or attenuated vaccines, human and animal cell culture used in research and infections agents from research and industrial laboratories, wastes from production of biologicals, toxins, dishes and devices used for transfer of cultures
Category No. 4	Waste sharps Needles syringes, scalpels, blades, glass, etc. that may cause punctures and cuts, including both used and unused drugs
Category No. 5	Discarded medicines and cytotoxic drugs Wastes comprising of outdated, contaminated and discarded medicines
Category No. 6	Soil Waste Items contaminated with blood and body fluids including cotton, dressings, soiled plaster casts, lines bleedings other material contaminated with blood.
Category No. 7	Solid Waste Wastes generated from disposable items other than the waste sharps, such as tubings, catheters, intravenous sets, etc.
Category No. 8	Liquid waste Waste generated from laboratory and washing, cleaning, house keeping and disinfecting activities
Category No. 9	Incineration Ash Ash from incineration of any bio-medical waste
Category No. 10	Chemical Waste Chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.

Out of the categories listed in Table-4.2, the biomedical waste categories to be to be generated in the dispensary proposed to be developed as a part of the project are given in Table-4.3.

TABLE-4.3
Categories of bio-medical waste to be generated
in the dispensary proposed to be developed as a part of the project

Waste Category No.	Waste category type
Category No. 1	Human Anatomical Waste Human tissues, organs, body parts
Category No. 4	Waste sharps Needles syringes, scalpels, blades, glass, etc. that may cause punctures and cuts, including both used and unused drugs
Category No. 5	Discarded medicines and cytotoxic drugs

Waste Category No.	Waste category type
	Wastes comprising of outdated, contaminated and discarded medicines
Category No. 6	Soil Waste Items contaminated with blood and body fluids including cotton, dressings, soiled plaster casts, lines bleedings other material contaminated with blood.
Category No. 7	Solid Waste Wastes generated from disposable items other than the waste sharps, such as tubings, catheters, intravenous sets, etc.
Category No. 8	Liquid waste Waste generated from laboratory and washing, cleaning, house keeping and disinfecting activities
Category No. 9	Incineration Ash Ash from incineration of any bio-medical waste
Category No. 10	Chemical Waste Chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.

The bio-medical waste must be segregated in accordance to the guidelines laid under Schedule-I of Bio-medical Waste (Management and Handling) rules notified by Ministry of Environment and Forests. The proposed colour coding and container for disposal are given in Table-4.4.

TABLE-4.4
Colour coding and type of container for disposal of Bio-medical waste

Colour coding	Type of container	Waste category
Yellow	Plastic bag	Category 1 and category 6
Red	Disinfected container/ plastic bag	Category 6 and category 7
Blue/white transparent	Plastic bag/ puncture proof container	Category 4 and category 7
Black	Plastic bag	Category 5, category 9 and category 10 (solid)

The treatment measures recommended for various categories of waste is outlined in Table-4.5.

TABLE-4.5
Recommended treatment measures of various categories of waste

Waste type	Recommended treatment
Category No. 1 – Human Anatomical wastes	Incineration
Category No. 4 – Waste sharps	Secured landfill
Category No. 5 – Discarded medicines and lytotoxic drugs	Secured landfill
Category No. 6 – Solid Waste	Incineration
Category No. 7 Solid Waste	Incineration
Category No. 8 – Liquid waste	Treatment through an Effluent Treatment Plant (ETP)
Category No. 9 – Incineration Ash	Secured landfill
Category No. 10 – Chemical waste	Secured land fill

It is proposed to treat the effluent generated from the dispensary in an Effluent Treatment Plant (ETP) prior to its disposal. The ETP shall comprise of the following units:

- Screen
- Grit chamber
- Equalization tank
- Neutralization tank
- Clari-floculator
- Activated carbon filter.
- Ozonator
- Guard pond

An amount of R.10.0 million has been earmarked for commissioning of the following :

- Incineration
- Secured landfill
- Effluent Treatment Plant (ETP)

4.6 BUDGET FOR PUBLIC HEATH DELIEVERY SYSTEM

The total budget earmarked for Public Health delivery system shall be Rs. 32.27 million. The details are given as below:

- Dispensary and First aid posts : Rs. 22.27 million
- Disposal of Bio-medical waste : Rs. 10.00 million
- Total : Rs. 32.27 million**

CHAPTER-5

ENVIRONMENTAL MANAGEMENT IN LABOUR CAMPS

5.1 INTRODUCTION

The aggregation of large number of works and technical labour in the project area during the construction of phase is likely to put considerable stress on the ecosystem of the area. The aim of the EMP is to minimize these stresses. It should be made mandatory for the contractor to provide adequate facilities at the labour camp which are described in the following sections.

5.2 PROVISION OF HEATING

The contractor can make a block of two large rooms in which about 30-40 workers can stay. Community toilets for each block can be constructed close by. During winter months, a central heating system can also be provided, otherwise, workers will be forced to cut trees to meet the fuel requirements to heat the water required for various uses.

5.3 PROVISION OF WATER SUPPLY

The water for drinking purpose is collected from the rivers or streams flowing upstream of the labour camps. The water is stored in tanks and supplied for use. The water quality in general is good and does not require any elaborate treatment. However, it is proposed to disinfect the water prior to distribution. The settlements/ labour camps shall be placed far from the drinking water sources.

5.4 SANITATION AND SEWAGE TREATMENT FACILITIES

One community latrine can be provided per 20 persons. The sewage from the community latrines can be treated in oxidation ditch. Each labour camp can be provided with an Aerated Lagoon. The treated effluent from oxidation ditch be disposed off in nearest water body. However, efforts shall be made to ensure, that treated effluent is disposed only in these water bodies, which are not used for meeting domestic water requirements.

The total construction time for the project is about 6 years. At peak construction phase, there will be an increase in population by 11,200. To ensure that the

sewage from the labour camps do not pollute the river water, it has been estimated that about 560 community latrines and a sewage treatment plant shall be constructed for treatment. The total cost required will be Rs. 20.8 million (refer Table-5.1).

TABLE- 5.1
Cost Estimate for sanitary facilities for labour camps

S. No.	Unit	Rate (Rs./unit)	Number	Cost (Rs. million)
1.	Community latrines	30,000	560	16.8
2.	Sewage Treatment Plant		-	4.0
	Total			20.8

5.5 SOLID WASTE MANAGEMENT FROM LABOUR CAMPS

The labour colony will be located at barrage site, powerhouse and at adit sites. During construction phase, about 3,000 labour and 500 technical staff is likely to congregate. The increase in population is expected to be of the order of 11,200. The solid waste likely to be generated from labour camps shall be of the order of 2.24 tonnes/day. Adequate facilities for collection, conveyance and disposal of solid waste need to be developed. The solid waste will be disposed at the designated landfill sites.

The landfill shall have is impervious clay as the bottom most layer. The second layer shall be impervious liner (Geomembrane), third layer is sand, after that well compacted solid waste is to be put over the sand, then again a layer of clay, finally a layer of soil. Some vegetation can be done at the top most layer. It will give a good aesthetic view of landfill.

Various aspects of solid waste management include:

- Refuse storage
- Collection and Transportation
- Disposal

a) Refuse storage

In the proposed project, labour camps are proposed to be located at two or three location. In each of the labour colony, provisions shall be made to separately store the degradable and non-degradable solid waste.

A solid waste collection truck will be commissioned to collect the solid waste. Efforts will be made to separately collect the degradable and non-degradable

solid waste. For this purpose workers will be provided with two separate dust bins to segregate the bio-degradable as well as non-biodegradable wastes. A sustained awareness programme will be conducted to educate workers about the segregation of degradable and bio-degradable wastes.

Disposal

The degradable portion of the solid waste would be disposed off at the muck disposal sites. The non- degradable portion such as plastic bottles, cans, etc. shall be segregated and disposed off at separate sites identified by the district administration.

Cost estimate

The total cost required for solid waste management is Rs.11.06 million. The details are given in Table-5.2.

TABLE-5.2
Cost estimates for solid waste management

S. No.	Item	Cost (Rs. million)
1	Two covered trucks for conveyance of solid waste to landfill site	3.00
2	Manpower cost for 12 persons @ Rs. 5000/ month for 6 years including 10% escalation/year	5.56
3	Reclamation and stabilization cost	2.00
4	Awareness programme	0.50
	Total	11.06

5.6 PROVISION OF FREE FUEL

As a part of EMP, following measures are proposed:

- make a clause mandatory in the contract of every contractor involved in project construction to provide supply of fuel to their labourers, so that trees are not cut for meeting their fuel demands.
- establish LPG godown within the project area for providing LPG cylinder to run community kitchens.
- establish kerosene oil depot near project area with the help of state government to ensure proper supply of kerosene oil.

ICCSL in association with the state government should make necessary arrangements for distribution of kerosene oil and LPG. These fuel would be supplied at subsidized rates to the local/contract laborers for which provision has been kept in the cost estimate.

The total cost required for provisions of fuel has been estimated as Rs. 95.96 million. The details are given in Tables 5.3 to 5.5.

TABLE-5.3**Cost estimate for LPG distribution**

Year	No. of Employees	Annual requirement @1cylinder per family per month (No. of cylinders)	Total Cost @Rs. 400/cylinder (Rs. million)
I	400	4800	1.92
II	500	6000	2.64
III	500	6000	2.90
IV	500	6000	3.19
V	500	6000	3.51
VI	500	6000	3.87
Total			18.03

TABLE-5.4**Cost estimate for Kerosene distribution**

Year	No. of labours	Quantity @15 litre per family per month (litre/yr)	Total Cost (Rs. million)
I	1500	270,000	5.40
II	3000	540,000	11.88
III	3000	540,000	13.07
IV	3000	540,000	14.38
V	3000	540,000	15.81
VI	3000	540,000	17.39
Total			77.93

TABLE-5.5**Cost estimate for provision of fuel**

S. No.	Fuel	Cost (Rs. million)
1.	LPG for technical staff	18.03
2.	Kerosene for labour population	77.93
	Total	95.96

5.7 BUDGET

A total provision of Rs. 127.82 million has been earmarked for implementation of various measures in labour camps. The details are given in Table-5.6.

TABLE-5.6

Cost estimate for implementation of various measures in labour camps

S. No.	Fuel	Cost (Rs. million)
1.	Sanitation facilities for labour camps	20.80
2.	Solid waste management in labour camps	11.06
3.	Fuel distribution in labour camps	95.96
	Total	127.82

5.8 IMPLEMENTING AGENCY

Various measures recommended in this chapter shall be included in the contract document of the contractor involved in construction activities. The implementation of these measures shall be monitored by the project proponents. However, the sites for disposal of treated effluent from sewage treatment plant and solid waste shall be identified in consultation with district administration.

CHAPTER-6
MUCK MANAGEMENT PLAN

6.1 INTRODUCTION

A large quantity of muck is expected to be generated as a result of tunneling operations, construction of roads, etc. Muck generated from excavation of any project component is required to be disposed in a planned manner so that it takes a least possible space and is not hazardous to the environment. The muck disposal sites cause increased sedimentation in the rivers (though insignificant compared to natural sedimentation) and totally spoils the visual aesthetics of the area. It is of prime importance that these sites will have to be rehabilitated as soon as the disposal sites are full.

6.2 MUCK GENERATION

The total quantity of muck expected to be generated has been estimated to be of the order of 4.061 Mm³. The component wise detail of muck to be generated are given in Table-6.1. Based on the geological nature of the rocks and engineering properties of the soil, a part of the muck can be used as construction material. However, the balance requires being suitably disposed. Normally, muck is disposed in low-lying areas or depressions. Trees, if any, are cut before muck disposal, however, shrubs, grass or other types of undergrowth in the muck disposal at sites perish. In the proposed project 0.4 Mm³ muck is proposed to be disposed at different sites.

TABLE-6.1
Component wise detail of muck to be generated

S. No.	Name of Component	Qty. Of Muck (excavated) (m ³)		
		Open Excavation	Underground Excavation	Total
1	River Diversions works	25,000		25,000
2	Diversion Barrage	407,350		407,350
3	Intake ,Sedimentation chambers & flushing conduits	650,900		650,900
4	HRT & Construction Adits	116,433	1,470,101	1,586,534
5	Surge Shaft	2,000	40,635	42,635
6	Pressure Shaft & Valve Chamber		106,267	106,267

S. No.	Name of Component	Qty. Of Muck (excavated) (m ³)		
		Open Excavation	Underground Excavation	Total
7	Power House Complex	37,712	279,094	316,806
8	TRT & outfall works	9,216	115,206	124,422
9	Road	546,225	234,225	780,450
	Total	1,794,836	2,245,528	4,040,364

6.3 DISPOSAL OF MUCK AND RECLAMATION OF MUCK DISPOSAL SITES

As per the existing proposal for the construction of Nyamjangchhu hydroelectric project about 4.04 Mm³ of muck is to be generated. The total quantity of muck to be generated considering 40% swelling factor is 5.66 Mm³. It is proposed that 0.702 Mm³ of muck shall be utilized for backfilling. The quantity of material to be used in construction or protection works 1.05 Mm³. Hence the balance quantity of muck to be disposed off shall be about 3.91 Mm³. The muck shall be disposed at designated sites. The details are given in Table-6.2.

TABLE-6.2
Details of muck utilization and disposal

S. No.	Name of Component	Qty. Of muck debris generated considering 40% as swelling factor (m ³)	Qty. to be used as backfill (m ³)	Qty. to be used in construction or protection works (m ³)	Qty. of Muck for disposal (m ³)
1	River Diversions works	35,000	35,000	-	-
2	Diversion Barrage	570,290	339,450	-	230,840
3	Intake ,Sedimentation chambers & flushing conduits	911,260	57,200	-	854,060
4	HRT & Construction Adits	2,221,148	270,000	475,960	1,475,188
5	Surge Shaft	59,689	-	17,907	41,782
6	Pressure Shaft & Valve Chamber	148,732	-	44,619	104,113

S. No.	Name of Component	Qty. Of muck debris generated considering 40% as swelling factor (m ³)	Qty. to be used as backfill (m ³)	Qty. to be used in construction or protection works (m ³)	Qty. of Muck for disposal (m ³)
7	Power House Complex	443,528	-	133,059	310,470
8	TRT & outfall works	174,191	-	52,257	121,934
9	Road	1,093,050	-	327,915	765,135
	Total	5,656,888	701,650	1,051,717	3,903,521

Normally, muck is disposed in low-lying areas or depressions. Trees, if any, are cut before muck disposal, however, shrubs, grass or other types of undergrowth in the muck disposal at sites perish. The total area earmarked for muck disposal is 69.1819 ha. The details are given in Table-6.3. The muck disposal sites are shown in Figure-6.1.

TABLE-6.3
Details of muck disposal site

Component	Village	Land Classification		Total Land (ha)
		Private Land (ha)	Community Land (ha)	
Muck disposal Site M-1	Muchat	0	7.459	7.459
Muck disposal Site M-2	Kyaley teng	0	8.659	8.659
Muck disposal Site M-3	Shakti	0	1.9571	1.9571
Muck disposal Site M-4	Shakti (BTK)	0	2.9283	2.9283
Muck disposal Site M-5	Shakti (BTK)	0	8.0694	8.0694
Muck disposal Site M-6	BTK	0	4.7789	4.7789
Muck disposal Site M-7	BTK	0	5.767	5.767
Muck disposal Site M-8	Shakti (BTK)	0	2.8847	2.8847
Muck disposal Site M-9	Sherbang	0	3.2569	3.2569
Muck disposal Site M-10	Sherbang	0	4.415	4.415
Muck disposal Site M-1	Sherbang	0	3	3

Component	Village	Land Classification		Total Land (ha)
		Private Land (ha)	Community Land (ha)	
Muck disposal Site M-12	Kherteng	0	3.9238	3.9238
Muck disposal Site M-13	Kumba	0	6.6	6.6
Muck disposal Site M-14	Kumba	0	2.5898	2.5898
Muck disposal Site M-15	Muchat	0	7.459	7.459
Total		-	69.1819	69.1819

The dumping of muck will be done in the scientific manner by providing appropriate protection walls with deep foundations so that muck will not flow and washed away in the river. Masonry work, crate work and check dam will also be provided wherever necessary in order to avoid the chances of soil erosion and to ensure flow of silt, free water. Besides these engineering measures, proper plantation will be done at the dumping sites for reclamation of the dumping areas.

Muck generally lacks nutrients and therefore, are difficult to re-vegetate. However, if no attempts to vegetate the slopes are made, the muck could slide lower down during rain and may eventually wash off the check dams also. Since, top soils are not available in large quantities in Himalayas, it may not be possible to apply a thin layer of soil over the muck. Bio-fertiliser technique developed by National Environmental Engineering Research Institute (NEERI) can be adopted in the proposed project. NHPC has successfully used this technique in Uri hydroelectric project. Similar approach can be utilized in the proposed project as well. In this process, the unused excavated material is piled and stacked with proper slopes at the designated muck disposal sites. The slopes are broken up by creating benches across them. This is done to provide stability to the slopes and also to provide ample space for planting of trees that would further help in holding and consolidating biotechnological approach. The traditional methods of afforestation of these areas would be supplemented with the use of fungus, i.e. Vesicular Arbuscular Mycorrhizae (VAM) and nitrogen fixing bacteria that form partnership with plant roots. These grow on plant roots and provide water and nutrition especially phosphorus to plants at faster rate. The seeding of plants would be inoculated with VAM and nitrogen fixing bacteria before planting. It has

been found that plants inoculated with bio-fertilizers grow at faster rate especially in the medium where the soil/rock is devoid of nutrients.

The afforestation with suitable plant species shall be done. The species to be planted shall be decided by the forest Department, state government of Arunachal Pradesh.

6.4 BUDGET

The total expenditure required for stabilization of muck disposal sites has been estimated to be of the order of Rs.55.13 million. The details are given in Table-6.4.

TABLE-6.4
Break-up of cost for stabilization of muck disposal sites

S. No.	Items	Cost (Rs. million)
1	Construction of check dams along river banks @ Rs. 2.0 million/km for a stretch of 12.0 km.	24.00
2	Preparation of muck disposal site@ Rs. 0.1 million/ha for 69.18 ha	6.92
3	Provision of 15 cm soil layer over an area of 69.18 ha @ Rs. 0.2 million/ha	13.84
4	Development of vegetation over an area of 69.15 ha@ Rs. 150,000/ha	10.37
	Total	55.13

CHAPTER-7

RESTORATION AND LANDSCAPING OF CONSTRUCTION SITES

7.1 INTRODUCTION

The landscape and restoration plan targets towards overall improvement in the condition of the area. The landscape plan provides benefits to improve beautification and its utility. All the activities are aimed at restoring the areas where scars would be formed. The restoration would prevent soil erosion enhance forest cover and stabilize degraded areas.

7.2 QUARRYING OPERATIONS

A project of this magnitude would require significant amount of construction material.

- Concrete and Shotcrete Volume : 8,75,000 m³
- Fine Aggregate : 2,75,000 m³
- Coarse Aggregate : 5,25,000 m³

The above construction material shall be arranged from the identified quarry site near Gorsam and major portion from the excavated muck of the HRT between Zimithang and BTK. The quantities from the HRT excavated muck and quarry site is estimated to contribute about 10,00,000 m³ and 5,00,000 m³ (30% swelling factor) respectively for the requirement of coarse aggregate. Fine aggregate requirement shall be met locally from the river bed and crushed sand. The quantity of aggregate in the Gneissic terrain would be more than the required quantities and the test report also suggests the suitability of the same.

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

River Bed Material for Aggregates

For the construction purpose river bed materials shall be utilized and for that two locations are identified on the downstream of the barrage. One location is near to the Zimithang village where there is a natural blockade of river due to previous

floods. There big sized boulders of gneiss of about 30-40m length are observed. These boulders can be used for the construction material. Another location is near to the BTK nala and it is also a natural blockade which is formed in past few years. The boulders are larger in the river bed and can be utilized for construction material. The rocks from the quarries were found to be suitable for the use as coarse aggregate and crushed sand in concrete for non-wearing and wearing surfaces.

During the construction phase a large quantity of construction material like stones, pebbles, gravel and sand would be needed. Significant amount of material is available in the river bed. It is proposed to extract construction material from borrow areas in the river bed. The extraction of construction material may affects the river water quality due to increase in the turbidity levels. This is mainly because the dredged material gets released during one or all the operations mentioned below:

- excavation of material from the river bed.
- loss of material during transport to the surface.
- overflow from the dredger while loading
- loss of material from the dredger during transportation.

The cumulative impact of all the above operations is increase in turbidity levels. Good dredging practices can however, minimize turbidity. It has also been observed that slope collapse is the major factor responsible for increase in the turbidity levels. If the depth of cut is too high, there is possibility of slope collapse, which releases a sediment cloud. This will further move outside the suction radius of dredged head. In order to avoid this typical situation, the depth of cut be restricted to:

$$\gamma H/C < 5.5$$

where,

γ	-	unit weight of the soil
H	-	depth of soil
C	-	Cohesive strength of soil

Sand quarries

In the project area there are few locations from where sand of coarse and fine segments can be extracted. Tests have been done to assess the suitability of sand in the Zimithang area, BTK area & Namtsering area. All the locations are in the river banks and nearby. The quantity of the river borne sand is not sufficient for

the construction of the project and thus to be collected or transported from other locations.

7.3 RESTORATION PLAN FOR QUARRY SITE AND BORROW AREA

The measures adopted for landscaping of these quarry sites have been described below:

i) Measures to be adopted before quarrying

The top 6-12" of soil will be removed before starting the quarrying activity or any other surface disturbance. This top soil will be kept separate and stock piled so that it can be reused after quarrying is over for rehabilitation of sites.

ii) Measures to be adopted after quarrying

Diversion of run off

Effective drainage system will be provided to avoid the infiltration of run-off and surface waters into the ground of quarry sites. Garland drains around quarry site shall be constructed to capture the runoff and divert the same to the nearest natural drain.

Filling of depressions

Removal of rocks from quarry sites for different construction works will result in the formation of depression and/or craters. These will be filled by the dumping materials consisting of boulders, rock, gravel and soil from nearby plant/working sites.

Construction of retaining walls

Retaining walls will be constructed at the filled up depressions of quarry sites to provide necessary support particularly where there are moderately steep slopes. In addition concrete guards, shall be constructed to check the soil erosion of the area.

Rocks for landscaping

After the quarrying activities are over, these sites will be splattered with the leftovers of rocks and boulders. These boulders and rocks can support the growth of mosses and lichens, which will act as ecological pioneers and initiate the process of succession and colonization. The boulders of moderate size will be used to line the boundary of a path.

Laying of the top soil

The depressions/craters filled up with rock aggregates will be covered with top soil. Fungal spores naturally present in top soil will aid plant growth and natural

plant succession. The top soil will be further enriched by organic manure and Vesicular-arbuscular mycorrhizal (VAM) fungi. This will help in the process of soil reclamation and the early establishment of juvenile seedlings.

Revegetation

The work plan formulated for revegetation of the dumping sites through 'Integrated Biological and Biotechnological Approach' would be based upon the following parameters:

- i) Evaluation of rock material for their physical and chemical properties to assess the nutrient status to support vegetation.
- ii) Formulation of appropriate blends of organic waste and soil to enhance the nutrient status of rhizosphere.
- iii) Isolation and screening of specialized strains of mycorrhizal fungi, rhizobium, azotobacter and phosphate solubilizers (bio-fertilizers inoculums) suitable for the mined out sites.
- iv) Mass culture of plant specific biofertilizer and mycorrhizal fungi to be procured from different institutions/organisations which are engaged in the phyto-remediation activity of degraded areas.
- v) Plantation at quarry sites/areas using identified blend and biofertilizer inoculum.

A provision of 11.05 million has been earmarked for quarry slope stabilization. The details are given in Table-7.1.

TABLE-7.1
Cost estimate for restoration of quarry site and borrow area

S. No.	Activities/purpose	Cost (Rs. million)
1.	Filling up the land with soil	0.50
2.	Cost of green manure	0.50
3.	Cost of sapling (10,000 saplings/ha)	0.50
4.	Cost of fertilizers and pesticides	1.00
5.	Fencing with RCC pillars and barbed wire	3.00
6.	Maintenance activities including cleaning of weeds @ Rs.50,000 for 5 years	3.05
7.	Digging of pits	0.50
8.	Construction of garland drains	2.00
	Total	11.05

7.4 LANDSCAPING AND RESTORATION PLAN

Area for landscaping

The working area of dam site, power house complex colony area have been selected for beautification of the project area after construction is over. The reservoir created due to the construction of dam may be a local point of tourist attraction. This could be used for sport fishing, so there is a need to construct benches for sitting, development of resting sheds and footpath. The beautification would be carried out by developing flowering beds for plantation ornamental plant and flower garden.

There would be sufficient open space in power house complex and colony area. Forested area in the power house complex would provide aesthetic view and add to natural seismic beauty. The beautification in the colony area would be carried out by development of flowering beds for plantation of ornamental plant, creepers, flower garden and a small park, construction of benches for sitting, resting sheds, walk way and fountain.

A provision of Rs.5.0 million has been earmarked for landscaping and beautification of the area.

7.5 BUDGET

A total provision of (11.05 + 5.00) Rs. 16.05 million has been earmarked for Restoration of quarry and borrow area, reclamation of construction sites landscaping and beautification.

CHAPTER-8**ENVIRONMENTAL MANAGEMENT IN ROAD CONSTRUCTION****8.1 INTRODUCTION****Project Roads**

A network of new roads is required to facilitate completion of the project as per anticipated time schedule. Major components like Barrage, Power House, Surge Shaft and Permanent Colonies for the project near village Kharteng and Zimithang will require have to be interconnected by construction of new roads on the left bank. A bridge has to be constructed across river Nyamjang Chhu upstream of the existing BTK bridge to approach adits to HRT from the existing road on right bank. The total length of new roads to be constructed has been estimated as 60.0 km. The details are given in Table-8.1.

TABLE-8.1**Details of roads to be constructed as a part of the project**

Connecting details	Length (km)
Length of road to reach various adits and other project components	54.5
Length of road from existing road to Power House	2.5
Length of internal road from existing road at Barrage on Right bank and new Road on Left bank.	3.0
Total	60.0

Apart from the above major roads, about 20 km of road network will be required for approach to the various muck dumping yards. Thus, 50 km of new road will have to be constructed as a part of the project. About 40 km of existing roads in the project area from Tawang to Zimithang may require strengthening and widening including bridges and cross drainage works.

For transporting major equipment such as turbines, generators, main transformers, spherical valves, etc, road link is available up to project site from other locations of India through Assam.

8.2 IMPACTS DUE TO CONSTRUCTION OF ROADS

The construction of roads can lead to the following impacts:

- The topography of the project area has steep slope, which descends rapidly into narrow valleys. The conditions can give rise to erosion hazards due to net downhill movement of soil aggregates.

- Removal of trees on slopes and re-working of the slopes in the immediate vicinity of roads can encourage landslides, erosion gullies, etc. With the removal of vegetal cover, erosive action of water gets pronounced and accelerates the process of soil erosion and formation of deep gullies. Consequently, the hill faces are bared of soil vegetative cover and enormous quantities of soil and rock can move down the rivers, and in some cases, the road itself may get washed out.
- Construction of new roads increases the accessibility of a hitherto undisturbed areas resulting in greater human interferences and subsequent adverse impacts on the ecosystem.
- Increased air pollution during construction phase.

8.3 MANAGEMENT MEASURES

The approach roads will have to be constructed as a part of the access to the construction site. In a hilly environment, construction of roads sometime disturbs the scenic beauty of the area. In addition, landslides are often triggered due to road construction because of the loosening of rocks by water trickling from various streams.

Steeply sloping banks are liable to landslides, which can largely be controlled by provision of suitable drainage. The basic principle is to intercept and divert as much water as possible, before it arrives at a point, where it becomes a nuisance. The other erosion hazard is that of surface erosion of the bank, which is best controlled by vegetation. However, in a steeply sloping terrain, difficulty lies in growing vegetation on steeply sloping banks. Engineering solutions such as surface drainage, sub-surface drainage, toe protection and rock bolting can be used. Landslides can be stabilized by several methods-engineering or bioengineering measures alone or a combination of these. The cost required for implementation of various measures has already been incorporated in the overall budget earmarked for construction of roads.

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. The stripped muck is generally cleared by dumping the material along the slopes. These dumped material finally flow down to the valleys and ultimately finds its way to the river. However, it is recommended to adopt a more systematic approach. The stripped material should be collected and dumped in the designated muck disposal area, which will have check dams to prevent the muck to flow down into

the river. After disposal operation is complete at the dump site, the dump yard should be contoured and vegetated.

The various aspects to be considered while making the project roads are briefly described in the following paragraphs.

Construction

- Area for clearing and grubbing shall be kept minimum subject to the technical requirements of the road. The clearing area shall be properly demarcated to save desirable trees and shrubs and to keep tree cutting to the minimum.
- Where erosion is likely to be a problem, clearing and grubbing operations shall be so scheduled and performed that grading operations and permanent erosion control of features can follow immediately thereafter, if the project conditions permit; otherwise temporary erosion control measures shall be provided between successive construction stages. Under no circumstances, however, should very large surface area of erodible earth material be exposed at any one time by clearing and grubbing.
- The method of balanced cut and fill formation shall be adopted to avoid large difference in cut and fill quantities.
- The cut slopes shall be suitably protected by breast walls, provision of flat stable slopes, construction of catch water and intercepting drains, treatment of slopes and unstable areas above and underneath the road, etc.
- Where rock blasting is involved, controlled blasting techniques shall be adopted to avoid over-shattering of hill faces.
- Excavated material should not be thrown haphazardly but dumped duly dressed up in a suitable form at appropriate places where it cannot get easily washed away by rain, and such spoil deposits may be duly trapped or provided with some vegetative cover.

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 negotiated, check dams with silting basins shall be constructed and that soil is not eroded and carried away by high velocity flows.
- Location and alignment of culverts should also be so chosen as to avoid severe erosion at outlets and siltation at inlets.

Grassing and Planting

- Tree felling for road construction/works should be kept bare minimum and strict control must be exercised in consultation with the Forest Department. Equivalent amount of new trees should be planted as integral part of the project within the available land and if necessary, separate additional land may be acquired for this purpose.
- Depending on the availability of land and other resources, afforestation of roadside land should be carried out to a sufficient distance on either side of the road.

8.4 BUDGET

An amount of Rs. 120.0 million has been earmarked for implementation of measures to mitigate adverse impacts due to construction of roads. The details are given in Table-8.2.

TABLE-8.2

Details of expenditure for implementation of measures for management of Impacts due to construction of roads

S. No.	Item	Cost (Rs. million)
1.	Clearing @Rs.0.1million per km for 60 km	6.0
2.	Provision of breast walls, construction of catch water and interceptor drains @Rs.1.0 million per km for 60 km	60.0
3.	Provision of drainage system along roads @Rs.0.8 million per km for 60 km	48.0
4.	Roadside plantation, Jute matting etc. @ Rs.0.1million per km for 60 km	6.0
	Total	120.0

CHAPTER-9

GREENBELT DEVELOPMENT PLAN

9.1 INTRODUCTION

The greenbelt development plan aims to overall improvement in the environmental conditions of the region. The plan with a five-fold objective addresses issues such as prevention of land degradation due to activities during construction phase; enhancing the forest cover for increasing the biodiversity of the region; providing aesthetic value to the project area and consequently inviting a proportionate tourist flux; enhancing the ecological equilibrium of the area; and to a large proportion in combating soil erosion. Although the forest loss due to reservoir submergence and other project appurtenances have been compensated as a part of compensatory afforestation. It is proposed to develop greenbelt around the periphery of various project appurtenances, selected stretches along reservoir periphery.

9.2 NEED FOR GREENBELT DEVELOPMENT PLAN

The green belt on either side of the reservoir will reduce the sedimentation and ensure protection of the reservoir area from any other human activity that could result in the reservoir catchment damage. On moderately steep slopes tree species will be planted for the creation of green belt which are indigenous, economically important, soil binding in nature and an thrive well under high humidity and flood conditions.

9.3 SCHEME FOR GREENBELT DEVELOPMENT

The scheme of plantation around the reservoir is given as follows:

- i) The green belt will start from the immediate vicinity of the reservoir rim on both the banks, up to the tail of the reservoir moderately steep slopes are available for plantation.
- ii) The width of the green belt will be around 50 m or as physiographic and land features allow. There would be at least 2-3 layers of plantation.
- iii) The green belt will be put under a protective regulatory framework to ensure that it is not degraded or disturbed. No ecologically disruptive activity will be allowed in this zone.

9.4 BUDGET

The plantations would be carried out on an approximate area of 20 ha. This work would be completed in two years at an estimated cost of Rs.1.4 million at the

rate of Rs.70,000/- per ha which includes the cost of nursery creation, advance works, actual plantations and maintenance. The plantation for this purpose will be carried out by Forest Department, state government of Arunachal Pradesh.

CHAPTER-10

CONTROL OF AIR POLLTION

10.1 IMPACTS ON AIR QUALITY

In a water resources project, air pollution occurs mainly during project construction phase. The major sources of air pollution during construction phase are:

- Fuel combustion in various construction equipment, e.g. crushers, drillers, rock bolters, diesel generating vehicles, etc.
- Fugitive emissions from crusher
- Impacts due to vehicular movement

a) Pollution due to fuel combustion in various equipment

The operation of various construction equipment requires of combustion of fuel. Normally, diesel is used in such equipment. The major pollutant, which gets emitted as a result of diesel combustion, is SO₂. The SPM emissions are minimal due to low ash content. Based on past experience in similar projects, SPM and SO₂ are not expected to increase significantly. Thus, in the proposed project, no significant impact on ambient air quality is expected as a result of operation of various construction equipment.

b) Emissions from crusher

The operation of the crusher during the construction phase is likely to generate fugitive emissions, which can move even up to 1 km in predominant wind direction. During construction phase, one crusher of 60 tph capacity is likely to be commissioned. During crushing operations, fugitive emissions comprising of the suspended particulate will be generated. There could be marginal impacts to settlements close to the sites at which crusher is commissioned. However, based on past experience, adverse impacts on this account are not anticipated. However, during finalizing the project layout, it should be ensured that the labour camps, colonies, etc. are located on the leeward side and outside the impact zone (about 1.5 to 2 km) of the crushers.

c) Impacts due to vehicular movement

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 the movement of trucks and other heavy vehicles. However, such ground level emissions do not travel for long distances. Thus, no major adverse impacts are anticipated on this account.

10.2 MITIGATION MEASURES

a) Control of Emissions

Minor air quality impacts will be caused by emissions from construction vehicles, equipment and DG sets, and emissions from transportation traffic. Frequent truck trips will be required during the construction period for removal of excavated material and delivery of select concrete and other equipment and materials. The following measures are recommended to control air pollution:

- The contractor will be responsible for maintaining properly functioning construction equipment to minimize exhaust.
- Construction equipment and vehicles will be turned off when not used for extended periods of time.
- Unnecessary idling of construction vehicles to be prohibited.
- Effective traffic management to be undertaken to avoid significant delays in and around the project area.
- Road damage caused by sub-project activities will be promptly attended to with proper road repair and maintenance work.

b) Air Pollution control due to DG sets

The Central Pollution Control Board (CPCB) has issued emission limits for generators upto 800 KW. The same are outlined in Table-10.1, and are recommended to be followed.

**TABLE-10.1
Emission limits for DG sets prescribed by CPCB**

Parameter	Emission limits (gm/kwhr)
NOx	9.2
HC	1.3
CO	2.5
PM	0.3
Smoke limit*	0.7

Note : * Light absorption coefficient at full load (m⁻¹)

The above standards needs to followed by the contractor operating the DG sets. The other measures are recommended as below:

- Location of DG sets and other emission generating equipment should be decided keeping in view the predominant wind direction so that emissions do not effect nearby residential areas.
- Stack height of DG sets to be kept in accordance with CPCB norms, which prescribes the minimum height of stack to be provided with each generator set to be calculated using the following formula:

$$H = h + 0.2 \times \sqrt{\text{KVA}}$$

H = Total height of stack in metre

h = Height of the building in metres where the generator set is installed

KVA = Total generator capacity of the set in KVA

c) Dust Control

The project authorities will work closely with representatives from the community living in the vicinity of project area to identify areas of concern and to mitigate dust-related impacts effectively (e.g., through direct meetings, utilization of construction management and inspection program, and/or through the complaint response program). To minimize issues related to the generation of dust during the construction phase of the project, the following measures have been identified:

- Identification of construction limits (minimal area required for construction activities).
- When practical, excavated spoils will be removed as the contractor proceeds along the length of the activity.
- When necessary, stockpiling of excavated material will be covered or staged offsite location with muck being delivered as needed during the course of construction.
- Excessive soil on paved areas will be sprayed (wet) and/or swept and unpaved areas will be sprayed and/or mulched. The use of petroleum products or similar products for such activities will be strictly prohibited.
- Contractors will be required to cover stockpiled soils and trucks hauling soil, sand, and other loose materials (or require trucks to maintain at least two feet of freeboard).
- Contractor shall ensure that there is effective traffic management at site. The number of trucks/vehicles to move at various construction sites to be fixed.
- Dust sweeping - The construction area and vicinity (access roads, and working areas) shall be swept with water sweepers on a daily basis or as necessary to ensure there is no visible dust.

10.3 IMPLEMENTING AGENCY

Various management measures needs to be implemented for Control of air pollution control need to be included in the Tender Document for the Contractor involved in construction activities. The same shall be monitored on a regular basis by the project proponents.

CHAPTER-11

MEASURES FOR NOISE CONTROL

11.1 IMPACTS ON NOISE LEVELS

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

11.2 MITIGATION MEASURES

The contractors 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.

- vehicles to be equipped with mufflers recommended by the vehicle manufacturer.
- staging of construction equipment and unnecessary idling of equipment within noise sensitive areas to be avoided whenever possible.
- notification will be given to residents within 100 m of major noise generating activities. The notification will describe the noise abatement measures that will be implemented.
- monitoring of noise levels will be conducted during the construction phase of the project. In case of exceeding of pre-determined acceptable noise levels by the machinery will require the contractor(s) to stop work and remedy the situation prior to continuing construction.

The following Noise Standards for DG sets are recommended for the running of DG sets during the construction:

- The maximum permissible sound pressure level for new diesel generator sets with rated capacity upto 1000 KVA shall be 75 dB(A) at 1 m from the enclosure surface.
- Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
- The Acoustic Enclosure should be made of CRCA sheets of appropriate thickness and structural/ sheet metal base. The walls of the enclosure should be insulated with fire retardant foam so as to comply with the 75

dBA at 1m sound levels specified by CPCB, Ministry of Environment & Forests.

- The acoustic enclosure/acoustic treatment of the room should be designed for minimum 25 dB(A) Insertion Loss or for meeting the ambient noise standards, whichever is on the higher side.
- The DG set should also be provided with proper exhaust muffler.
- Proper efforts to be made to bring down the noise levels due to the DG set, outside its premises, within the ambient noise requirements by proper siting and control measures.
- A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

Noise due to crusher

Based on literature review, noise generated by a crusher is in the range of 79-80 dB(A) at a distance of 250 ft or about 75 m from the crusher. Thus, noise level at a distance of 2 m from the crusher shall be of the order of 110 dB(A). The exposure to labour operating in such high noise areas shall be restricted upto 30 minutes on a daily basis. Alternatively, the workers need to be provided with ear muffs or plugs, so as to attenuate the noise level near the crusher by atleast 15 dB(A). The exposure to noise level in such a scenario to be limited upto 4 hours per day.

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 that the exposure period of affected persons be limited as specified in Table-11.1.

TABLE-11.1**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

CHAPTER-12

WATER POLLUTION CONTROL

12.1 CONTROL OF WATER POLLUTION DURING CONSTRUCTION PHASE

During project construction phase, sufficient measures need to be implemented to ameliorate the problem of water pollution from various sources. The sewage generated from various labour camps should be treated in septic tanks and disposed by discharging into nearest water body. However, efforts shall be made to discharge the treated effluent only in these water bodies, which are not used for meeting domestic water requirements.

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 needs to be treated before disposal. Settling tanks of appropriate size for treatment of effluent from various crushers should be provided.

During tunneling work the ground water flows into the tunnel along with construction water, which is used for various works like drilling, shortcreting, 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. As per DPR, 6 adits shall be required for the tunneling work. Thus, effluents are expected to be generated from 2 to 3 locations. 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 could also be used as cover material for landfill disposal site. An amount of Rs. 1.8 million needs to be earmarked for construction of various settling tanks.

12.2 CONTROL OF WATER POLLUTION DURING OPERATION PHASE

In the project operation phase, a plant colony with 50 quarters is likely to be set up. It is recommended to provide a suitable Sewage Treatment Plant (STP) to treat the sewage generated from the colony. The cost required for construction of sewage STP in the project colony has already been covered in the budget earmarked for construction of the project colony. Hence, the cost for the same has not been included in the cost for implementing EMP.

CHAPTER-13

RESETTLEMENT AND REHABILITATION PLAN

13.1 GENERAL

Most often, development projects are planned based on the availability of exploitable natural resources. Upon commissioning these act on growth foci. This attracts flow of finances, investments, jobs and other livelihood opportunities, which brings in people from different cultural and social background. Such planned activities not only provide impetus to the local economy but also bring about a multi-dimensional economic, social and cultural change. Most often it has been observed that such development projects are commissioned in economically and socially backward areas, which are inhabited by some of the indigenous populations. Commissioning of development project invariably brings about a number of desired and undesired impacts along with it.

The Nyamjangchhu Hydro-electric Project (NHEP) is located in a backward area. A detailed social economic study was undertaken to understand the overall social and economic status of the project affected families residing in the project affected villages. This comprehension would help planners to make an assessment of the likely overall impacts of the proposed project on socio-economic aspects.

13.2 STUDY OBJECTIVES

The main aim of the study is to assess the socio-economic status of the project affected villages/ families/ persons, and subsequently to prepare Resettlement and Rehabilitation Plan for the Project Affected Families (PAFs) affected by the Nyamjangchhu Hydroelectric Project. More specifically, the objectives of the study are to:

- Undertake a survey of the affected villages and population, i.e. villages falling within the submergence area and the working area of the project.
- Understand various socio-economic aspects of the affected population viz., profile of the affected villages, demographic characteristics and socio-economic conditions.
- Formulate a Resettlement and Rehabilitation package for the project affected families.

13.3 STUDY APPROACH AND METHODOLOGY

The proposed Nyamjangchhu hydro-electric project is located amidst a socially and economically backward and sensitive indigenous tribal community, viz., *Morpa* of Arunachal Pradesh. A detailed socio-economic study was undertaken to understand the overall social and economic status of the PAFs, their life-style and to assess the likely impacts of the project in terms of loss of personal and community property of the PAFs as well as the changes that are foreseen in the social, cultural and economic environment of the PAFs due to the proposed Nyamjangchhu Hydro-electric Project.

Household-level Schedules were used to conduct the socio-economic survey. The information on following socio-economic parameters was collected:

- Village profile
- Demographic profile
- Educational levels
- Occupational Profile
- Land holding pattern
- Assets owned
- Livestock and other socio-economic parameters etc.

After the completion of the field survey, the schedules were cleaned of their internal discrepancies. Thereafter the schedules were coded and fed into computer for analysis. The keyed information/ data were then analyzed. Based on the results and opinions of the affected population (as captured through the schedules), the R&R Plan has been prepared. The state of Arunachal Pradesh does not have its own state-level resettlement and rehabilitation policy/ guidelines. However, recently the Governor of Arunachal Pradesh, vide Notification No. LM – 20/2005 dated 2nd Sep. 2005 has adopted the National Policy on Resettlement and Rehabilitation for Project Affected Families – 2007 (NRRP – 2007) for the state of Arunachal Pradesh with effect from 2nd September 2005. In view of this development, the National Policy on Resettlement and Rehabilitation for Project Affected Families – 2007 (NRRP – 2007) has been used to prepare the resettlement and rehabilitation plan for the PAFs of Nyamjangchhu hydro-electric project.

13.4 PROJECT AFFECTED FAMILIES

A census survey of the project affected families/ population was carried-out. This section gives an overall summary of the socio-economic conditions of the affected population residing in the affected villages. In all there are 5 villages, namely, Khaleteng, Kharteng, Kungba, Lumla and Soksen, in which various

project appurtenances are proposed, as a result of land acquisition would be carried-out in these villages for the project.

It was observed during survey work that the total number of families in the 3 project affected villages are:

- Khaleteng : 4
- Kharteng : 12
- Soksen : 31
- **TOTAL : 47**

13.5 RESETTLEMENT & REHABILITATION PRINCIPLES

The State Government of Arunachal Pradesh has its own Rehabilitation Policy – State Rehabilitation and Resettlement Policy 2008, which was promulgated as per notification LM-20/2005 dated 20th September 2008. The National Policy on Resettlement and Rehabilitation for Project Affected Families – 2007 (NRRP – 2007) which has been formulated by the Department of Land Resources, Ministry of Rural Development. The guidelines of NRRP – 2007 and the State R&R Policy have been followed, and which ever guidelines were higher have been used for the preparation of Resettlement and Rehabilitation Plan for the PAFs of Nyamjangchhu hydroelectric project.

An R&R Plan provides a broad conceptual and ideological framework for rehabilitation and resettlement. It provides prerequisite data (group-wise and area-wise), on which a Rehabilitation Action Plan (RAP) can be based. The Plan provides concepts, principles and framework as well as projections for various alternatives of rehabilitation. It tries to understand and describe the general socio-economic dynamics of the population to be displaced. Moreover, it gives order of expenditure for the implementation of R&R measures. A Rehabilitation Master Plan is essential because of the following factors:

- Improper compensation is the root cause of discontentment and alienation amongst the project affected population;
- Land is acquired for a development project, but the displacement is involuntary. PAFs often face forcible eviction and have no choice, but to accept the new social set-up.
- Rural environment is often transformed to semi-urban environment within a short period of time. This leads to a rise in the cost of living, while the scope of income from traditional sources of living is

likely to be reduced. Thus, PAFs find it difficult to make both ends meet in the new setting.

The objectives of the Rehabilitation and Resettlement Plan (RMP) are to:

- Provide assistance and other support to the PAFs so that they regain their previous standard of living, if not improve, within a reasonable transition period.
- Pay compensation for loss of land, houses and all other immovable properties to the PAFs as per the Land Acquisition Act (LAA). This is done primarily as there is no other National Law under which Project authority can acquire land for the construction of projects. Besides, the Land Acquisition Act, 1894 has laid down certain norms for compensation for acquisition of private property.
- Improve the quality of life, activities connected with primary education, primary health care, women and child welfare, care of the aged & destitute can be organized.
- Assist the PAFs in regaining their economic status in the initial stages in such a way that they can sustain on their own and do not have to depend on the project authorities for long. The project authorities can slowly phase-out their assistance and leave the PAFs to depend on their own economic activities and social lifestyle.

13.6 RESETTLEMENT AND REHABILITATION INTERVENTIONS

The process of R&R has two distinct components namely resettlement and rehabilitation. Resettlement primarily involves the physical relocation of the affected population to a new residential site. Rehabilitation on the other hand means to assist the affected population so that every individual could regain and/or improve him/her life and socio-economic status after displacement. Imparting skills and/or vocations to the PAPs primarily is undertaken in this.

Resettlement and Rehabilitation involves the following interventions:

- Acquisition of land and homestead plots would have to be compensated in accordance with the Land Acquisition Act, 1894 and provisions laid in the NRRP-2007
- Resettlement involves provision of alternate housing site along with amenities and facilities. Also, assistance is given to the PAFs while

shifting to these sites. The intervention for Resettlement broadly includes:

- Provision of Houses, Housing plot, Construction assistance etc.
 - Assistance to PAFs for shifting to new sites
 - Provision of essential Civic Amenities and Services.
- The Rehabilitation package is conceptualized around a development strategy to bring about a positive socio-economic transformation of the PAFs, so as to improve the quality of their life. This is done primarily through the following measures:
- Provision of alternate land/ job/ vocational training
 - Opportunities to avail the facilities of training in various trades

In line with the R&R interventions mentioned above the following measures are suggested for each of the components, in the following paragraphs.

13.7 ESTIMATION OF AFFECTED LAND & PAFs

The total land required for the project is 254.5526 ha. The details are given in Table-13.1.

TABLE-13.1
Ownership status of land to be acquired for Nyamjang chhu hydroelectric project

S. No.	Type of land	Area (ha)
1	Private land	10.0829
2	Community land	244.4697
	Total	254.5526

As per our survey, it was observed that the locals are aware and know about the physical location and extent of their lands within their village. However, they have never measured and quantified their lands. During survey it was observed that the farmers did not have even a vague idea about the extent (measure) of their land. Thus it was impossible to quantify lands owned and proportion of land affected due to project activities.

Based on the field assessment, it is observed that, in all there are 54 project affected families who are expected to lose land. No family is likely to lose homestead. The details of project affected families are given in Table-13.2.

TABLE-13.2
Details of Project Affected Families

Details of land category	Number of PAFs
Only Land	47
Only Homestead	0
Both Land & Homestead	0
Total	47

Source: Field studies.

As per available data/information a total of 54 project affected families will lose land in varying proportions under agricultural land and/or homestead land due to the process of land acquisition for in H. E. Project. These PAFs belongs to villages Khaleteng, Kharteng, Kungba, Lumla and Soksen. In addition, many of the PAFs will also lose various horticultural trees, which are standing on the lands proposed for acquisition. These trees will have to be compensated for.

13.8 RESETTLEMENT AND REHABILITATION PLAN

The resettlement and rehabilitation plan for the project affected families/ persons of the proposed Nyamjangchhu hydroelectric project has been formulated within the provisions and/or guidelines as given in the National Policy on Resettlement and Rehabilitation for the Project Affected Persons – 2007 (NRRP – 2007), formulated by the Department of Land Resources, Ministry of Rural Development. Although, the guidelines of NRRP – 2007 have been followed to a large extent while formulating the R&R plan, but in some provisions of the policy guidelines, where the details of provisions are not clearly specified, the Consultant based on past experiences in similar projects, in Arunachal Pradesh has suggested/ specified the R&R facilities.

Measures for Rehabilitation

As per the Assessment carried out by WAPCOS, there are 54 PAFs that are likely to get affected/lose their agricultural lands due to acquisition of their land for the proposed project. Thus, they would have to be compensated for the acquisition of agricultural land. Over and above this compensation, the PAFs will be given “land for land” or “vocation/ job” or “financial assistance” in addition to various rehabilitation benefits as per the NRRP – 2007.

Land for Land would have to be meticulously followed, especially in view of PAFs’ tribal origin. All the PAFs who are expected to lose land would be compensated as per the rates that would be assessed and decided by the District Authorities. The details of rehabilitation measures as outlined in the NRRR – 2007 are highlighted in Table-13.3.

TABLE-13.3
Provisions under NRRP – 2007 for Rehabilitation

Provisions under NRRP – 2007	Cost/ Land requirement
Within the provisions of the NRRP – 2007 each PAF owning agricultural land in the affected zone and whose entire land has been acquired may be allotted agricultural land or cultivable wasteland to the extent of actual land loss subject to a maximum of one hectare of irrigated land or two hectares of un-irrigated land/ cultivable wasteland in the district.	<p>About 7.5 ha of agricultural land is proposed to be acquired. Thus, for the purpose of this project equal amount of irrigated land (7.5 ha) is being proposed to be allotted under the land for land option. However, the Consultant is of the opinion, that adequate and suitable irrigated land may not be available. Thus, a provision of about 15 ha of un-irrigated land needs to be kept.</p> <p>It is observed that all the PAFs are losing less than 1 ha of their lands.</p> <p>The Project authority, in consultation with the District administration would provide the required amount of land to be allotted to the affected parties subject to availability of Government land in the districts.</p>
Further, in case of allotment of wasteland/degraded land in lieu of acquired land, each PAF shall get financial assistance of Rs.10,000/- per hectare for land development.	A provision of Rs. 0.15 million (15 ha x Rs.10,000) may be earmarked for cost towards land development.
In addition, in case of allotment of agricultural land, a one-time financial assistance of Rs.5,000/- per PAF for loss of agricultural produce shall be given.	A provision of Rs.0.235 million (Rs.5000 x 47 PAFs) may be earmarked for loss of agricultural produce.
Stamp duty and other fees for registration shall be borne by the requiring agency.	Will be complied as per Policy
On the other hand, in case each PAF owning agricultural land in the affected zone and whose entire land has been acquired shall get one-time financial assistance equivalent to 750 days minimum agricultural wages for "loss of livelihood" where neither agricultural land nor regular employment to one member of the PAF has been provided.	A provision of Rs.3.525 million (47 PAFs x 750 days x Rs.100 MAW) may be earmarked for providing financial assistance for loss of livelihood.
Within the provisions of the NRRP-2007, each displaced PAF shall get a	A provision of Rs.1.175 million (47 x 250 MAW x Rs.100) may be earmarked

Provisions under NRRP – 2007	Cost/ Land requirement
monthly subsistence allowance equivalent to 20 days of minimum agricultural wages per month for a period of 1 year, upto 250 days of MAW.	for this purpose.
One member from the displaced household would be imparted Vocational Training at the project cost to avail training for development of entrepreneurship to take up self-employment projects. as per the training program options of the Ministry of Tribal Affaires	A provision for the cost likely to be incurred on providing vocational training may be earmarked for Rs.0.282 million (Rs.1000 x 6 months x 47)
One student from each affected household is proposed to be given a scholarship for a period of two years for continuity of their education.	A provision of Rs.0.564 million (Rs.500 x 24 months x 47 students) may be earmarked for this purpose.

The training programmes of Ministry of Tribal Affairs (MoTA) are given in Table-13.4. The training programmes to members may be imparted as per the programmes of MoTA available

TABLE-13.4

Scheme of MoTA identified for skill development of PAPs

S. No.	Options for Skill development
1.	Bamboo Furniture Making
2.	Dhaba & Restaurant
3.	Fruit & Vegetable shop
4.	Horticulture
5.	Minor Forest Product
6.	Piggery
7.	Poultry

Measures for Compensation of other properties

In the proposed project, majority of the population depends on land for their livelihood. In addition to the compensation for loss of land and homestead the affected persons would be entitled/eligible to receive compensation for loss their horticultural crops/ trees. The details of horticultural crops/ trees are highlighted in Table-13.5.

TABLE-13.5**Details of horticultural crops/trees getting affected**

Horticultural crops/ trees	Numbers
Mango	2
Apricot	6
Apple	2700
Orange	73
Guava	43
Pines	300
Palm	2
Total	3126

The district authorities would evaluate and assess the rates of compensation for the horticultural trees based on their age and the compensation would be paid to the concerned PAFs.

Additional Benefits

In addition to the afore-said R&R benefits, the project affected persons/families would be entitled to the following benefits as per the NRRP – 2007 as well. These benefits are directed towards the Scheduled Tribe project affected persons/families.

- Each project affected family of ST category shall be given preference in allotment of land.
- Each tribal PAF shall be entitled to get R&R benefits mentioned in above paras under the policy.
- Each tribal PAF shall get additional financial assistance equivalent to 500 days minimum agricultural wages for loss of customary rights/ usages of forest produce.
- As all affected persons are local tribals, this provision of the NRRP – 2007 will be extended to all.
- Tribal PAFs will be resettled close to their natural habitat in a compact block so that they can retain their ethnic, linguistic and cultural identity.
- Tribal PAFs shall get land free of cost for community & religious gatherings.
- Tribal PAFs resettled out of the district/ taluka will get 25% higher R&R benefits in monetary terms.
- The tribal land alienated in violation of the laws and regulations in force on the subject would be treated as null and void and the R&R benefits would be available only to the original tribal land owner.

- The tribal families residing in the project affected areas having fishing rights in the river/pond/dam shall be given fishing rights in the reservoir area.
- Tribal PAFs enjoying reservation benefits in the affected zone shall be entitled to get the reservation benefits at the resettlement zone.

Thus a total provision of **Rs.2.35 million** (47 x 500 MAW x Rs. 100) needs to be kept for additional financial assistance for loss of customary rights/usages of forest produce.

Area Development Activities

In addition, the Project affected families shall be provided the basic amenities and infrastructure facilities at the resettlement site as per norms specified by the appropriate Government. It is desirable that provision of drinking water, electricity, schools, dispensaries and access to the resettlement sites amongst others be included in the resettlement plan formulated by the Administrator of R&R. Since the prescribed scale have not been specified in the NRRP-2007, the Consultant, based on its field observation, and past experience in similar types of projects in Arunachal Pradesh, suggest that the project proponent shall have to provide the following Civic Amenities. Since tribal villages are integrated and very closely knit, facilities for the PAFs may be extended to the remaining villagers as well, as these affected villages are very small, in terms of number of families or population residing in them.

- It is suggested that **Power supply** may be provided to all the three affected villages. Free power supply of about 2kW to each of the resettled household may be given for a period of 5 years. Thereafter, tariff could be charged at market rates from the resettled households. An amount of Rs.1.00 million has been earmarked for this purpose.
- **Piped water supply** for drinking purpose. This could be provided by harnessing the natural sources of water and constructing storage tanks. These community tanks could then be connected with pipeline, community taps. The approximate cost for storage tanks, laying the PVC pipeline for distribution, works out to be approximately Rs.5.0 million @ Rs.1.0 million per village can be extended to all the affected villages.
- The project villages lack proper sanitation facilities. Although most of the villagers are not in the habit of using lavatory facilities presently, therefore it is suggested to provide cost effective lavatory facilities for

them. It is suggested to provide about 20 community lavatories with septic tanks and soak pits in all the four affected villages to be used by the residents. An amount of Rs.0.6 million/village can be earmarked. An amount of **Rs.3.0 million** can be earmarked for this purpose.

- A **Higher Secondary School with playground** is proposed to be constructed at the project cost for the benefit of the PAFs as well. About 1500 sq.m. of land would be required for construction of higher secondary school. This includes school building (800 m²) and play ground (700 m²). The school building should have at least 20 rooms (size 40m² including room, common areas, etc), which would include primary section as well. The site for the school shall be finalized by the project proponents, in consultation with local government/ administration. Necessary electrical fitting for the bulb/tube-light, Fan are also proposed in each room. The cost of construction of the school is approximately **Rs.4.5 million** (Rs.4.0 million + 0.50 million lump-sum water supply and electrification). **In case the local administration proposes to upgrade the existing higher secondary school in the vicinity of the project area, this amount shall be provided for the same.** The PAFs shall be assured to get benefit of their wards education in this school.
- A lumpsum cost of **Rs.5.00 million** (Rs.3.00 million can be earmarked for augmentation/ new construction of building, residential complexes, etc and Rs.2.0 million for other infrastructure facilities, such as bed, furniture, equipment, one ambulance, etc.) may be earmarked for this purpose. This cost has to be borne by the project authority. The recurring cost for salaries of staff and expenses on drugs and medicines would be borne by the district administration.

The facilities suggested as a part of the Area Development Activities Resettlement should be made available not only to the resettled households but also to the remaining villagers (affected families) in the study area and its vicinity. Thus, a total provision of Rs.19.5 million may be earmarked for this purpose. The details are given in Table-13.6.

TABLE-13.6**Summary of Area Development Activities**

S. No.	ADA Activities	Cost (Rs. million)
1	Power supply	3.0
2	Piped water supply	4.0
3	Sanitation facilities	3.0
4	Higher secondary school with play ground	4.5
5	Health Care Facility	5.0
	Total	19.5

13.9 INSTITUTIONAL/ ADMINISTRATIVE ARRANGEMENT FOR IMPLEMENTATION OF R&R MEASURES

In order to ensure smooth and effective land acquisition, implementation of R&R measures, monitoring of R&R operations etc., the NRRP – 2007 lays provision for appointment for commissioner R&R and Administrator R&R.

The State Government shall appoint an officer of the rank of Commissioner/ Secretary of that government for R&R in respect of such projects to which this policy (NRRP-2007) applies to the commissioner shall be responsible for supervising the formulation of R&R plans/schemes, proper implementation of such plans/schemes and redressal of grievances.

The State Government shall, by notification, appoint in respect of that project, an officer not below the rank of District Collector of the State Government to be Administrator for R&R. Subject to the superintendence, directions and control of the appropriate Government and Commissioner for R&R, the Administrator for R&R shall take all measures for the rehabilitation and resettlement of all PAFs in respect of that project. The overall control and superintendence of the formulation of R&R plan and execution of the same shall rest in the Administration for R&R. The Administrator for R&R shall be assisted by officers and employees as the appropriate Government may provide.

In view of the above, WAPCOS suggest the following institutional arrangement for effective implementation & monitoring of R&R activities.

A) Supervisory Body

- Commissioner for R&R
- Project In-charge

B) Implementation Body

- Administrator for R&R
- Head of Project
- Representatives of village level Committees (VLC)
- Representatives of women of the affected villages.
- Representatives of Nationalized Bank
- Representatives of Forest Department
- Representatives of Local NGOs
- MLA/MP of the Area

Besides the foregoing organizational arrangement, liaison should be established by the Administrator for R&R with the other government departments, which will extend support in the implementation of land acquisition and rehabilitation programmes. Specifically, government organizations like Department of Revenue, Rural Development, Agriculture, Forest, Horticulture, Rural Industries etc., can be contacted for dovetailing their programmes for the economic rehabilitation of PAFs. These organizations/departments shall not only extend their various development schemes for the economic welfare of the PAFs but would also provide technical guidance and training to PAFs in carrying out economic activities. However, the NRRP-2007 indicates R&R Committee at Project level, under the Chairmanship of Administrator for R&R.

Monitoring and Evaluation

Monitoring and Evaluation (M&E) must be simultaneous with the implementation of Rehabilitation Plan. It requires specialized skill for application of general project monitoring procedures to the process of land acquisition and rehabilitation. Conventional monitoring, normally carried out by the Government machinery, often misses focus on certain vital aspects and does not identify certain shortcomings, which may otherwise prove very important. While the conventional government monitoring will continue, an external M&E agency will also be engaged to help in proper monitoring of land acquisition and rehabilitation programmes. The main purpose of involving such an agency is to bring the problems and difficulties faced by the PAFs to the notice of Administrator R&R on a regular basis for their redressal as well as to help in formulating and undertaking corrective measures. The external Monitoring and Evaluation (M&E) agency can submit half yearly reports on the progress of implementing Rehabilitation Master Plan (RMP) along with suggestions and

corrective measures required for improvement in the implementation of Rehabilitation Plan.

For Land Acquisition and rehabilitation programme, M&E system will consist of:

- i) Administrative monitoring;
- ii) Socio-economic performance, and
- iii) Impact evaluation.

Administrative monitoring will be conventionally carried out by SLAO, project authorities, Resettlement Commissioner and other concerned government agencies/departments. The focus will be on physical (like number of land holders affected and land based resettlement, area identified for allotment to Village Level Committee, etc.) and financial (like compensation paid, payment to M&E agency, office establishment cost, etc.) parameters. The socio-economic monitoring which will be carried out concurrently is the crux of M&E exercise to provide interim measures based on the field level situations. This along-with impact evaluation at the end of plan period will be carried out by the M&E agency. While covering the affected community, monitoring will focus on the vulnerable groups like women, physically handicapped, etc. The household information collected through the socio-economic survey will form the benchmarks for comparison. However, these benchmarks will be supplemented in order to create new reference points against performance, effects and objectives.

Monitoring and Evaluation Guidelines

Monitoring of the progress of R&R is important because of the sensitivity of these issues. The objective of monitoring is to assess the progress of resettlement activity, to identify difficulties, ascertain problem areas, and provide indication for the need of calling attention to some specific issues at an early stage. Following tasks have to be performed by the group at different stages of the project:

- Establish baseline information on individual PAFs and their pre-project standards of living, health conditions, nutritional patterns, etc. This should precede resettlement in general by a year.
- The planning of the resettlement monitoring studies could cover disbursement of compensation and grants.

- Monitoring of resettlement sites regarding, preparation of land, construction activities, water and other facilities required before the actual resettling of PAFs.
- The resettlement monitoring system could cover transport of people, belongings and allocation of replacement assets. Their report should also include information on performance of field staff and concerned official's participation of the PAFs and host community reactions.
- After resettlement, a few sensitive indicators using sample survey techniques should be measured, mainly to understand how effective the R&R plan has been in reality.
- The monitoring and evaluation can continue for several years after actual relocation. The frequency of monitoring can be reduced after the completion of R&R work. The monitoring reports need to be submitted periodically to assess progress of resettlement and its effects compared with established policy and specific timetables and benchmarks at each phase.

Post-Project Monitoring

Status of availability of alternative homestead for project affected persons, development of infrastructural facilities such as schools, sewer networks, roads, etc. are some of the aspects which could be considered for monitoring and modifications may be suggested if required. It needs to be appreciated that R&R issues are politically sensitive issues and often need timely attention. For such reasons, it is suggested that the monitoring be conducted by an independent agency not connected with the project. Therefore, an independent Consultant having experience in R&R studies in similar areas, i.e. north-eastern states and not connected with the project, can be appointed for monitoring the project. The Consultant will review the rehabilitation and resettlement programme after 2nd, 4th and 6th year from the completion of the R&R activity. A total provision of Rs.1.0 million has been kept in the project estimate for this purpose.

Participation of PAFs

Involvement of affected communities in planning and implementation of rehabilitation programmes according to their felt needs and socio-economic conditions is of vital importance. To obtain co-operation, participation and feedback, PAFs need to be systematically informed and consulted during preparation and implementation of resettlement plan about their options and

rights. In the proposed project, co-operation and participation of PAFs in the resettlement process could be ensured through their involvement in each of the following stages.

➤ **Involvement in preparation of Rehabilitation Master Plan**

As a part of participatory planning, community meetings should be held on a routine basis to explain about the project and the R&R policy of the project. Direct communication with the PAFs will negate the politicization of the R&R Process. The communication with the PAFs can be through the Village Level Committee.

➤ **Involvement of PAFs in implementation process**

The Village Level Committee can be involved in the implementation of Rehabilitation Plan particularly during the identification of forest land to be allotted to Village Level Committee. They should also be consulted in finding out alternative economic opportunities to supplement their household income. However, some NGO groups can also be associated which can interact directly with the project authorities and the affected population.

13.10 BUDGET FOR R&R

A total budget of **Rs. 28.781 million** would be required for implementation of R&R Plan. The details are given in Table-13.7.

TABLE-13.7

Budgetary estimate for implementation of R&R Plan

S. No.	R&R Components	Cost (Rupees million)
1.	Rehabilitation plan	
	<ul style="list-style-type: none"> • "land for land" to be the basis - 15 ha of un-irrigated land needs to be identified and disbursed to PAFs 	
	<ul style="list-style-type: none"> • Land development cost 	0.150
	<ul style="list-style-type: none"> • Loss of agricultural production 	0.235
	<ul style="list-style-type: none"> • One time Financial assistance for loss of livelihood 	3.525
	<ul style="list-style-type: none"> • Subsistence allowance 	1.175
	<ul style="list-style-type: none"> • One time financial assistance for "training for development of entrepreneurship" 	0.282
	<ul style="list-style-type: none"> • Scholarship for students 	0.564
	<ul style="list-style-type: none"> • Financial assistance for "loss of customary rights/ usages of forest produce" 	2.350
	Sub-Total (Rehabilitation) [1]	8.281

S. No.	R&R Components	Cost (Rupees million)
2.	Area Development Activities [2]	19.50
3.	Monitoring and evaluation set-up [3]	1.00
Grand Total [1+2+3]		28.781

CHAPTER-14

ENERGY CONSERVATION MEASURES

14.1 GENERAL

Energy conservation measures would be implemented to ensure that the use of non-renewable resources is minimised. A key component of achieving energy conservation would be the development of an Energy Management Action Plan. This plan would be included as part of the Construction and Operational EMPs.

The Energy Management Action Plan would be consistent with the energy conservation measures during both construction and operation phase.

14.2 ENERGY CONSERVATION DURING CONSTRUCTION PHASE

The following mitigation measures would be undertaken during construction works.

- Efficient work scheduling and methods that minimise equipment idle time and double handling of material;
- Throttling down and switching off construction equipment when not in use;
- Switching off truck engines while they are waiting to access the site and while they are waiting to be loaded and unloaded;
- Switching off site office equipment and lights and using optimum lighting intensity for security and safety purposes;
- Careful design of temporary roads to reduce transportation distances;
- Regular maintenance of equipment to ensure optimum operations and fuel efficiency.

14.3 ENERGY CONSERVATION DURING OPERATION PHASE

The following mitigation measures would be implemented during site operations

- Design of buildings and terminal layout would aim to achieve the following energy efficiencies:
- Employing renewable energy sources such as day lighting and passive solar heating;
- Designing roads on the site to reduce transportation distances.

14.4 ENERGY EFFICIENT EQUIPMENT

Large energy savings could be achieved in using energy efficient equipment. The following actions are examples of how energy savings could be achieved by the terminal operator(s):

- Using energy efficient electrical appliances;
- Installing lighting control devices where appropriate and linking to photo-electric dimming; and
- Providing sufficient energy metering and switching for energy management.

Energy would also be conserved through efficiency in work schedules and practices such as:

- Use of modern container yard management systems for the efficient stacking and retrieval of containers and to minimise vehicles waiting times;
- Road and rail transport scheduling to minimise energy use and wastage, e.g. increasing backloading and minimising waiting times;
- Promoting the increase in rail mode share of container freight movement which would reduce the number of containers to be moved by road;
- Switching off truck engines while they are waiting to access the site and while these are waiting to be loaded and unloaded;

- Throttling down and switching off idle equipment;
- Regular maintenance of all powered equipment to ensure appropriate fuel consumption rates; and
- Communication and education of energy conservation measures to employees.

14.5 BUDGET

An amount of Rs. 5.0 million has been earmarked for implementation of various energy conservation measures.

CHAPTER - 15

TRIBAL DEVELOPMENT PLAN

15.1 GENERAL

India has the largest concentration of tribal people anywhere in the world except perhaps in Africa. The tribals are children of nature and their lifestyle is conditioned by the Eco-system. India, with a variety of ecosystems, presents a varied tribal population throughout its length and breadth.

According to 1991 Census, population of the Scheduled Tribes in the country is 67.8 million, which is about 8.1% of the total population of the country. The population of Scheduled Tribes has been found increasing after 1951. The decadal population growth between Census Year 1981 to 1991 in respect of tribal population has been much more (31.64%) than the same for entire population (23.51%). The details of demographic changes are depicted in Table 15.1.

TABLE-15.1

Demographic Changes in Tribal Population of the country

Census Years	Total population (in million)	Population of ST	S.T. %
1951	361.1	19.1	5.29
1961	439.2	30.1	6.85
1971	548.2	38.0	6.93
1981	685.2	51.6	7.53
1991	846.3	67.8	8.10
2001	1028.6	84.3	8.19

Source: Ministry of Tribal Affairs Website; Ministry of Tribal Affairs, Government of India

As compared to the sex ratio for overall population (927 females per 1000 male), the sex ratio among the Scheduled Tribes is more towards females (972 females per thousand males). According to 1991 Census, the population of Arunachal Pradesh, which is essentially tribal, was 864558.

15.2 DEMOGRAPHIC PROFILE OF STUDY AREA VILLAGES

15.2.1 Population

The total population in the study area villages is 4093 residing in 960 households. The percentage of male and female population is 49.13% and 50.86% respectively. The overall average sex ratio in the study area is 1035 females per 1000 males. The population below the age of 6 years (or infant

population) accounted for about 22.47% of the total population. The average family size in the study area villages is 4.3 persons per household. The village-wise demographic details in the study area villages Study Area Villages are shown in Table 15.2.

TABLE – 15.2
Demographic profile of the Study Area Villages

Study Area Villages	No. of Household	Total Population	Male Population	Female Population	Population less than 6 yr	Sex Ratio	Avg. Family
Zemithang Circle							
Socketen	165	672	352	320	154	909	4.1
Lumpo	53	262	140	122	72	871	4.9
Muchut (Kharakpu)	68	336	171	165	72	965	4.9
Khelengteng	22	134	64	70	37	1094	6.1
Shakti	91	339	172	167	75	971	3.7
Lumla Circle							
Lumla Village (Soleng)	91	396	197	199	76	1010	4.4
Kungba	53	227	102	125	40	1225	4.3
Kharteng	79	330	154	176	76	1143	4.2
Phomang	44	180	84	96	38	1143	4.1
Baghar	48	219	97	122	55	1258	4.6
Sherbang	43	173	95	78	47	821	4.0
Gispu	142	535	244	291	111	1193	3.8
Namtsering	39	195	99	96	52	970	5.0
Gompa Village(Basti)	22	95	40	55	15	1375	4.3
Total	960	4093	2011	2082	920	1035	4.3

Source: Primary Census Abstract, 2001.

15.2.2 Literacy

Within the study area, the overall average literacy rate is about 18.5%. The male and female literacy rates are 24% and 13.3% respectively. The village-wise details of literate population in the study area villages are given in Table – 15.3.

TABLE – 15.3

Village-wise Literate population in the study area villages

Study Area Villages	Total Population	Total Literates	Literate Males	Literate Females	Total Illiterates	Illiterate Males	Illiterate Females
Zemithang Circle							
Socktsen	672	85	59	26	587	293	294
Lumpo	262	80	50	30	182	90	92
Muchut (Kharakpu)	336	93	57	36	243	114	129
Khelengteng	134	28	20	8	106	44	62
Shakti	339	23	18	5	316	154	162
Lumla Circle							
Lumla Village (Soleng)	396	138	80	58	258	117	141
Kungba	227	11	6	5	216	96	120
Kharteng	330	23	15	8	307	139	168
Phomang	180	4	2	2	176	82	94
Baghar	219	13	9	4	206	88	118
Sherbang	173	27	20	7	146	75	71
Gispu	535	143	96	47	392	148	244
Namtsering	195	40	25	15	155	74	81
Gompa Village(Basti)	95	49	24	25	46	16	30
Total	4093	757	481	276	3336	1530	1806

Source: Primary Census Abstract, 2001.

15.2.3 Occupation

The village-wise details on occupational profile within the Study Area Villages are outlined in Table – 15.4. It is observed that about 54.14% of the total population in the Study Area Villages is engaged in different economically productive activities, and have been classified as “Total Workers” by the Census Department. On the other hand, remaining 46.86% are non-workers or dependent population. Among the working population, about 77.84% constitute the Main workers, while the Marginal workers comprise about 22.16% of the total population.

TABLE – 15.4**Occupational profile in the study area villages**

Study Area Villages	Total Population	Total Working Population	Main Workers	Marginal Workers	Non Working Population
Sockettsen	672	325	277	48	347
Lumpo	262	145	88	57	117
Muchut (Kharakpu)	336	182	144	38	154
Khelengteng	134	80	66	14	54
Shakti	339	223	212	11	116
Lumla Village (Soleng)	396	122	91	31	274
Kungba	227	148	132	16	79
Kharteng	330	184	133	51	146
Phomang	180	106	77	29	74
Baghar	219	122	64	58	97
Sherbang	173	99	61	38	74
Gispu	535	293	242	51	242
Namtsering	195	114	84	30	81
Gompa Village(Basti)	95	32	22	10	63
Total	4093	2175	1693	482	1918

Source: Primary Census Abstract, 2001.

15.3 ACCESS TO VARIOUS SOCIAL INFRASTRUCTURES

15.3.1 Educational facilities

The details of schools available in the study area are depicted in Table 15.5. As per this table, it is observed that villages Sockettsen, Lumpo, Muchut (Kharakpu), Shakti, Lumla Village (Soleng), Kungba, Kharteng, Sherbang, Gispu, and Namtsering, have a Primary school within the villages. While the other 4 villages are located at varying distances from the nearest primary school. Middle school is available in only in Lumla, while other villages do not have a middle school and are located at varying distances from the nearest middle school. Similarly, Lumla has a Secondary school in the whole study area, while other villages do not have secondary school. Senior secondary school is not available in any of the study area villages. College is located more than 10 km distance from all the study area villages. Adult literacy centre is available in villages Lumla, Kungba and Kharteng. So far as industrial training centre, and other schools are concerned, none of the villages in the study area have these educational facilities.

TABLE – 15.5

Educational facilities available in the study area

Study Area Villages	Primary School	Middle School	Secondary School	Sr. Secondary School	College	Adult Literacy Centre
Socketen	1	> 10 km	NA	NA	> 10 km	NA
Lumpo	1	> 10 km	NA	NA	> 10 km	NA
Muchut (Kharakpu)	1	5 - 10 km	NA	NA	> 10 km	NA
Khelengteng	< 5 km	< 5 km	NA	NA	> 10 km	NA
Shakti	1	> 10 km	NA	NA	> 10 km	NA
Lumla Village (Soleng)	1	1	1	NA	> 10 km	1
Kungba	1	> 10 km	NA	NA	> 10 km	1
Kharteng	1	5 - 10 km	NA	NA	> 10 km	1
Phomang	5 - 10 km	5 - 10 km	NA	NA	> 10 km	NA
Baghar	< 5 km	< 5 km	NA	NA	> 10 km	NA
Sherbang	1	> 10 km	NA	NA	> 10 km	NA
Gispu	1	> 10 km	NA	NA	> 10 km	NA
Namtsering	1	5 - 10 km	NA	NA	> 10 km	NA
Gompa Village (Basti)	< 5 km	< 5 km	NA	NA	> 10 km	NA

Source: Village Directory, Census of India, 2001

Note: NA = Note Available

15.3.2 Health Care facilities

The development of health facilities for scheduled tribe got impetus through successive plans. The Primary Health Centres (PHC) Health Sub-Centres (HSC) and ICDS project established in tribal areas are indicators of extension of medical services to the tribals.

So far as health care facilities are concerned in the study area, it would be worthwhile to state that only Lumla has a Dispensary, Child Welfare Centre, Primary Health Centre, and a Community Health Worker. Like-wise villages Socketen and Gispu have a Child Welfare Centre each.

Primary Health Centre. Except for villages Wothung, Dillung, Dishing and Chillang, all other villages have a Child Welfare Centre in the village. The details of health care facilities available in the study area are depicted in Table 15.6.

TABLE – 15.6

Details of health care facilities available in the study area

Study Area Villages	Hospitals (All Types)	Dispensary (All Types)	Maternity & Child Welfare Centre	Child Welfare Centre	Primary Health Centre	Community Health Workers
Socketen	> 10 Km	NA	> 10 Km	1	> 10 Km	NA
Lumpo	> 10 Km	NA	> 10 Km	NA	> 10 Km	NA
Muchut(Kharakpu)	> 10 Km	NA	> 10 Km	NA	5 - 10 Km	NA
Khelengteng	> 10 Km	NA	> 10 Km	NA	> 10 Km	NA
Shakti	> 10 Km	NA	> 10 Km	NA	> 10 Km	NA
Lumla Village (Soleng)	> 10 Km	1	> 10 Km	1	1	1
Kungba	> 10 Km	NA	> 10 Km	NA	> 10 Km	NA
Kharteng	> 10 Km	NA	> 10 Km	NA	> 10 Km	NA
Phomang	> 10 Km	NA	> 10 Km	NA	> 10 Km	NA
Baghar	> 10 Km	NA	> 10 Km	NA	> 10 Km	NA
Sherbang	> 10 Km	NA	> 10 Km	NA	> 10 Km	NA
Gispu	> 10 Km	NA	> 10 Km	1	> 10 Km	NA
Namtsering	> 10 Km	NA	> 10 Km	NA	> 10 Km	NA
Gompa Village(Basti)	< 5 Km	NA	< 5 Km	NA	< 5 Km	NA

Source: Village Directory, Census of India, 2001

Note: NA = Note Available

Although medical facilities are poor, Health Care Facilities are in operation to serve the Tribal Belt of Tawang and Lumla.

Tawang is the district headquarters and the Government of Arunachal Pradesh has been operating a 30 Bedded Main District Hospital in Tawang with the following facilities:

- One Number of X-Ray Machine
- One Number of Ultra Sound Machine
- One Pathology Lab
- 8 Doctors are working in the Hospital comprising of 5 General Physician Doctor, 1 Eye Specialist, 1 Gynecologist and 1 Homeopathy Doctor.
- 20 Nos. of Auxiliary Nurse midwifery (ANM) and 4 Nos of Staff Nurses (GNM) have been working.
- 12 Nos. of Health Assistants have been working.

It was also gathered that the State Government provides medicines worth Rs. 20.00 lac approximately per annum.

Lumla is the Circle headquarters and the Voluntary Health Association of India has been operating a 12 Bedded Community health center in Lumla with the following facilities:

- One Pathology Lab.
- 2 Doctors are working in the Hospital comprising of 1 General Physician Doctor, and 1 Homeopathy Doctor.
- 4 Nos. of Auxiliary Nurse midwifery (ANM).
- 4 Nos. of Health Assistants have been working.

Two Sub-Centers are under operation in Lumla Circle. These centers are located at Shakti Village with 2 ANMs and Dudungar with 2 ANMs. In addition to this, GoAP has taken over one Sub Center from Voluntary Health Association of India at Zimithang and is likely to be functional very shortly. State Government provides medicines worth Rs. 3.00 to 4.00 lac approximately per annum.

The common communicable diseases are Tuberculosis and Skin diseases. Amongst the non-communicable diseases, liver related diseases are prevalent in the area.

15.3.3 Water Supply and Sanitation Facilities available in project area

Data/ information pertaining to Water Supply and Sanitation facilities available in Lumla Sub Division was also collected. In Arunachal Pradesh, Water Supply and sanitation falls in the jurisdiction of Public Health Engineering Department of Government of Arunachal Pradesh (GoAP). Following Facilities are available/ under construction in the Lumla Sub Division:

- A Water Treatment Plant of capacity 0.2 mld is in operation for providing drinking water supply to Lumla Township and its peripheral rural villages.
- Distribution work for supply of water from this plant is already complete for Shakti, Gispu and BTK villages falling in the project area.
- Distribution work for supply of water from this plant is under progress for New Zimithang, Sherbang, Homgla, Milumgarh, Kharteng, Phoomang and Bagar villages falling in the project area.

- Construction of individual household lavatory for every BPL house under Lumla Sub Division is in progress.
- Toilets exist in all schools of Lumla and its peripheral villages.
- Public Health Engineer Department (PHED) has already submitted a DPR for supply of water for Jamgloom area. This area does not fall in the proposed project area.

15.3.4 Housing Schemes in Project Area

Details in respect of available Housing scheme and information related to Housing were also gathered. Block Development Office (BDO) coordinates the schemes related to Housing. Indira Awas Yojna Scheme exists in the Lumla Sub Division, which is also extended to the BPL families. Under this scheme, the BDO is currently undertaking material distribution work. The BDO so far has distributed 45 CGI sheets per family to about 32 BPL families, 35 CGI sheets per family to about 112 families and 15 CGI sheets to each family which have been distributed to 78 families.

Further, it was also learnt that there are about 30 homeless families in entire Lumla Sub Division.

15.3.5 Micro Financing and Agribusiness in the Project Area

In order to prepare the Tribal Development Plan for the proposed Nyamjang Chhu hydro-electric project, representatives have approached the concerned department to collect details in respect of available options for Micro Financing and Agri-business. Various schemes for rural development and agri-business are available in the sub-division, and these are facilitated by the Block Development Office. Information related to Micro Financing and Agri-business in Project area is as under:

- A State Bank of India is in operation at Lumla, within the Lumla Sub Division
- Financing is available to BPL beneficiaries for cultivation of vegetables, in which each BPL family is given Rs. 20,000/- for every five year plan. Out of this amount, Rs. 10,000/- is a Bank Loan and the remaining Rs. 10,000/- is a Government subsidy.
- Besides, a Community Based Financial organization is operational in the Mangma community, within the proposed project area, which apparently has no link with the Government machinery.

15.3.6 Industries and Construction works

At present there are no industries of any type, within the project area. However, in Lumla sub division, there is one craft center situated at a place called Zero (Mangalam). This center has only 2 teachers and 2 students at present.

15.3.7 Modes of Transport and Communication

The project area is located in a remote and difficult terrain. At present, there is no State operated Transport Facility in the entire Lumla sub-division including the proposed project area. Although, there is a State operated Bus Depot located at the district headquarter at Tawang, and bus services are in operation upto Bomdila and Tawang.

The only mode of transportation includes shared-taxis for the use of the communities of Lumla sub-division. These shared-taxis are operated by individual and private entrepreneurs and operators from amongst the community. These taxis ply within and outside the sub-division.

BSNL Telephone system is in operation through a telephone exchange situated at Tawang. In addition, Wireless in Local Loop (WLL) telephone facilities is available within Lumla township only.

15.4 STRATEGY FOR DEVELOPMENT: THE TSP APPROACH

The Tribal Sub Plan (TSP) Strategy has been adopted for all round development of tribal areas throughout the country since Fifth Five Year Plan. Under the TSP approach almost entire tribal inhabited area have been covered under any one of the following, depending upon their population percentile:

- i) Integrated Area Development Project (ITDPs)
- ii) Modified Area Development Approach (MADA)
- iii) Clusters
- iv) Primitive Tribal Groups

The TSP approach ensures allocation of fund for tribal areas from State Plan as well as Central Ministries, at least proportionate to population of tribals in the state (from state plan) and to the overall proportionate tribal population for the country from the budget of Central Ministries.

15.5 PLANS/PROGRAMMES OF THE MINISTRY

Ministry of Tribal Affairs continued to implement various Schemes/programs aimed at welfare and development of Scheduled Tribes. An Overview of the activities of the Ministry is as follows:

SPECIAL CENTRAL ASSISTANCE TO TRIBAL SUB-PLAN: (SCA TO TSP)

The Ministry of Tribal Affairs extends special central assistance to the TSP States and Union Territories and also to North Eastern States of Assam, Manipur and Tripura as an additional grant to these states/UTs. These grants are basically meant for family oriented income generating scheme in various TSP areas to meet the gaps, which have not otherwise been taken care of by the State Plan.

GRANTS UNDER PROVISION OF ARTICLE 275 (1) OF THE CONSTITUTION

The Ministry provides Grant-in-Aid to TSP and tribal majority States under Article 275 (1) of the constitution to meet the cost of such projects for tribal development as may be undertaken by the State Government for raising the level of administration of Scheduled Areas therein to the level of the rest of the state. In the Ninth Plan, besides other projects, from the funds allocated under this Scheme it was proposed to establish 100 Residential Schools on the pattern of Navodaya Vidyalayas.

ASHRAM SCHOOLS IN TRIBAL SUB-PLAN AREAS

The Ministry under the Scheme provides funds to all the States and UTs having tribal population for establishment of residential schools for STs in an environment conducive to learning near their habitations on sharing basis (50:50) to States and 100% to UTs.

15.6 VILLAGE GRAIN BANK SCHEME

This Scheme provides Grants for establishment of Village Grain Banks to prevent deaths of STs specially children in remote and backward tribal villages facing or likely to face starvation and also to improve nutritional standards. The Scheme provides funds for building storage facility, procurement of Weights & Measures and for the purchase of initial stock of one quintal of food grain of local variety for each family. A Committee under Chairmanship of village Headman runs the Grain Bank thus established.

15.7 GRANT-IN-AID TO VOLUNTARY ORGANIZATION WORKING FOR WELFARE OF SCHEDULED TRIBES

The prime objective of the scheme is to enhance the reach of welfare schemes of Government and fill the gaps in service deficient tribal areas, in the sectors such as education, health, drinking water, agro-horticultural productivity, social security net etc. through the efforts of voluntary organizations (VOs)/non-governmental organizations (NGOs), and to provide an environment for socio-economic upliftment and overall development of the Scheduled Tribes (STs). Any other innovative activity having direct impact on the socio-economic development or livelihood generation of STs may also be considered through voluntary efforts.

Under this scheme 90% grant is provided by the ministry and 10% cost is required to be borne by the non-governmental organizations from their own resources, except in Scheduled Areas where the Government bears 100% cost. The scheme provides a list of categories of projects viz. residential school, non-residential schools, 10 or more bedded hospitals, mobile dispensaries, computer training centers, etc., which could be covered under the scheme, and also prescribes fixed financial norms. The scheme does not provide any construction cost.

The Proposals by NGOs are required to be routed through State Government and the recommendation of the "State Committee for Supporting Voluntary Efforts" constituted under the chairmanship of principal Secretary/Secretary, Tribal Welfare/Development Department of the State/UT are mandatory. The recommendation of State Committee is valid for that financial year in which it is made.

15.8 TRIBAL DEVELOPMENT PLAN

In view of the Ministry of Tribal Affairs' Strategy for development: the TSP Approach and Plans/Programs of the ministry, the following Tribal Development Plan has been chalked-out.

15.8.1 Educational Development

As already mentioned earlier, there are 10 primary schools, 1 middle school and 1 secondary school in the study area. The secondary school is located at Lumla, which is also the sub-division headquarters.

Lumla already has a Primary, middle and secondary school. Atleast one school could be constructed at Lumla, in line with the Ministry's TSP. The existing secondary school could be either upgraded into a school on the pattern of Navodaya Vidyalaya or a completely new school could be constructed with the allocated funds. A lump-sum cost of **Rs. 5.0 million** is being earmarked for this purpose.

In addition, a provision of about 10000 sq.ft is being made for construction of an Ashram School, one each on each bank within the study area. Ten out of fourteen villages in the study area have a primary school. It is therefore suggested that 2 of these 10 schools may be upgraded to an Ashram School upto secondary school level. A lump-sum cost of **Rs. 10.0 million** (Rs. 5 million for each school) is being kept for this purpose. The state government needs to augment the number of teachers and bear the expenses of salaries.

Within the 10 km study area there are about 14 villages. It is therefore suggested that vans could be utilized to transport children from their respective villages to schools and vice-versa. It is suggested that 4 vans could be purchased and pressed into service for transportation of school going children. Two vans each could ply on either banks of the river, connecting through most of the villages within the study area. A lump-sum cost of **Rs. 3.0 million** is being made for purchase of van.

15.8.2 Development of Health Care facility

Voluntary Health Association of India has been operating a 12 Bedded Community health center in Lumla, the Circle headquarters. The following facilities are already available at this facility:

- One Pathology Lab.
- 2 Doctors are working in the Hospital comprising of 1 General Physician Doctor, and 1 Homeopathy Doctor.
- 4 Auxiliary Nurse and Mid-wife (ANM).
- 4 Health Assistants

It is suggested as part of the Tribal development plan, that the Government of Arunachal Pradesh (GoAP) may take-over this health care facility. A lump-sum amount of **Rs. 7.0 million** may be ear-marked for up-gradation of infrastructure facilities, such as additional space, medical equipment, furniture, beds, etc., in this health care facility. It is also suggested that this medical facility to have a

dedicated Tuberculosis Centre/ Clinic, as this is a very common communicable disease in this area.

The State Government could continue to provide medicines, salaries to staff, and maintenance of facility.

15.8.3 Modes of Transport and Communication

The project area is located in a remote and difficult terrain. At present, there is no State operated Transport Facility in the entire Lumla sub-division including the proposed project area. The only mode of transportation includes shared-taxis for the use of the communities of Lumla sub-division.

As part of the Tribal Development Plan, it is suggested that the project developer could initiate a dialogue with the State Government to initiate State run transport services in Lumla sub-division. An amount of **Rs. 3.0 million** can be earmarked for this purpose.

15.8.4 Development of Village Grain Bank

So far as our observations are concerned, each family usually has a grain storage facility within their homesteads. For the Village Grain Bank scheme, each of the 14 villages in the study area need to identify a suitable area for construction of a Village Grain Bank storage facility. An amount of **Rs. 7.0 million** (0.5 million x 14 villages) is being made for this purpose.

15.8.5 Grant-in-aid to Voluntary Organizations

The project Developer needs to encourage locals to form Community Based Organizations or Non-Governmental Organizations. Also, the project developer could hire the services of an NGO, which in this context would not only help and assist the Government in filling the gaps in service provided to tribal areas, in the sectors such as education, health, drinking water, agro-horticultural productivity, social security net etc., help the local population by creating an environment for socio-economic upliftment and their overall development, but would also assist the project developer in creating awareness about the project, assist in R&R issues, etc. A lump-sum amount of **Rs. 2.0 million** is being earmarked for hiring an NGO for monitoring and evaluation of various schemes.

15.9 BUDGET FOR TRIBAL DEVELOPMENT PLAN

An amount of **Rs. 37.0 million** is being made for implementation of the Tribal Development Plan. This cost is over and above the cost of Resettlement and Rehabilitation and Area Development Activities. The details are shown in Table 15.7.

TABLE – 15.7
Budget for Tribal Development Plan

S. No.	Items	Budget (Rs. million)
1	Construction/ Upgradation of existing school to Navodaya Vidyalaya	5.0
2	Construction/ Upgradation of existing school to Ashram school	10.0
3	Purchase of van/ mini-bus for transportation of school going children	3.0
4	Up-gradation of Health Care facility	7.0
5	Development of Transport and Communication facilities	3.0
6	Village grain bank scheme	7.0
7	Voluntary organization working for welfare of scheduled tribes – Hiring of NGO	2.0
TOTAL		37.0

CHAPTER-16

ENVIRONMENTAL MONITORING PROGRAMME

16.1 THE NEED

Environmental monitoring is an essential component for sustainability of any water resources project. It is an integral part of any environmental assessment process. Any water resources development project introduces complex inter-relationships in the project area between people, various natural resources, biota and the many developing forces. Thus, a new environment is created. It is very difficult to predict with complete certainty the exact post-project environmental scenario. Hence, monitoring of critical parameters is essential in the project operation phase. An Environmental Monitoring Programme has been designed with the following objectives:

- Assess the changes in environmental conditions, if any, during construction and operation of the project.
- Monitor the effective implementation of mitigatory measures.
- Warning of any significant deterioration in environmental quality so that additional mitigatory measures may be planned in advance.

16.2 AREAS OF CONCERN

From the monitoring point of view, the important parameters are water quality, landuse, ambient air quality, ecology, etc. An attempt is made to establish early warning of indicators of stress on the environment. Suggested monitoring details are outlined in the following sections.

16.3 WATER QUALITY

Construction Phase

It is proposed to monitor the effluent before and after treatment from oxidation ditch. The frequency of monitoring could be once per month. It is assumed that 3 oxidation ditches shall be constructed to treat the sewage generated from five labour camps. A total of (3 oxidation ditches * 12 months* 2 samples, i.e. before and after treatment) 72 samples/year need to be analysed. The parameters to be monitored include pH, Bio-chemical Oxygen Demand, Total Suspended Solids and Total Dissolved Solids. The cost of analysis of one sample is expected to be Rs.1,500. Thus, total cost for analysis of 72 samples is expected to be Rs. 0.11 million/year. The analysis work can be done by a laboratory recognized by the State Pollution Control Board.

Operation phase

The surface water quality of the proposed reservoir needs to be monitored thrice a year. The proposed parameters to be monitored are as follows:

pH, temperature, electrical conductivity, turbidity, total dissolved solids, calcium, magnesium, total hardness, chlorides, sulphates, nitrates, DO, COD, BOD, Iron, Zinc and Manganese. The sampling sites shall be:

- 1 km upstream of the dam site.
- Reservoir water.
- 1,3 and 5 km downstream of the dam site

The total cost of analysis will be Rs.0.3 million per year. This analysis shall be done throughout the entire life of the project. The analysis work can be conducted by a reputed external agency recognized by State Pollution Control Board.

During project operation phase, a Sewage Treatment Plant (STP) is proposed to be set up to treat the effluent from the project colony. Once every week, it is envisaged to analyse a sample each before and after treatment from the STP. The parameters to be analysed include pH, Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solids and Total Dissolved Solids. The cost of analysis of 104 samples @ Rs.1500 per sample works out to Rs.0.16 million/year. Thus, total cost for analysis in project operation works out to Rs.0.46 million/year.

16.4 AIR QUALITY AND METEOROLOGY

Project Construction Phase

The ambient air quality monitoring during construction phase can be carried out by an external agency, approved by State Pollution Control Board at four stations close to construction sites. Every year monitoring is to be done for the following three seasons:

- Winter
- Summer
- Post-monsoon

The frequency of monitoring could be twice a week for four consecutive weeks at each station for each season. The parameters to be monitored are Respirable Particulate Matter (RPM), Sulphur dioxide (SO₂) and Nitrogen Oxides (NO_x).

Every year, ambient air quality is to be monitored for (4 stations * 2 days/week * 4 weeks x 3 seasons) 96 days. A total cost of Rs. 0.48 million/year @ Rs. 5,000/day can be earmarked for this purpose.

A meteorological laboratory can be set up at one of the ambient air quality monitoring stations. Automatic recorders for temperature, humidity, wind speed & direction, rainfall needs to be commissioned at the site. An amount of Rs.0.5 million can be earmarked for this purpose.

16.5 NOISE

Project Construction Phase

Noise emissions from vehicular movement, operation of various construction equipment may be monitored during construction phase at major construction sites. The frequency of monitoring could be once every three months. For monitoring of noise generators an Integrating Sound Level Meter will be required.

Project Operation Phase

No major impact due to noise is observed in operation phase.

16.6 SOIL EROSION AND SILTATION

Project Construction Phase

No monitoring programme is suggested for project construction phase

Project Operation Phase

Soil erosion rates, slope stability of embankments of barrage, efficacy of soil conservation measures, need to be closely monitored twice a year. The NEEPCO staff at the project site can do the study. The study should be undertaken throughout the life of the project so as to design the soil erosion prevention measures and also for the rehabilitation/decommissioning of the project. Following parameters like soil erosion rates, stability of bank embankment would be measured. In addition to above, soil quality at various locations in the catchment area needs to be monitored once every year. The parameters to be monitored are pH, organic matter and texture.

16.7 ECOLOGY

Project Construction Phase

A detailed ecological survey covering forestry, fisheries, wildlife is recommended during entire construction phase. The survey can be conducted once every year for the entire construction period. The various aspects to be covered include:

- Qualitative and Quantitative assessment of flora and fauna.
- Monitoring of restoration of muck disposal area.

Monitoring of aquatic ecology will be essential to achieve sustainable yield of fish. Some of the parameters to be monitored are phytoplanktons, zooplanktons, benthic life and fish composition, etc. The monitoring can be conducted by a reputed external agency, for which an amount of Rs.0.90 million/year can be earmarked.

Project Operation Phase

Status of afforestation programmes, changes in migration patterns of the aquatic and terrestrial fauna species should be studied. The study could be undertaken with a frequency of once per year till the entire design life of the barrage. A provision of Rs.0.1 million/year can be kept for this purpose. The monitoring can be conducted by a reputed external agency.

16.8 INCIDENCE OF WATER-RELATED DISEASES

Project Construction Phase

Identification of water-related diseases, adequacy of local vector control and curative measures, status of public health are some of the parameters which should be closely monitored three times a year with the help of data maintained in the government dispensaries/hospitals.

Implementation : Public Health Department,
and Dispensary constructed
for labour camps

Cost per annum : Rs.0.2 million

Project Operation Phase

Increased prevalence of various vector borne diseases and adequacy of local vector control and curative measures need to be monitored. The monitoring can be done three times in a year.

Implementation : Dispensary at the project site

Cost per annum : Rs.0.2 million

16.9 LANDUSE PATTERN

Project Operation Phase

During project operation phase, it is proposed to monitor land use pattern once every year. An amount of Rs.0.3 million can be earmarked for this purpose.

16.10 SUMMARY OF ENVIRONMENTAL MONITORING PROGRAMME

The details of environmental monitoring programme are given in Tables 16.1 and 16.2 respectively.

TABLE-16.1
Summary of Environmental Monitoring Programme during
Project Construction Phase

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

TABLE-16.2
Summary of Environmental Monitoring Programme during
Project Operation Phase

S. No.	Items	Parameters	Frequency	Location
1.	Water	pH, Temperature, EC, Turbidity, Total Dissolved Solids, Calcium, Magnesium, Total Hardness, Chlorides, Sulphates, Nitrates, DO. COD, BOD, Iron, Zinc, Manganese	Thrice a year	<ul style="list-style-type: none"> • 1 km upstream of dam site • Water spread area • 1, 3 and 5km downstream of dam site
2.	Effluent from Sewage Treatment Plant (STP)	pH, BOD, COD, TSS, TDS	Once every week	<ul style="list-style-type: none"> • Before and after treatment from Sewage Treatment Plant (STP)

S. No.	Items	Parameters	Frequency	Location
3.	Erosion & Siltation	Soil erosion rates, stability of bank embankment, etc.	Twice a year	-
4.	Ecology	Status of afforestation programmess of green belt development	Once in 2 years	-
5.	Water-related diseases	Identification of water-related diseases, sites, adequacy of local vector control measures, etc.	Three times a year	<ul style="list-style-type: none"> • Villages adjacent to project sites
6.	Aquatic ecology	Phytoplanktons, zooplanktons, benthic life, fish composition	Once a year	<ul style="list-style-type: none"> • 1 km upstream of dam site • Water spread area • 1, 3 and 5 km downstream of dam site
7.	Landuse	Landuse pattern using satellite data	Once in a year	Catchment area
8.	Soil	pH, EC, texture, organic matter	Once in a year	Catchment area

CHAPTER-17

COST ESTIMATES

17.1 COST FOR IMPLEMENTING ENVIRONMENTAL MANAGEMENT PLAN

The total amount to be spent for implementation of Environmental Management Plan (EMP) is Rs.588.2 million. The details are given in Table-17.1.

TABLE-17.1
Cost for Implementing Environmental Management Plan

S. No.	Item	Cost (Rs. million)
1.	Compensatory Afforestation, and Bio-diversity conservation	53.15
2.	Catchment Area Treatment	70.20
3.	Fisheries Management	26.46
4.	Public health delivery system	32.27
5.	Environmental Management in labour camp	127.82
6.	Muck management	55.13
7.	Restoration and Landscaping of construction sites	16.05
8.	Environmental management in road construction	120.00
9.	Greenbelt development	1.40
10.	Water pollution control	1.80
11.	Resettlement and Rehabilitation Plan	28.781
12.	Energy Conservation measures	5.00
13.	Tribal Development Plan	37.00
14.	Environmental Monitoring during construction phase (Refer Table-17.2)	13.05
	Total	588.111, say Rs. 588.2 million

17.2 COST FOR IMPLEMENTING ENVIRONMENTAL MONITORING PROGRAMME

The cost required for implementation of the Environmental Monitoring Programme is of the order of Rs.7.32 million @ Rs.1.2 million/ year. A 10% annual price increase may be considered for every year. The construction period for estimation of cost for implementation of Environmental Monitoring programme during construction phase has been taken as 6 years. The details are given in Table-17.2. The cost required for implementation of the Environmental Monitoring Programme at operation phase is of the order of Rs.1.46 million/year. The details are given in Table-17.3.

TABLE-17.2**Cost for Implementing Environmental Monitoring Programme
during construction phase**

S. No	Item	Cost (Rs. million/year)	Total cost for construction period of 6 years with 10% escalation per year (Rs. million)
1	Water quality	0.11	1.04
2	Air quality	0.48	4.56
3	Ecology	0.90	8.54
4	Incidence of water related diseases	0.20	1.90
	Total	1.69	13.05

TABLE-17.3**Cost for Implementing Environmental Monitoring Programme
during operation phase**

S. No	Item	Cost (Rs. million/year)
1	Water quality	0.46
2	Ecology	0.50
3	Incidence of water related diseases	0.20
4	Land use pattern	0.30
	Total	1.46

ANNEXURE-I

PRELIMINARY REPORT OF THE STUDY

ON

**MINIMUM ENVIRONMENTAL FLOW FOR THE SUSTENENCE OF
ECOLOGY AND BIODIVERSITY IN NYAMJANG CHHU RIVER FOR
NYAMJANG CHHU HEP, TAWANG**

SUBMITTED TO

BHILWARA ENERGY LIMITED



**CENTRAL INLAND FISHERIES RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
BARRACKPORE, KOLKATA 700120, West Bengal**

INTRODUCTION

Arunachal Pradesh is the largest state in the north-east region with an area of 83,743 km². Physiographically the state is divided into the flood plains; the foothills and the greater Himalayas. The greater Himalaya comprises areas under permanent ice fields and temperate regions. The mountain peaks show a great variation in height from 1,829 m to 6,400 m with highest peak in Tawang and receives highest rainfall with an average more than 3000mm. Though there are five major rivers flowing through the state such as Kameng, Subansiri, Siang, Lohit and Tirap, Tawang chhu is the main river in the Tawang district and flows mainly in the east-west direction. Nyamjang Chhu is a major right bank tributary of Tawang Chhu. It originates in Tibet and enters India near the village of Khinzemane and flows mostly in the north-south direction up to its confluence with Tawang Chhu. Many tributaries add to the waters of Nyamjang Chhu, such as the Gomkang Rong Chhu, the Sumta Chhu, the Taksang Chhu to name a few. The Nyamjang Chhu merges with the Tawang Chhu near Lumla and the resultant river flows into Bhutan where it is known as Gamri Chhu.

Nyamjang Chhu Hydroelectric project is a run-of-the-river scheme with peaking pondage to harness the hydropower potential of River Nyamjang Chhu. The Project (NJCHEP) is located along Nyamjang Chhu between Zimithang and Lumla. The diversion site is located near Zimithang having coordinates at latitude 27°43'06" N, longitude 91°43'37" E and the powerhouse is located near confluence of Nyamjang Chhu and Tawang Chhu at latitude 27°31'16" N , longitude 91°41'12" E, an approximate distance of 25 km from the barrage site. It has been proposed that the length of the barrage would be 174.50m and the maximum height of barrage above average river bed level would be 10.20m. The catchment area upstream from Zimithang Village (barrage site) is about 2650 km². Out of this 2650 km², about 1945 km² of catchment area is above permanent snow line of EL.4500 m and 705 km² of catchment area receives precipitation in the form of rainfall.

In the light of rapid development of enormous hydropower generating units, most of the rivers ecosystems are in stake. Therefore the concept of Environmental flow came into existence, which mainly refers to the water considered sufficient for protecting the structure

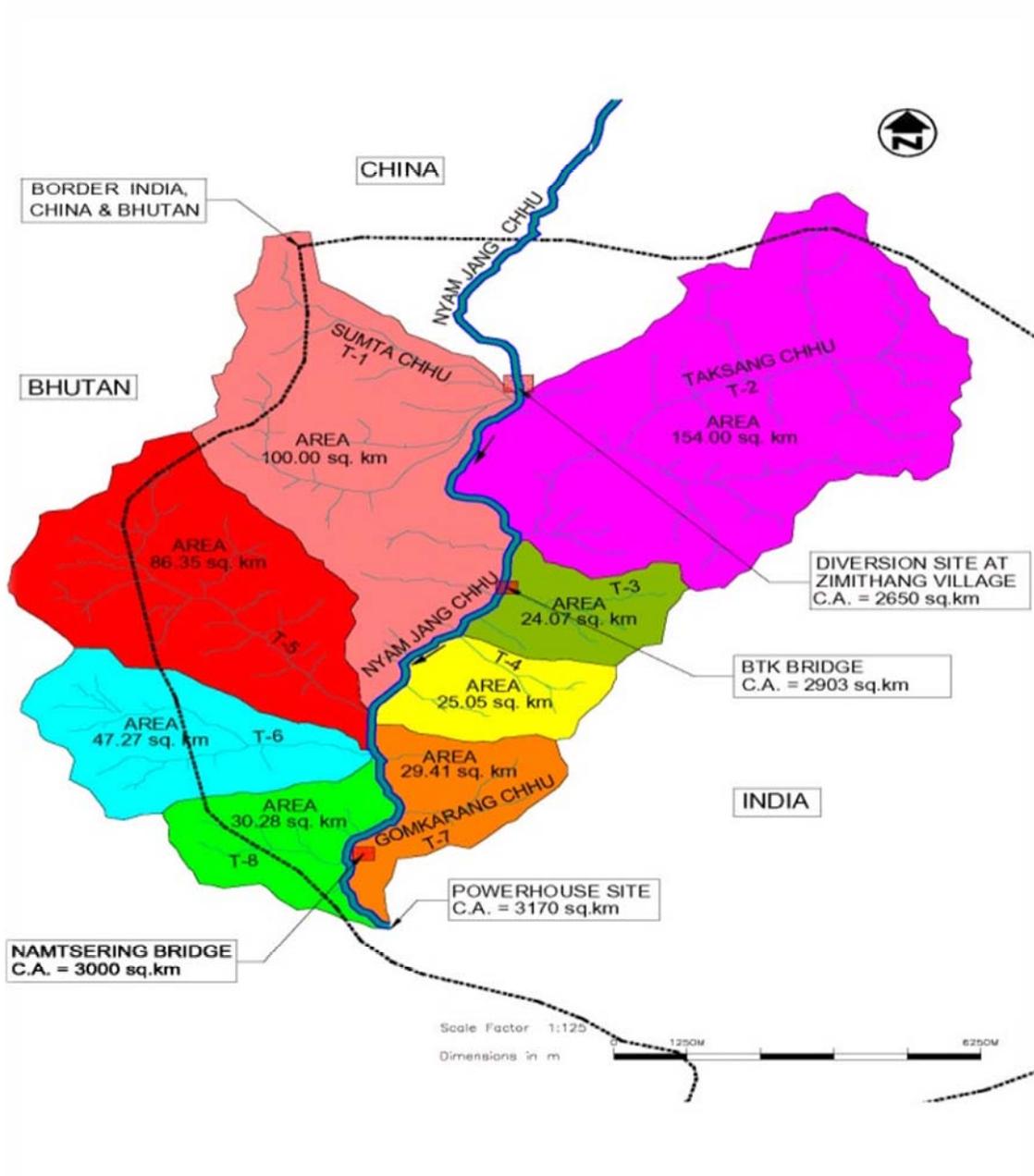


Fig 1. Index map of the Nyamjang Chhu river and the project site

and function of an ecosystem and its dependent species. Environmental flows are required to be maintained through a river reach for sustaining its ecosystem and dependent species. It means enough water is to be released in the downstream of the river system after utilizing the water for the development projects in order to ensure downstream environmental, social and economic benefits. Realizing its importance, several countries have made ensuring environmental flows mandatory. In India, the Himalayan rivers are mostly exploited through hydropower projects, which affects on river ecosystem mainly on fish and fisheries. Fish and fisheries being an important component of river, deserve utmost attention in the planned hydroelectric power generation projects with respect to conservation and livelihood for local fishers. Hydroelectric projects that proposed or under construction in Nyamjang Chhu river will affect the river ecology by altering the aquatic habitats, normal feeding and breeding grounds of the residential fish population. Riverine flow is a major determinant of physical habitat in rivers, which in turn influences biotic composition. Flow regime changes lead to habitat alterations, shifting in species composition, loss of biodiversity and failure in migration and breeding of residential fishes. The proposed barrage construction for NJCHEP project will alter the natural river flow, which may affect the flora and fauna of the river.

The specific terms of reference for study on environmental flow fixed by the MoEF is as follows: *"an estimation to be made for environmental flows downstream for sustenance of aquatic environment and for downstream uses, considering details of streams joining the river below the proposed dam site with their approximate distance from the dam site, their nature (whether perennial or seasonal) etc.* A detail environmental flow study shall be carried out through the premier institutions such as Central Inland Fisheries Research Institute (CIFRI), Barrackpore. So, it is needed to find out the minimum environmental flow requirement in the river for maintenance of healthy ecological condition towards sustenance of fishery and fish food organisms. Under this backdrop following objectives were investigated

OBJECTIVES:

- To assess the present status of aquatic habitat in terms of fishes and fish food organisms.
- To study the impact of seasonal flow regimes on fish and fish food organisms.
- To estimate the minimum environmental flow required for sustenance of fisheries.

Keeping the above objectives, the investigation was carried out according to the proposed action plan and information on the following aspects such as river morphology, preliminary data on main channel and streams, current velocity, water depth, river width, deep pools, sediment quality, fish faunal diversity, breeding and spawning ground, migratory fish species, biotic community status including plankton, periphyton, benthos were collected on Monsoon period (September 2010).

SELECTION OF SAMPLING SITES:

A total of 27 Km stretch of Nyamjang Chhu river flowing downstream from the barrage site to the TRT was surveyed and four sites i.e. Zimithang, BTK Bridge, Namstering and confluence point with Tawng Chhu were selected for the sample collection (Fig. 1). The survey was conducted in the form of direct sites visit, observation from the top view and secondary information collection from the project officials and other sources for the first hand understanding development on hydrobiology, riverine ecology, fish and fisheries, fish food organisms, and migration pattern of important fish that are likely to be affected by the proposed HE project. The detailed information on the sampling sites and their geographical position and morphology is given in Table 1. Information on the streams joining to the river has been collected and as given in Table 2. Data on 10 daily flow series at Zimithang and at BTK bridge was also collected from the technical personel and mentioned in the Table. The flow series at the diversion site has been approved by Central water commission (vide no. 2/Arunachal Pradesh/15/CEA/09-PAC/688-91 dated 26-02-2010)

Table 1. Geographical position and morphology of the selected sites

Parameters	Zimithang	BTK Bridge	Namstering	Confluence point (Kumba)
Village	Zimithang	Inkong	Namtseing	Kumba
District	Tawang	Tawang	Tawang	Tawang
Elevation(MSL)	2094	1599	1167	1139
Longitude	N 27 42 52.6	N 27 38 04.7	N 27 32 00.7	N 27 30 24.1
Latitude	E091 43 36.2	E091 43 21.6	E 091 40 29.1	E 091 40 28.4
Stream Width (m)	45-50	55-65	65-75	35-40
Stream Depth (m)	2-2.5	3.2	3.7	4-4.5
Stream Velocity(m/sec)	2	1.2	4.5	5.2
Bank full river width (m)	160-180	75-85	65-75	40-45
Flooding river width (m)	150-180	70-80	80-95	45-50
Bank full river depth (m)	4-5	5.5	4.5	4.5
Flooding river depth (m)	7-8	6-7	6-7	5-6
Substrate Composition (Relative %)	River borne materials, Sand, Loam, Gravel	Clay, loam, sand	Gravel, Sand, Silt	Bolders, gravels, sand
Recruitment/ Fish Seeds	Adult/ yearlings	Fingelings/Seeds	Fingelings/Seeds	Could not catch

Table 2. Streams joining to the Nyamjang Chhu in downstream from Barrage to TRT

SL. No	Name of Streams	Left Bank(LB)/ Right Bank(RB)	Distance from Barrage site (meter)	Average discharge during monsoon(cumec)
1	SUMTA CHHU	RB	300	3.5
2	GORSUM	RB	4000	-
3	SHIRDI	RB	5500	-
4	BLUDI	RB	7000	-
5	TAKSANG CHHU	LB	8500	5.4
6	BTK BRIDGE	LB	10000	-
7	BTK	RB	10500	-
8	SHAKTI VILLAGE	LB	12500	-
9	SHAKTI	LB	13000	-
10	THIKCHI	RB	16000	3.0
11	GISPU	LB	17000	-
12	SHERBANG	LB	20000	-
13	GONKANG	LB	21000	1.0
14	NAMSTERING	RB	24500	1.1

- : data not available

UNIT: CUMIECS

10-DAILY FLOW SERIES AT ZIMTHANG, NYAMLANG CHHU RIVER BASED ON TAWANG FLOWS (FINAL SERIES CONSIDERED FOR FLOW DURATION STUDY)

Month	Period	Days	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Average
JAN	I	10	11.56	14.34	14.37	14.37	12.82	13.72	10.81	11.18	11.85	12.61	13.98	13.46	18.68	20.44	21.7	31.84	21.75	16.98
	II	10	10.77	14.08	14.11	12.55	13.27	10.06	11.54	10.49	12.23	12.82	13.13	13.16	16.54	20.62	20.7	31.01	21.5	16.35
	III	11	10.33	13.4	13.41	12.3	12.82	9.83	11.43	10.65	12.23	12.82	13.13	13.13	16.8	20.56	20.06	32.23	21.58	16.22
FEB	I	10	9.64	15.34	15.36	12.44	13.25	10	12.15	9.57	11.26	13.17	12.44	12.44	16.36	20.03	20.26	28.01	19.01	14.96
	II	10	9.09	15.53	15.65	13.19	13.64	10.21	12.82	9.89	10.24	12.62	12.45	12.45	16	18.71	20.43	28.63	14.11	14.68
	III	8	8.93	12.94	13.1	12.13	13.59	10.29	12.76	9.88	10.19	11.66	12.85	12.85	16.19	16.83	20.04	29.36	15.33	14.13
MAR	I	10	11.1	12.17	14.11	14.11	12.63	12.9	12.54	11.95	9.51	10.85	10.69	12.6	16.18	21.82	22.75	12.34	17.19	13.84
	II	10	15.82	12.45	16.35	13.18	20.09	25.7	12.07	10.52	10.79	10.79	11.75	13.33	16.25	20.7	22.42	13.64	18.73	16.93
	III	11	24.2	14.03	21.9	22.92	15.41	21.01	14.25	9.85	12.02	13.81	13.74	16.12	28.53	23.14	14.11	30.71	18.48	
APR	I	10	20.83	18.49	22.26	19.81	24.89	13.37	19.46	11.94	25.31	12.95	15.39	24.41	24.41	22.7	24.89	17.09	38.88	20.80
	II	10	29.52	23.19	42.44	24.84	24.83	18.61	23.88	14.84	23.11	14.27	24.6	28.14	32.34	32.34	22.2	31.56	28.72	
	III	10	24.52	28.84	26.3	33.82	27.59	20.34	32.56	23.83	28.17	22.26	28.49	34.04	34.04	35.87	40.23	19.59	37.81	28.89
MAY	I	10	37.18	43.86	38.41	42.08	40.91	40.91	37.87	37.53	20.8	29.57	21.96	29.51	34.34	33.2	35.19	35.1	47.53	35.32
	II	10	38.71	42.74	38.43	54.11	39.4	44.09	38.16	17.17	42.33	31.24	40.91	40.91	32.53	52.7	41.04	39.4	56.5	40.59
	III	11	44.84	36.98	42.54	42.39	46.89	41.72	56.03	69.7	91.8	39.62	73.27	70.92	67.71	77.94	64.96	99.47	91.92	117.2
JUN	I	10	64.2	54.94	71.9	62.64	58.14	56.03	69.7	91.8	39.62	73.27	70.92	67.71	77.94	64.96	99.47	91.92	117.2	72.49
	II	10	91.11	62.59	73.79	66.6	65.62	59.69	89.64	107.47	46.88	86.65	79.69	91.13	86.78	86.66	114.33	79.31	54.92	80.12
	III	10	103.28	94.49	81.91	90.64	103.48	112.2	89.76	184.52	79.22	108.32	108.32	90.73	135.86	150.86	92.32	100.52	70.45	106.89
JUL	I	10	128.78	85.53	69.57	77.11	146.39	108.57	114.12	179.31	77.42	85.15	69.61	118.39	157.59	134.16	95.86	108.92	59.67	108.83
	II	10	128.51	94.65	87.29	67.87	123.1	124.95	110.09	167.43	80.41	89.03	86.99	97.23	143.15	149.3	121.99	109.25	95.2	108.32
	III	11	100.46	110.98	94.77	93.42	100.16	118.16	87.34	153.91	101.7	103.28	91.33	137.19	115.47	146.72	126.18	121.26	240.99	120.78
AUG	I	10	137.74	110.85	145.18	83.66	106.07	104.17	101.9	160.52	79.64	118.07	91.82	101.98	111.69	131.89	147.11	90.51	97.17	112.93
	II	10	134.9	95.42	127.24	93.28	109.51	114.51	155.77	217.43	87.95	107.1	86.38	142.34	105.73	126.16	140.72	84.63	100.2	119.37
	III	11	118.22	117.61	125.99	112.17	109.7	92.97	99.4	199.15	111.59	99.16	115.95	143.08	114.35	107.39	130.52	103.45	82.47	116.66
SEP	I	10	125.5	96.54	98.96	91.48	89.8	113.33	113.79	107.28	114.74	115.05	91.68	94.53	112.75	90.95	105.24	78.34	111.6	102.44
	II	10	87.94	85.55	98.73	88.64	85.09	109.85	78.51	91.35	100.48	86.15	83.55	122.37	60.96	67.66	100.34	62.19	88.70	
	III	10	87.18	65.12	86.5	83.06	85.83	74.61	92.47	79.57	67.35	84.38	75.02	67.42	89.56	58.16	59.91	75.2	58.37	76.89
OCT	I	10	66.98	56.37	67.57	59.77	56.1	74.99	57.51	78.39	61.78	60.87	60.87	57.86	78.44	96.03	60.66	60.81	55.51	67.13
	II	10	51.61	66.13	66.49	42.56	48.61	48.63	48.63	71.96	58.84	45.54	48.19	48.45	72.24	48.76	53.89	39.73	43.12	47.24
	III	11	41.47	43.82	60.35	34.12	41.06	44.98	40.91	50.92	54.75	36.33	38.84	48.19	48.45	72.24	48.76	53.89	39.73	43.12
NOV	I	10	36.64	36.14	37.1	36.12	37.1	36.29	32.76	39.21	42.65	29.39	38.84	40.94	67.88	39.8	34.48	35.39	24.91	37.91
	II	10	33.65	33.57	36.43	33.65	35.88	33.31	31.41	24.03	35.97	26.62	31.91	38.72	58.38	34.61	33.73	34.43	16.57	33.70
	III	10	31.87	32.21	35.28	32.21	29.84	31.55	32.02	21.51	22.52	24.54	25.54	34.76	51.01	30.83	29.85	32.92	13.12	30.10
DEC	I	10	18.36	19.25	22.82	17.2	14.11	15.85	17.1	17.89	18.13	18.13	19.41	24.22	33.94	24.42	35.1	24.99	11.47	20.79
	II	10	18.28	17.51	17.25	15.81	12.71	15.19	15.19	15.21	15.49	17.28	18.22	23.12	24.81	23.18	33.75	23.03	9.13	18.87
	III	11	14.47	15.52	14.34	15.55	15.29	13.4	13.43	13.43	14.25	14.58	17.28	17.21	20.16	22.27	23.23	31.59	8.87	16.86
Flow Vol (Mm ³)			1475.84	1485.14	1621.93	1482.01	1615.30	1688.83	1897.31	2088.24	1335.37	1583.04	1489.48	1673.44	1934.39	1870.61	1838.82	1645.94	1837.80	1633.23

Detail of water and soil quality and biotic status from the sampling sites were analysed by standard methods.

WATER QUALITY ANALYSIS:

Fish inhabit in the aquatic environment, so water quality plays an important role in growth and physiological process. To have an understanding about the existing water quality of the Nyamjang Chhu river, specifically in the stretch of the proposed HE project, eleven water quality parameters have been analyzed for each selected sampling sites. The water samples was collected and analyzed by following standard scientific methods. The water temperature of the investigated sites (13.1 °C – 16.6 °C) is found suitable for growth and survival of cold water fishes. Productive water bodies are generally slight turbid in nature. The water transparency values of the investigated sites have indicated a moderate aquatic productivity of the river. However, the observed water pH ranges is found to be conducive for optimum growth and health of cold freshwater fishes. Dissolved oxygen concentration above 8.0 mg l⁻¹ is an indication of healthy and productive quality in freshwater ecosystems. From that point of view, Nyamjang Chhu river contains a healthy environment for fishes and other aquatic organisms. The high dissolved oxygen concentration in the river is due to natural aeration of water by surface agitation during flowing through its mountain embanked course. The recorded free CO₂ values of water are far below the tolerance limit of the freshwater fishes. The analysis of the water quality is given in Table 3.

SOIL QUALITY ANALYSIS:

The soil samples were collected from each selected site for physical and chemical analysis. For chemical assessment of soil quality four parameters were identified. The soil composition analysis has revealed that the upper stretches of the stream between barrage to TRT, composed of river borne materials mainly sand, silt, clay, loam, and gravels an indication of fertile benthic environment. While at confluence point, the physical components mainly composed of boulders, gravels, and sand and in these sites the level of periphyton (attached living organisms) were higher. The detail analysis of the soil quality is given in Table 4.

Table 3. Water quality analysis collected from different sites

Parameters	Zimithang	BTK Bridge	Namstering	Confluence point (Kumba)
Temperature (⁰ C)	13.1	14.6	16.5	17.5
Transparency (cm)	12	11	15	12
pH	7.4	7.6	7.5	7.4
Conductivity ($\mu\text{s}/\text{cm}^2$)	223	200	173	167
Dissolved Oxygen (mg l^{-1})	8.0	8.4	8.4	8.5
Free CO ₂ (ppm)	2.0	2.8	3.4	1.6
CO ₃ Alkalinity (ppm)	NIL	NIL	NIL	NIL
HCO ₃ Alkalinity (ppm)	56.0	52.0	44.0	38.0
Total Alkalinity (ppm)	56.0	52.0	44.0	38.0
Total Hardness(mg l^{-1})	115	107	88	82
No ₃ (ppm)	0.01-0.05	0.01-0.05	0.01-0.05	0.01-0.05

Table 4. Soil quality analysis collected from different sites

Parameters	Zimithang	BTK Bridge	Namstering	Confluence point (Kumba)
Clay (%)	2.0	0.0	1.5	0.0
Silt (%)	8.0	1.0	5.0	1.0
Sand (%)	90.0	99.0	93.5	99.0
pH	7.6	7.9	7.8	7.8
Specific conductance ($\mu\text{s}/\text{cm}^2$)	204	167	127	205
Organic Carbon (%)	2.07	0.075	0.105	0.045
Available Phosphate (mg/100 g)	2.46	0.923	1.31	1.73
Copper (ppm)	23.201	15.847	12.787	13.645
Manganese (ppm)	415.45	453.47	450.31	457.39
Zinc (ppm)	13.743	12.989	9.683	11.438

BIOTIC STATUS:

Plankton and periphyton:

The biotic status mainly indicates the productivity of the water bodies in terms of aquatic living organisms such as Phytoplanktons, Zooplanktons, Periphytons, Benthic populations and fishes. As the water and soil quality of upper stretched of the stream between barrage and TRT is suitable for the growth and sustenance of these organisms, the population density was found more. The plankton samples were collected, preserved and assessed by following the standard method. While the periphyton samples were collected by scrap method from submerged rocks of the selected sites. Preservation and assessment of the collected samples were done by following standard method. Among the planktons and periphytons, the dominate group/taxa were *Chlorophyceae* sp. such as *Ankistrodesmus* sp., *Microspora* sp., *Ulothrix* sp., *Zygnema* sp., *Mougeotia* sp., among *Bacillariophyceae* sp. such as *Fragillaria* sp. , *Navicula* sp., *Cymbella* sp., *Pinnularia* sp., among *Myxophyceae* sp. such as *Anabaena* sp., *Phormidium* sp., *Oscillatoria* sp. and among *Desmidiaceae* sp. such as *Closterium* sp., *Cosmarium* sp. While at Namtsering Bridge station the benthic population mainly dominated by *Argia* spp. (Order: Odonata, Sub-order-Zygoptera). The availability of this species is contributed by the low stream velocity as well as the protected small water area below the bridge. The detail abundance of the plankton, periphyton and benthos population of Nyamjang Chhu river between barrage site to TRT is given in Table 5.

Fisheries:

It is interesting to note that the local village people at Zimithang and BTK Bridge consider fish as the most sacred animal and never allow for fishing or for any commercial purpose. In addition to the better bottom biota and moderate stream flow that make ideal for the growth and survivability of the fishes. During the investigation, fish samples were collected through experimental fishing by using different gears such as cast net, and drag net (Fig. 2). Adult fish of *Schizothorachthys progastus* size of 6.4 to 26.5 cm were recorded at Zimithang. While fingerlings/juveniles of 5.5 to 7.5 cm size of the same species in large number were observed at BTK and Namtsering Bridge (Fig. 3A-B). In addition, *Lepidocephalus berdmorei* was also recorded at BTK Bridge (Fig. 3C).

Table 5. Abundance of plankton, periphyton and benthos population at selected sampling sites

Groups	Stations			
	Zemithang	BTK	Namtsering	Kumba
Plankton (UI ⁻¹)	26	28	12	19
Periphyton (nos./cm ²)	938	780	990	5288
Benthos (nos./m ²)	-	-	4	-
Plankton abundance				
Phytoplankton (%)				
Chlorophyceae	14.28	28.57	-	33.33
Bacillariophyceae	42.85	14.28	33.33	50.00
Myxophyceae	42.85	42.85	66.66	16.66
Zoo-plankton	Nil	Nil	Nil	Nil
Periphyton (%)				
Chlorophyceae	30	26.92	38.88	28.72
Bacillariophyceae	60	40.38	16.66	23.40
Myxophyceae	10	26.92	44.44	46.27
Desmidiaceae	-	5.76	-	1.59



A



B



C



D

Fig. 1 (A-D): Sampling sites A: Zimithang B: BTK Bridge C: Namstering; D: Confluence point (Kumba)



(A)



(B)

Fig. 2 Cast net (A) and Drag net (B) used for collection of fish sample



(A)



(B)



(C)

Fig. 3 (A-C): Fish samples A, B: *Schizothoracichthys progastus* C: *Lepidocephalus berdmorei*

CONCLUSION:

Though samples were collected from four identified sites below the barrage; more emphasis was given at the Zimithang and BTK for fish habitat and availability of fish food organisms, which are adjoining to the Barrage site. Based on the studies carried out, both the sites (Zimithang and BTK) were found to be conducive for the fish habitat. However, the BTK site was found more suitable for the juveniles of two species *Schizothoracichthys progastus*, *Lepidocephalus berdmorei*. It is noted that several streams have joined from both right and left bank to the main channel contributing major discharges to Nyamjang Chhu river in the downstream stretch of the river from the barrage. It is to mention that in the immediate vicinity of the barrage, about 300m downstream of the axis one of the major contributing stream (Sumta chhu) joins the channel indicating the continuous availability of water to the main river.

Based on the preliminary report and one season study the minimum flow required to be discharged from the barrage for the sustenance of aquatic habitat especially establishing the breeding and recruitment of the existing fish population can not be finalized. After studying further during remaining two seasons the minimum flow requirement will be determined. However, based on one season study and general guidelines (MoEF) the minimum flow requirement for the sustenance of ecology and biodiversity in Nyamjang Chhu river can be taken as 20% of the average flow of lean season in 90% dependable year which shall be finalized after three season studies and will be indicated in the final report.

CHAPTER-1
COMPENSATORY AFFORESTATION
AND
BIODIVERSITY CONSERVATION PLAN

CHAPTER-2
CATCHMENT AREA TREATMENT PLAN

CHAPTER-3
FISHERIES MANAGEMENT PLAN

CHAPTER-4
PUBLIC HEALTH DELIVERY SYSTEM

CHAPTER-5
ENVIRONMENTAL MANAGEMENT
IN LABOUR CAMPS

CHAPTER-6
MUCK MANAGEMENT PLAN

CHAPTER- 7
RESTORATION AND LANDSCAPING OF
CONSTRUCTION SITES

CHAPTER-8
ENVIRONMENTAL MANAGEMENT IN ROAD
CONSTRUCTION

CHAPTER-9
GREENBELT DEVELOPMENT PLAN

CHAPTER-10
CONTROL OF AIR POLLUTION

CHAPTER-11
MEASURES FOR NOISE CONTROL

CHAPTER-12
WATER POLLUTION CONTROL

CHAPTER-13
RESETTLEMENT AND
REHABILITATION PLAN

CHAPTER-14
ENERGY CONSERVATION MEASURES

CHAPTER-15
TRIBAL DEVELOPMENT PLAN

CHAPTER-16
ENVIRONMENTAL MONITORING PROGRAMME

CHAPTER-17
COST ESTIMATES

CONTENTS

FIGURES

EXECUTIVE SUMMARY