Tamil Nadu Green Energy Corporation Limited (TNGECL), Tamil Nadu

SILLAHALLA PUMPED STORAGE HYDRO-ELECTRIC PROJECT, STAGE-I (4X250 MW)

COMPREHENSIVE ENVIRONMENTAL IMPACT ASSESSEMENT / EMP STUDY REPORT

Consultant :

WAPCOS LIMITED

(A Government of India Undertaking)
(Ministry of JAL SHAKTI)
76-C, Institutional Area, Sector – 18,
Guru gram – 120015, Haryana (INDIA)
Email id: dam@wapcos.co.in

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INTRODUCTION

1.1 General

Tamil Nadu Green Energy Corporation Limited (TNGECL) propose to develop Sillahalla Pumped Storage project (PSP) in the Nilgiris District of Tamil Nadu to meet the increase in peak power demand. The proposed Pumped Storage Hydro-electric Project (PSHEP) envisages construction of an upper reservoir on Sillahalla River together with a lower reservoir downstream on Kundah River. The main storage for proposed scheme shall be in upper reservoir. The water thus stored in upper reservoir would be re-cycled to generate peaking power as sufficient head is available between the two reservoirs. Sillahalla River would perhaps be one of the biggest Pumped storage Schemes in the range of 1000 MW in India. High head pumped storage projects are always considered attractive world over. In India very few sites are available for pumped storage development as it requires number of site specific requirement to suit such development. Sillahalla PSHEP Stage-I offers a gross head of 430 m between the two proposed reservoirs which is amongst the select few high head schemes in India and thus the most attractive part of the scheme. This aspect will lead to minimum civil works and hence will be an economical scheme.

The above factors make Sillahalla Pumped Storage Hydro-electric Project Stage-I (4X250 MW) a very attractive proposition and merits its early implementation.

1.2 Project Location and Its Accessibility

Sillahalla Pumped Storage Hydro-Electric Project Stage-I (1000 MW) is planned in the Nilgiris district of the southern Indian state of Tamil Nadu. The coordinates of the propose Upper Dam site are 11° 18’ 57.64” N and 76° 39’ 2.74” E (Left Bank) and 11° 18’ 53.11” N, and 76° 38’ 51.74” E (Right Bank) respectively. The coordinates of the proposed Lower Dam site are 11 ˚ 16’ 34.11” N, 76 ˚ 40’ 11.72” E (Left Bank) and 11 ˚ 16’ 22.77” N, 76 ˚ 40’ 5.96” E (Right Bank) respectively.

The project location map is shown in **Figure-1.1**. The Google image of proposed dam site location is shown in **Figure-1.2**.

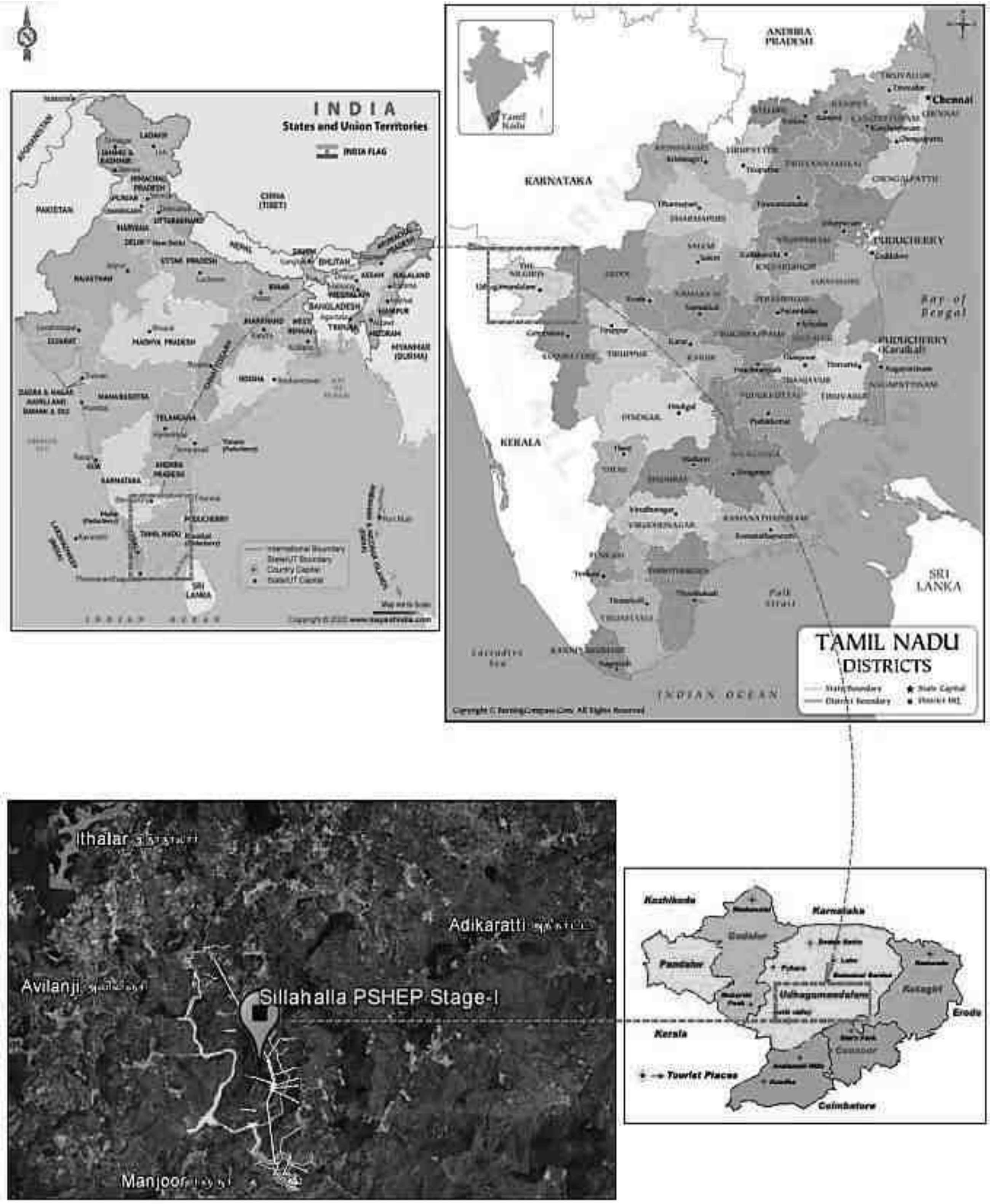


Figure-1.1: **Project Location Map**

Figure 1.2: The Google image of proposed dam site locations

The proposed project site can be approached by Road, Rail and Air from Coimbatore in Tamil Nadu. The accessibility of project site of various modes of transport is given in Table-1.1.

Table-1.1: Accessibility of project site by various modes of transport

S. No.	Medium of Transport	Details
1	By Air	Nearest airport is Coimbatore
2	By Rail	Nearest rail head is Mettupalayam /Coimbatore
3	By Road	From Coimbatore – 100 km by road (Coimbatore - Mettupalayam - Udhagamandalam – Sillahalla Dam site)
4	Sea Port	Tuticorin

1.3 Need for the Project

The present scheme is a very attractive scheme both in terms of technical feasibility and from economical consideration. The scheme envisages utilization of the waters of Sillahalla River (tributary of Kundah River) through underground Power house by a water conductor system. The proposed pumped scheme envisages peak power generation on a Pumped storage type development, harnessing a head of about 430+ m between proposed upper reservoir and lower reservoir.

To satisfy the energy needs of the State, Tamil Nadu Generation and Distribution Corporation Limited has a total installed capacity of 18747.28 MW which includes TNGEDCO owned State projects, share from the Central Generating Stations (CGS) and Private Power Purchase. Other than this, the State has installations in renewable energy sources like wind mill, solar, biomass and cogeneration up to 10479.61 MW.

To meet the ever-increasing energy demand in the coming years, TNGECL has proposed new generation projects in next 5 years. TNGECL has exploited the hydroelectric potential available in the state. However, to balance the excess power available during off peak hours and to tide over the peak hour shortage, Sillahallah Pumped Storage Hydro Electric Scheme (4x250 MW) has been proposed in the Nilgiris.

TNGECL has also proposed to establish small hydroelectric projects of capacity less than 25MW in the run of river scheme with total capacity of 110 MW. Power generation, especially coal based power plants are prone to have an adverse impact on the environment. Presently TNPGCL has four major coal based Thermal Power Stations with a total capacity of 4060 MW and four gas based power plants with a total capacity of 516 MW. TNGECL recognizes its social obligation and is conscious of the importance of prevention of degradation of the environment due to its Thermal Stations. Hence TNGECL is very much serious in incorporating the environmental safeguards relentlessly in all its Power Plants, right from the inception stage of the Project to the commissioning stage and in the day to day running of the Power Plants.

Since the Upper and Lower reservoirs of Sillahalla Pumped Storage Project (Sillahalla PSP) has effective storage capacity equivalent to five (5) to Six (6) hours of generation daily at full rated output, it is not possible for Sillahalla PSHEP to operate on weekly or seasonal basis. Therefore, the Project is deemed to be operational on Daily basis.

1.4 Inter-State / Inter-National Aspects

The proposed Sillahalla PSHEP Stage-I envisages two reservoirs, i.e. Upper Reservoir across Sillahalla river which is a tributary of Kundah river and the Lower

Reservoir across Kundah river which joins Bhavani river further downstream near Coimbatore, within the state of Tamil Nadu. The project area mainly lies between Upper and Lower Reservoirs in Kundah sub-basin. Kundah sub-basin which has a drainage area of 294 km^2 lies entirely in Tamil Nadu. Kundah River subsequently joins Bhavani River which has a drainage area of 7144 km^2.

In view of above, the proposed Sillahalla PSHEP Stage-I does not have any inter-state ramifications. Likewise, the proposed project has no international aspects as well.

1.5 Policy, Legal and Administrative Framework

In the emerging scenario of rapid economic growth, sustainability of existing resources for the present and future generations requires an integrated approach so that, the existing resources are optimally utilized without causing undue damage to the environment. To achieve this objective, the Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India (GoI) has enacted Acts, Legislations, Guidelines and Standards to ensure sustainable development and conserve the environment.

As per the guidelines pertaining to Environmental Clearance issued by MoEF&CC, dated September 14, 2006 and its subsequent amendments, the proposed Sillahalla PSP requires Environmental Clearance from MoEF&CC. A Comprehensive Environmental Impact Assessment (CEIA) report is pre-requisite requirement for obtaining the Environmental Clearance.

TNGECL has awarded the work of Preparation of Detailed Project Report (DPR) to WAPCOS Limited, A Government of India Undertaking under the aegis of Ministry of Jal Shakti. The preparation of CEIA Report for the said project is also part of the work awarded to WAPCOS Limited.

TNGECL had submitted online proposal for obtaining Terms of Reference (TOR) to carryout CEIA study to MOEF&CC on 05.10.2019.The proposal was considered by the Expert Appraisal Committee (EAC) for River Valley & Hydroelectric projects in its 1st meeting held on 28.07.2020. The Terms of Reference (TOR) was granted by MOEF&CC vide letter dated 23.09.2020 for conducting the CEIA Study for the proposed Sillahalla PSP. The point wise compliance of TOR is enclosed as

Annexure-I. Likewise, point wise compliance of Additional TOR is enclosed as Annexure-II.

1.6 Scope of the CEIA Study

The brief Scope of CEIA study includes the following:

- Assessment of the existing status of physico-chemical, ecological and socio-economic aspects of environment
- Identification of potential impacts on various environmental components due to activities envisaged during construction and operational phases of the proposed PSP.
- Prediction of significant impacts on major environmental components using appropriate techniques.
- Delineation of Environmental Management Plan (EMP) outlining measures to minimize adverse impacts during construction and operational phases of the proposed PSP.
- Formulation of Resettlement and Rehabilitation(R&R) Plan.
- Delineation of Formulation of Catchment Area Treatment (CAT) Plan.
- Formulation of Environmental Monitoring Programmes (EMoP) for implementation during construction and operation phases.
- Estimation of Cost for implementation of EMP, R&R Plan, CAT Plan and EMoP, Local Area Development (LAD) Plan and Corporate Environmental Responsibility (CER) Plan.

1.7 Stages in CEIA Study

The purpose of this section is to enumerate the steps involved in an Environmental Impact Assessment (EIA) study, which are described in the following paragraphs:

- **Scoping**: An exhaustive list of all likely impacts drawing information from as many sources as possible was prepared. The next step was to select a manageable number of attributes which were likely to be affected as a result of the proposed project.

Various criteria applied for selection of the important impacts were follows:

- magnitude
- extent
- significance

- **Description of Environment:** Before the start of the project, it is essential to ascertain the baseline levels of appropriate environmental parameters which could be significantly affected by the implementation of the project. The baseline status assessed as a part of CEIA study through data from primary as well as secondary sources.

- **Prediction of Impacts:** is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur as a result of the construction and operation of the proposed pumped storage project. An attempt has been made to forecast future environmental conditions quantitatively to the extent possible. However, for intangible impacts, qualitative assessment has been made so that planners and decision-makers are aware of their existence as well as their possible implications.

- **Environmental Management Plan (EMP) and Mitigation Measures:** the approach for formulation of an EMP is to maximize the positive environmental impacts and minimize the negative ones. The steps suggested as a part of EMP include modifications of plans, engineering designs, construction schedules and techniques, as well as operational and management practices. After selection of suitable environmental mitigation measures, cost required for implementation of various management measures has also been estimated as a part of the present study.

- **Environmental Monitoring Programme (EMoP):** An EMoP for implementation during project construction and operation phases has been outlined as a part of the CEIA Report to oversee the environmental safeguards, to ascertain the agreement between prediction and reality and to suggest remedial measures not foreseen during the planning stage but arising during construction and operation phases. The exercise will also generate data for future use and serve as a reference for assessment of impacts of hydropower projects in similar settings.

1.8 Outline of the Report

The present document outlines the findings of the CEIA study for the proposed Sillahalla PSP. The contents of the document are as follows:

Chapter-1 gives an overview of the need for the project. The policy, legal and administrative framework for Environmental Clearance has been summarized. The objectives and need for EIA study too have been covered.

Chapter-2 Gives a brief description of the proposed Sillahalla PSP

Chapter-3 Covers the environmental baseline conditions covering physical, ecological and socio-economic aspects of environment. The baseline study involved both field work and review of existing documents, which is necessary for appropriate utilization of data which may already have been collected for other purposes.

Chapter-4 Describes the anticipated positive and negative impacts as a result of the construction and operation of the proposed Sillahalla Pumped Storage Project on physico-chemical and ecological aspects of environment. Impact Assessment is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur as a result of the construction and operation of the proposed project. An attempt was made to forecast future environmental conditions quantitatively to the extent possible. For certain parameters, which cannot be quantified, approach has been to discuss such intangible impacts in qualitative terms so that planners and decision-makers are aware of their existence as well as their possible implications. Mitigation measures for amelioration of adverse Impacts too have been presented in the chapter.

Chapter-5 Describes the alternatives considered for the proposed Sillahalla PSP project.

Chapter-6: Covers the Environmental Monitoring Programme for implementation during project construction and operation phases.

Chapter-7 Describes various additional studies conducted during the study which included Public hearing details, Disaster Management Plan (DMP), Social Impact Assessment (SIA), R&R Plan for PAFs, Local Area Development Plan (LADP), etc.

Chapter-8: Covers the Project Benefits due to implementation of the proposed Sillahalla Pumped Storage Project

Chapter 9: Outlines the Environmental Cost Benefit analysis.

Chapter-10: Delineates various measures as a part of the Environmental Management Plan (EMP).

Chapter-11: Covers the Summary and Conclusions of the project.

Chapter-12: Lists the Experts involved in the CEIA study for Sillahalla Pumped Storage Project.

CHAPTER-2
PROJECT DESCRIPTION

2.1 General

The proposed Sillahalla PSHEP Stage-I is to be developed by utilizing the water of Sillahalla River, a perennial stream of the tributary of River Kundah in the Nilgiris District of Tamil Nadu by constructing an upper dam across Sillahalla stream and lower dam across Kundah river downstream of existing Kundah Palam Dam. Both the dams are interconnected by the tunnel to generate electricity for peak hours and recycle the water from lower to upper dam at the time of non-peak hours. The proposed upper reservoir is to be developed in Udhagamandalam and Kundah taluk, whereas the lower reservoir is to be developed in Kundah taluk of the Nilgiris district.

2.2 River System

The Kundah River is a tributary of the river Bhavani. It flows in the southern side of Ooty. It originates in the high peaks at El. 2629m along the dividing ridge between Tamil Nadu and Kerala of the Western Ghats in the Nilgiris District. Avalanche and Emerald are its two tributaries in the upper reaches and these two run down independently up to El.1920m. Further down, various tributaries including Sillahalla, Kanarhalla, Kowarimullihalla join the main river Kundah at about El.1625m. The Sillahalla River joins Kundah River on the left flank about 1.4 km upstream of Kundah Palam dam constructed across the Kundah River. Kundah Palam dam & Emerald dam surplus water enters Sillahalla Stream in middle of Edakadu. Below Kundah Palam, the river runs entirely in cascades with the Pegumbahallah draining a catchment area of about 41.44 sq km joining together at EL. 640 m on the right. Further down river Pegumbahallah, another tributary of Kundah originating at El. 2299 m joins at El.640m. Then finally the Kundah River joins River Bhavani at El.408 m near Pillur in Coimbatore District. The total catchment area of the Kundah basin upto its confluence with Bhavani River is about 285 sq km. The upper reservoir of the proposed Sillahalla Pumped Storage Hydro-Electric Project area is located on Sillahalla stream which is a tributary of Kundah River and the lower reservoir is also located on Kundah River below Kundah Palam forebay dam. Kundah Hydro-electric System in the Nilgiris District is shown in **Figure-2.1.**

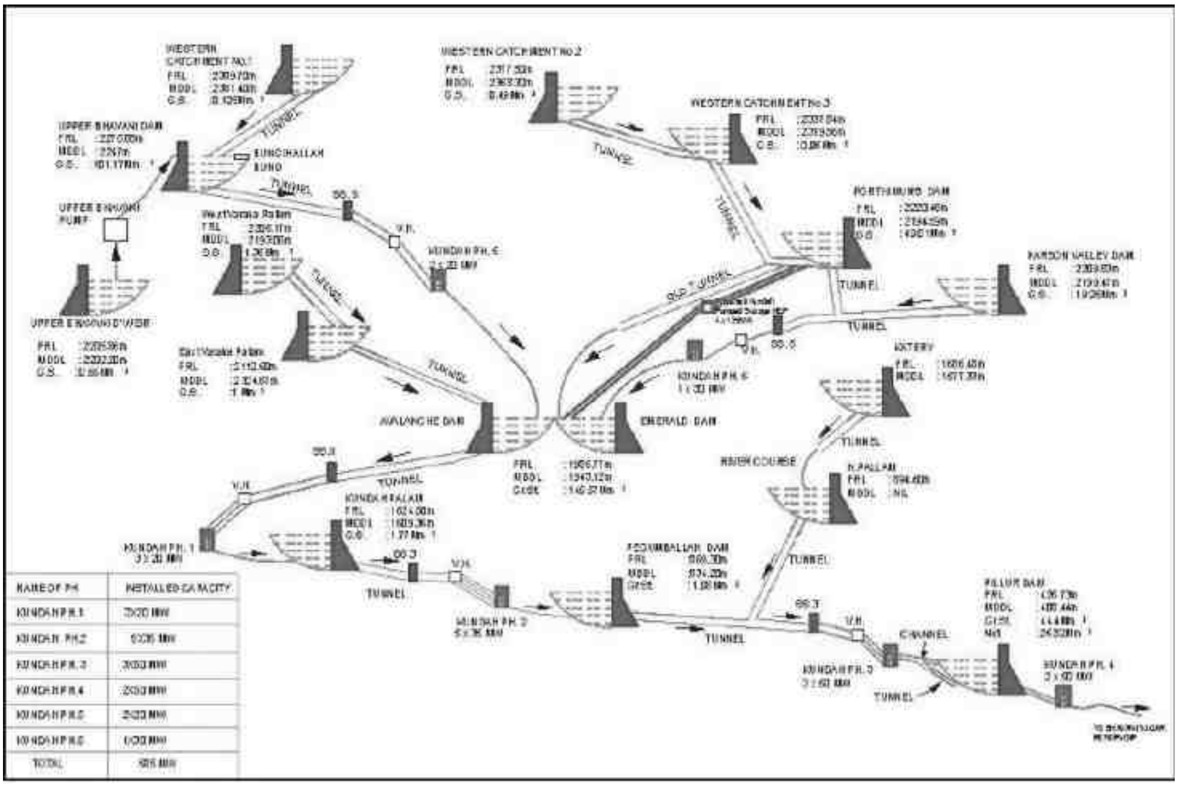


Figure 2.1: Kundah Hydro-electric System in the Nilgiris District

2.3 Proposed Scheme

The proposed Sillahalla PSP envisages the following components:

- Construction of concrete gravity upper dam of 82 m height and 327 m length across Sillahalla River.
- 1 no. Power intake with trash rack having mechanical raking arrangement and gate shaft.
- 1 no. 2862 m long, 9 m dia. circular concrete lined head race tunnel.
- 1 no. 70 m high, 20 m dia. circular concrete lined HRT surge shaft.
- 2 nos. 533 m long, 6.5 m dia. inclined circular steel lined pressure shaft.
- 4 nos. 55 m long, 4.75 m dia. circular steel lined Penstocks.
- An underground powerhouse cavern of size of 160m x24m x 55m to house 4 no. Francis reversible pump turbine generating units of 250 MW capacity each.
- 1 no. Transformer cavern 130m x 18m x 22.5m to house 4 nos. generator transformers.

- 4 nos. of draft tube tunnels of 5 m dia and 81 m length.
- 1 no. TRT surge chamber of size 85m x 10m x 88m.
- 1 no. 1567 m long, 9.75 m dia. circular concrete lined tail race tunnel to carry the water from power house to lower reservoir.
- 1 no. of Tail Race outlet with 1 no gate shaft and trash rack having mechanical raking arrangement.
- Construction of concrete gravity lower dam of 112 m height and 470 m length across Kundah River.
- 1 no. Main Access Tunnel (MAT) D- shaped of 1240 m long 8m width & 8m height.
- 3 nos. construction adit's – 1 no. adit 1 to HRT, 1 no. adit 2 to HRT surge shaft, 1 no. adit 3 to butterfly valve.

The layout of the proposed Sillahalla PSHEP, Stage-I is enclosed as Figure-2.2.

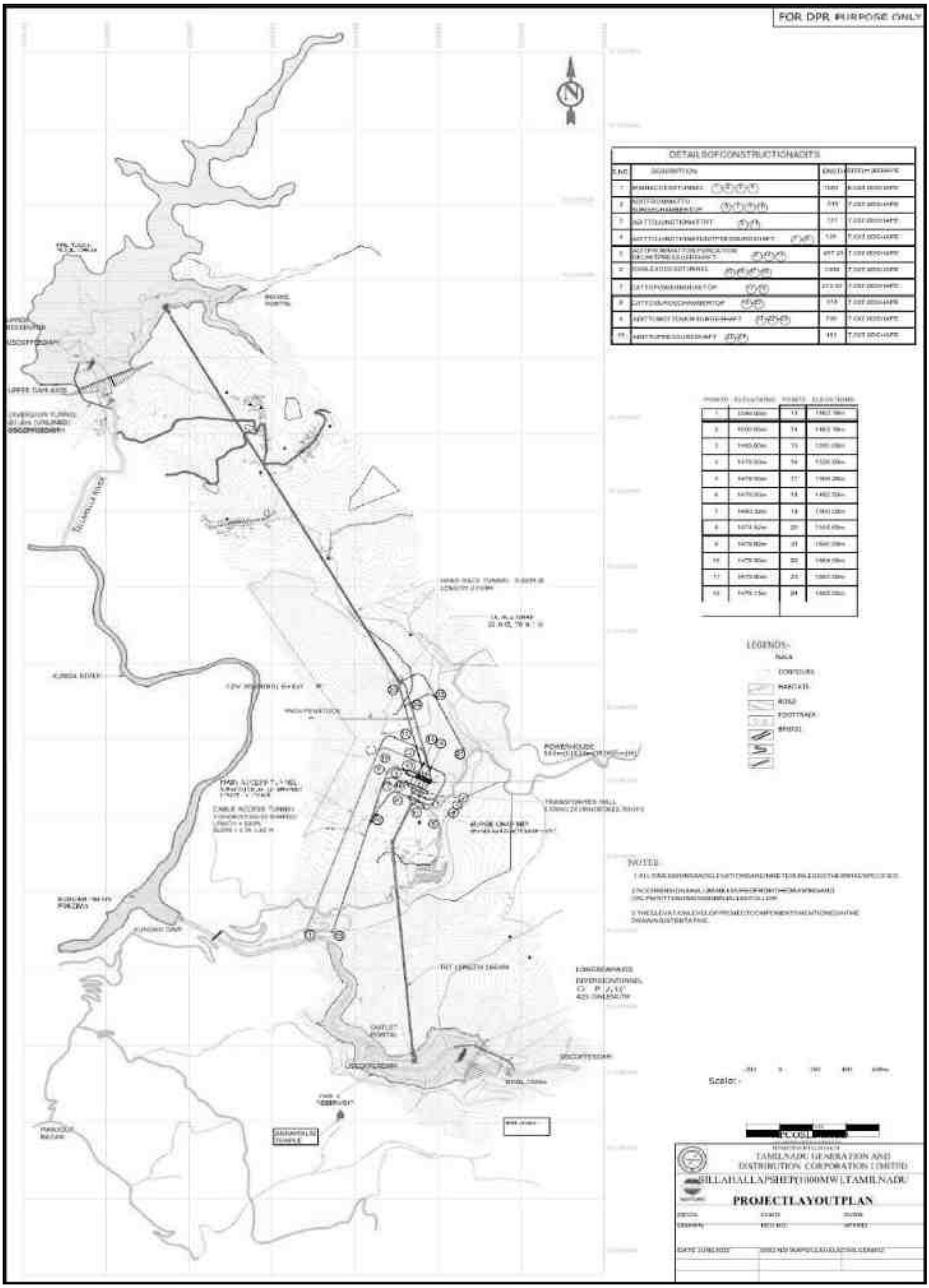


Figure-2.2: Project Layout of proposed Sillahalla PSHEP Stage-I

2.4 Installed Capacity

The factor influencing the installed capacity of pumped storage scheme at a site are the requirements of daily peaking hours of operation, operating head, live pondage in the reservoirs and their area capacity characteristics. The details are summarized in Table-2.1.

Table-2.1: Details of Installed Capacity

Installed Capacity (MW)	1000 MW
No. of units	4
Unit Size	250
Head (max) – Generating	420
Hours of Daily Peaking Operation	6
Energy Generation (Mwh)	6000
Pumping Energy (Mwh)	7000
Cycle efficiency (%)	85.7%

2.5 Power Evacuation Arrangement

The generation is proposed to be stepped up from 18kV to 400 kV for evacuation through GTs. Power to be generated at the PSS will be injected to the proposed 400/230kV Parali S/S through 400kV transmission system for further dispersal. It was suggested vide CEA Minutes of 42nd meeting of Standing Committee on Power System Planning for Southern Region dated 27.04.2018. In order to meet the power evacuation requirement as well as to supply load at PSS, the following is considered in this alternative.

- Sillahalla PSHEP (Stage-I) -Parali 400kV D/C line.
- Parali - Karamadai 400 kV D/C line is to run on D/C towers up to location no. 57 (Hilly terrain) utilizing Kundah PH II – Arasur 230 kV S/C line corridor. Subsequently, the line will be erected on 400 kV M/C tower (with four circuits) upto Karamadai 400/230 kV S/S (in Plains area).
- Multicircuit tower will also accommodate existing Parali – Karamadai 400 kV D/C line utilizing the corridor of existing Kundah PH III – Karamadai 230 kV S/C line.

The evacuation scheme diagram is given in Figure-2.3.

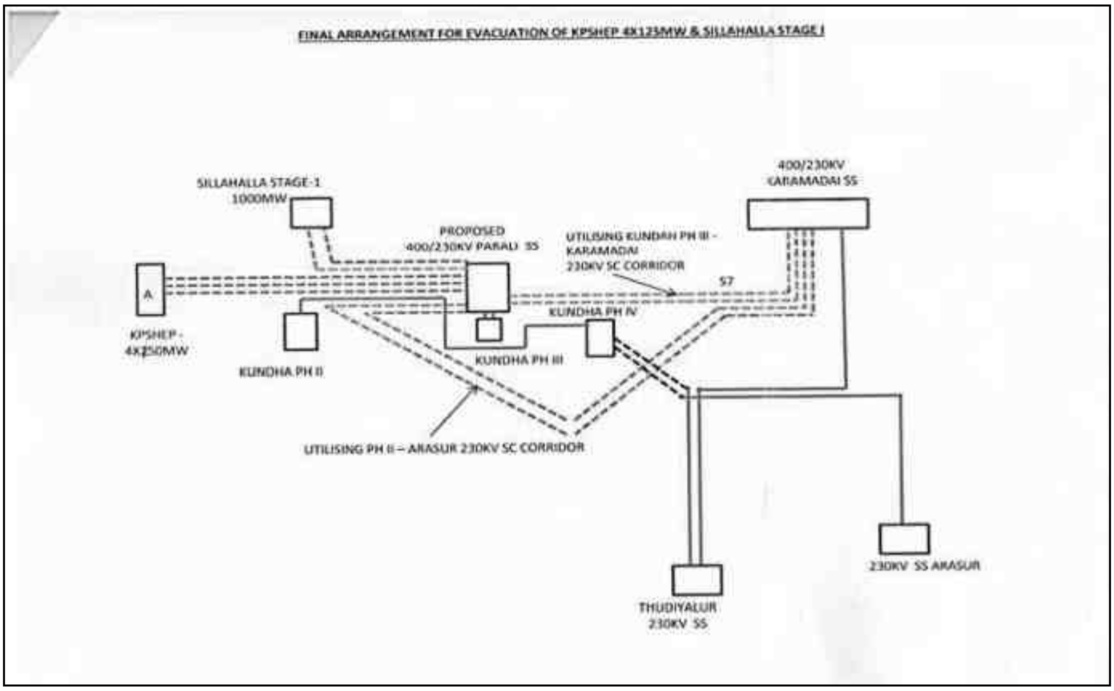


Figure-2.3: Evacuation scheme diagram

2.6 Salient Features

The salient features of the proposed Sillahalla PSP are given in Table-2.2.

Table-2.2: Salient Features of Sillahalla PSP

1. Location	
River	Upper Dam - Sillahalla River Lower Dam- Kundah River
Dam Axis (Upper	Latitude 11°18’53.72” Longitude 76°38’56.34”
Dam Axis (Lower)	Latitude 11°16’25.81” Longitude 76°40’13.00”
Access To The Project	
Road	Mettupalayam
Airport	Coimbatore- About 110 Kilometres
Railhead	Mettupalayam- About 65 Kilometres
Port	Tuticorin, Tamil Nadu

2. Project	
Type	Pumped Storage Project
Installed Capacity	4 X 250 MW
Peak Operating Duration	6 Hours Daily
3. Hydrology	
Catchment Area	
Upper Dam	65 Sq. Km.
Lower Dam	183.48 Sq. Km.
Average Annual Run-Off	
Upper Reservoir	113.00 cumec
Maximum Design Flood (Pmf)	
Upper Reservoir (Upper Dam)	1054.0 cumec
Lower Reservoir (Lower Dam)	2610.0 cumec
Diversion Flood	
Upper Reservoir (Upper Dam)	295.0 cumec
Lower Reservoir (Lower Dam)	760.0 cumec
4.0 Civil Structure	
4.1 Upper Reservoir	
FRL	1950.00 m
MDDL	1940.00 m
Pondage at FRL	27.836 MCM
Pondage at MDDL	17.218 MCM
Live Pondage	10.618 M MCM
4.2 Lower Reservoir	
FRL	1560 M
MDDL	1520 M
Pondage at FRL	8.048 MCM
Pondage at MDDL	2.044 MCM
Live Pondage	6.004 MCM
4.3 Upper Dam	
Type	Concrete Gravity Dam
Top of Dam	El 1952.00 m

Foundation Elevation (Deepest)	El 1877.00 m
Total Length of Dam at Top	560.00 m
Max. Height of Dam above Deepest Foundation Level	75.00 m
Top Width of Dam	7.00 m
4.4 Lower Dam	
Type	Concrete Gravity Dam
Top of Dam	El 1562.00 m
Foundation Elevation (Deepest)	El 1454.00 m
Total Length of Dam at Top	320.00 m
Max. Height of Dam Above Deepest Foundation Level	108.00 m
Top Width of Dam	7.00 m
4.5 Upper Dam- Spillway Arrangement	
Type	Ogee Spillway
Crest Elevation	El 1944.50 m
MWL	El 1950.00 m
Design Flood	1054 M^3/S at FRL/MWL 1950.00 m
No. of Bays	3 Bays , 12 m Wide Each
4.6 Upper Dam- Log Bay	
Type	Ogee Spillway
Crest Elevation	El 1946.00 m
No. of Bays	1 Bay , 6 m Wide
4.7 Lower Dam- Spillway Arrangement	
Type	Ogee Spillway
Crest Elevation	El 1552.00 m
MWL	El 1561.00 m
Design Flood	2610 m^3/s at FRL/MWL 1560.00 m
No. of Bays	4 Bays, 12 m wide each
4.8 Lower Dam- Log Bay	
Type	Ogee Spillway
Crest Elevation	El 1556.00 m

No. of Bays	1 Bay, 6 M Wide
4.9 Upper Dam- Diversion Works	
Design Diversion Flood	295 m^3/s
No of Tunnel	1 No.
Length of Tunnel	450 m
Diameter & Shape	7.0 m (Finished) & Circular (Unlined)
Invert Level (Start /End)	El 1896.50 m (At Inlet) & El 1878.50 m (At Outlet)
Height of Upstream Coffer Dam	15.60 m
Height of Downstream Coffer Dam	5 m
4.10 Lower Dam- Diversion Works	
Design Diversion Flood	760 m^3/s
No of Tunnel	1 No.
Length Of Tunnel	425 m
Diameter & Shape	7.2 m (Finished) & Circular (Concrete Lined)
Invert Level (Start /End)	El 1472.00 m (At Inlet) El 1444.00 m (At Outlet)
4.11 Power Intake	
Type	Horizontal Type With Anti-Vortex Louvers
Design Discharge	297.12 m^3/m
W X H X No.	13 M (W) X 13.5m (H) X 2 No.
Invert Level	El 1922 m
Transition Length	63.25 m
4.12 Headrace Tunnel (Concrete Lined)	
No. of Tunnel	1 No.
Diameter & Shape	9.0 M (Finished) & Circular (Concrete Lined)
Length	2760 m
Slope	1 In 64.5
Invert Level (Start /End)	El 1922 m (At Inlet) & El 1885 m (At Surge Shaft)

Design Discharge	297.12 m^3/s
Velocity	4.67 m/s
4.13 HRT Surge Shaft & TRT Surge Chamber **4.13.1 HRT Surge Shaft**	
Diameter	20 m
Height	95 m
No. of Surge Shaft	1 No.
Type	Circular (Concrete Lined)
Invert Level	El 1885 m
4.13.2 TRT Surge Chamber	
Size	85 m (L) X 12 m (W) X 88 m (H)
Invert Level	El 1477.50 m
4.14 Pressure Shaft (Steel Lining)	
No. of Tunnels	2 No.
Diameter & Shape	5.65 m (Finished) & Circular (Steel Lined)
Length	800 m & 758 m
Design Discharge	148.56 m^3/s (each)
Velocity	5.92 m/m
4.15 Unit Pressure Shaft (Steel Lining)	
No. of Tunnel	4 No.
Diameter & Shape	4.00 m (Finished) & Circular (Steel Lined)
Length	2 No. 64 m & 2 No. 60 m
Design Discharge	74.28 m^3/s (each)
Velocity	5.91 m/s
4.16 Tailrace Tunnel	
No. Of Tunnel	1 No.
Diameter & Shape	9.75 m (Finished) & Circular (Concrete Lined)
Length	1672 m
Slope	1 In 51

Invert Level (Start /End)	El 1500.50 m (At Outlet) & El 1477.50 m (At Surge Chamber)
Design Discharge	297.12 m^3/s
Velocity	3.98 m/s
4.17 Tailrace Outlet	
Type	Horizontal Type With Anti-Vortex Louvers
Design Discharge	297.12 m^3/s
W X H X No.	13 m (W) X 13.5 m (H) X 2 Nos.
Invert Level	El 1500.50 m
Transition Length	63.25 m
4.18 Powerhouse	
Type	Underground Cavern
Dimensions	160 m (L) X 21 m (W) X 50 m (H)
Installed Capacity	4 X 250 MW
No. of Units	4 Nos.
Turbine Center Line	El 1466.00 m
Service Bay Level	El 1479.50 m
4.19 Transformer Room	
Type	Underground Cavern
Dimension	160 m (L) X 16 m (W)X 21 m (H)
Transformer Floor Level	El 1479.50 m
GIS Floor Level	El 1493.50 m
4.20 Main Access Tunnel (Mat)	
Type	D- Shaped
Length	1583 m
W X H	8.0 m X 8.0 m
5.0 Electromechanical Equipment	
5.1 Pump Turbine	

Type	Francis Type, Vertical Shaft Reversible Pump-Turbine
Number of Units	Four (4) Units
Rated Turbine Head	387.00 m
Turbine Output at Rated Head	253.81 MW
Rated Pump Head	406.00 m
Pump Input at Rated Head	240.92 MW
Rated Turbine Discharge	74.28 m^3/s
Rated Pump Discharge	55.65 m^3/s
Synchronous Speed	375 rpm
5.2 Generator-Motor	
Type	Three (3) Phase, Alternating Current Synchronous, Generator-Motor, Vertical Shaft, Rotating Field, Enclosed Housing, Rim-Duct Air-Cooled and Suspended Type
Number of Units	Four (4) Units (Fixed Speed)
Rated Capacity	Generator; 250 MW Motor ; 285 MW
Rated Voltage	18.0 KV
Rated Frequency	50 Hz
Rated Speed	375 rpm
Over Load Capacity	110 % Rated Capacity
5.3 Main Transformer	
Type	Indoor, Oil-Immersed, 3 Single Phase Transformers With On-Load Tap Changer (Oltc) For Generation / Pumping Operation, ODWL Cooled
Numbers	4 Sets I.E. (4 X 3 Sets For Each Unit) = 12 + 1 (Spare) (Total 13 Nos.)
Rated Capacity	110 MVA Single Phase
5.4 Gas Insulated Switchgear	

5.4.1 Circuit Breaker	
Type	400 KV Gas Insulated Switchgear (GIS)
Number of Feeders	Nine (9) Feeders
Rated Voltage	420 KV
Rated Normal Current	2,000 A
5.5 400 KV XLPE Cable	
Type	Single Core 400 KV Cross Linked Polyethylene Insulated Type
Rated Voltage	400 KV
Number of Circuits	4 CKTS (4 X 3 Cables) + 1 Spare Cable
5.6 EOT Crane	
Type	Indoor, Electric Overhead Traveling Crane
Number of Units	Two (2) Units
Rated Capacity	250 Ton (Main Hoist), 50 Ton and 10 Ton
Span	20 m
5.7 Transmission Line	
Type	Single / Double Circuit, Twin Moose Conductors
Capacity Voltage Level	400 KV
Length	About 32 km, 54 km, 103 km (For 3 Different Substations)
5.8 Project Benefits	
Levelized Tariff	Rs. 6.48 ₹/kwh (Without Pumping Cost)
	Rs. 9.98 ₹/kwh (Including Pumping Cost 2.5 ₹/kwh)
First Year Tariff	Rs. 7.37 ₹/kwh (Without Pumping Cost)
	Rs. 10.87 ₹/kwh (Including Pumping Cost 2.5 ₹/kwh)

2.7 Land Requirement

The total land required for the project is approximately 310.157 ha. The details of component wise land requirement is given in Table-2.3. About 239.2444 ha of private land and 8.912 ha of forest land is proposed to be acquired for the Sillahalla Pumped Storage Project. Balance land (62.001 ha) to be acquired for the project is government land.

Table-2.3: Land requirement for the proposed Sillahalla PSHEP Stage-I

S. No.	Project Component	Forest land	Govt. land	Private land	Total Land
1	Upper Reservoir		40.457	93.501	133.958
2	Lower Reservoir		12.359	16.032	28.391
3	HRT	0.391	0.708	1.877	2.976
4	TRT		0.162	1.818	1.98
5	Power House	1.8		0.2	2
6	MAT, CAT, ADIT	1.52	0.396	2.7814	4.6974
7	Surge Shaft			0.45	0.45
8	Upper Dam Axis		0.436	2.289	2.725
9	Lower Dam Axis		0.1	2.236	2.336
10	HRT Intake			2	2
11	TRT Outlet			2	2
12	Diversion Tunnel/Coffer Dam		0.068	0.655	0.723
13	Potheadyard/CCVT			0.8	0.8
14	Project Colony		2.295	17.526	19.821
15	Labour Colony			7.155	7.155
16	Baching Plant		0.159	2.276	2.435
17	Contractor Facilities			6.5	6.5
18	Fabrication Yard/Store	4.242		3.655	7.897
19	Dumping Zone		1.947	54.863	56.81
20	Pressure Shaft	0.778		0.222	1
21	Roads	0.181	2.914	20.408	23.503
	Total	**8.912**	**62.001**	**239.2444**	**310.157**

About 287.202 ha of land is required for over ground works and 22.9554 ha of land is required for underground works. The details are given in Table-2.4. The classification of land viz. Private land, Government Land, Forest Land etc. required for over ground and underground works is given in Table-2.5.

Table-2.4: Total Extent of land required for over ground and underground works

S. No.	Type	Total (ha)
1	Underground works	287.202
2	Overground works	22.9554
	Total	**310.1574**

Table-2.5: Classification of land viz. Private land, Government Land, Forest Land etc. required for over ground and underground works

S.No.	Type of land	UG/OG	Land required as per LPS (Ha)	Total (In Ha.)
1	Private Land	Underground	7.1964	239.2444
		Overground	232.048	
2	Govt Land	Underground	11.27	62.001
		Overground	50.731	
3	Forest Land	Underground	4.489	8.912
		Overground	4.423	
	Total			**310.1574**

2.8 Project Cost

The total cost required for construction of the project is Rs. 5843 crore (as June 2022 price level and excluding IDC cost) refer in Table-2.6.

Table-2.6: Summary of Cost Estimates

Description	Project Cost (June 2022 Price Level) (Rs. crore)
Civil Works including H&M	4,097
E&M Works	1,746
Total	**5,843**

2.9 Construction Programme

The construction period of the project is scheduled to be 72 months, of which, 11 months for pre-construction work and 61 months for main construction work.

2.10 Construction power Requirement

Construction power will be required for the various construction equipment proposed to be deployed for the diversion tunnel, main dams, waterways and power house, switchyard, Quarry etc. Power will also be required for lighting project areas, workshop, colony, etc.

The construction power for Sillahalla PSHEP Stage-I will be required in two phases. For the first phase of construction work mainly Civil Work 3 MW (maximum) will be required initially for first two years. For the 2^{nd} phase of construction work 9 MW of power maximum will be required for the next four years mainly for Electro-Mechanical, Hydro-Mechanical work and civil work.

The construction power for Sillahalla PSHEP Stage-I will be available from the existing 132/33/11 KV substation at Kundah HEP and nearby Township.

2.11 Telecommunication Facilities

An electronic exchange with adequate capacity shall be provided at the project site during construction stage for voice communication. Mobile network shall be strengthened in the project area for effective communication. For communication between project staff, high frequency handsets (walkie talkie) shall be provided to ensure continuous online communication between officers and staffs for on the spot decision and co-ordination.

After completion of construction activities, the telecommunication facilities described above are proposed to be continued and strengthened to the extent necessary, so as to serve during the operation & maintenance stage.

2.12 Project Colony/buildings

It is envisaged to develop proper infrastructure works required including permanent and temporary staff residential buildings, office complex, field hostel, school, hospital, shops, canteen or mess, places for worship etc.

These Buildings and Colonies will have the following basic facilities:

- Potable water supply arrangements.
- Sanitation and sewage disposal arrangements.
- Drainage arrangements.
- Internal roads and their drainage works.
- Electrification.
- Fencing and security.

The Project construction is likely to last for 61 months. The peak manpower strength likely to be employed during project construction stage is estimated about 1800 Nos.

The following assumptions have been made for assessing the emigrating population in the area:

- 80% of workers and technical staff emigrating into the area are married.
- In 80% of the family of workers both the husband and wife will work.
- In 100% of the family of technical staff, only husband will work.
- 2% of total migrating population has been assumed as service providers.
- 50% of service providers will have families.
- Family size has been assumed as 5.

Based on experience of similar projects and above referred assumptions, the increase in the population as a result of migration may be of the order of 7200.

The water supply and sewage requirement during construction phase are proposed to be met from existing sources of TNGECL. The water shall be supplied after treatment by water treatment plant and shall be stored in overhead storage tanks. The domestic water requirement has been estimated as 70 lpcd (Liters Per capita per day). Thus, total water requirements work out to 0.50 mld (Million Liters per day).

It is assumed that about 80% of the water supplied will be generated as sewage. Thus, total quantum of sewage generated is expected to be of the order of 0.40 mld.

During operation phase, about 150 persons will be residing in the project colony. About 0.10 to 0.15 mld of sewage will be generated.

It is proposed to provide biological treatment facilities including secondary treatment units for sewage so generated from the BOD load after treatment shall reduce to 10 to 12 kg/day.

- **Owner's building and colonies**

The owner's colony would provide for residential as well as office accommodation to its staff, both for pre and post construction stages. In addition to residential complex, the colony would also have facilities for medical aid, places of worship, fire fighting, educational and vocational facilities, banking and telecom facilities, shopping, sports and recreational activities including community functions, fuel dispensing outlet, material testing laboratory, etc.

A small workshop or auto shop for up keep of automobiles in the post construction period would also be located in the colony.

One project colony has been proposed close to location of MAT on the left bank of the Kundah River, about 2km from the existing road MDR-86. This colony is proposed to have Main building for Project office and a residential campus for high rank officers.

One field hostel has also been envisaged for engineers and equivalent staff, one school for residential staff and a hospital. Other project colonies have been envisaged at each dam site for operation and maintenance.

The total number of permanent O&M Staff required for the project is estimated to be about 150 for which 9,000 Sq.m. flat area will be required.

Contractor’s colonies and buildings

Temporary buildings will include contactors colonies which would serve the purpose of residence and offices, facilities for social activities like shopping, social gatherings, worship, etc. for the contractors and their families engaged in project. Ample space for colonies of Civil, H&M and E&M contractor’s has been marked near powerhouse location the same location shall be partially shared by a proposed permanent hospital building and first aid centre during project execution phase.

Various installation to be put up by the contractors will include:

- Electrical workshop
- Mechanical workshop
- Fabrication shop
- Batching and mixing plant
- Penstock fabrication yard
- HM and EM storage yards
- Guest house
- Labour Camps

The total no. of engineers/officers and workers deployed by the contractors of various disciplines will be planned by them commensurate to the construction phase.

Two locations for labours colony has been marked as 1 on near upper dam site, 1 at near powerhouse complex area. The entire establishment for contractors has been presumed of temporary nature. Total area required to be established for contractors and other facilities is envisaged about 44.5 Ha.

Job Facility Areas

Various job facilities for construction of the project would be setup in the project area to develop an optimal working requirement suiting to the project component locations. They would primarily comprise of the following:

- Stores and Warehouses
- Penstock Fabrication Yard
- Batching and Mixing Plants

2.13 Muck Disposal Area

The project envisages construction of dams (upper & Lower), headrace tunnel, Upper surge shafts, pressure shafts, TRT surge chamber, underground power house, tailrace Tunnel, Transformer hall, inlet outlet, etc., will generates enormous quantities of muck. It is estimated that about 5.05 million cubic meter (MCM) of muck will be generated from various components of the project, as indicated in the Table-2.7.

Table-2.7: Muck generated from various project components

S. No.	Component	Quantity (MCM)
1	Upper Dam	1.3
2	Lower Dam	0.7
3	U/S Diversion Tunnel	0.03
4	D/S Diversion Tunnel	0.03
5	U/S Coffer Dam	0.005
6	D/S Coffer Dam	0.003
7	Intake	0.10
8	HRT Gate Shaft	0.01
9	HRT	0.23
10	HRT Surge Shaft	0.02
11	Pressure Shaft	0.03
12	Power House	0.21
13	Transformer Hall	0.10
14	TRT Surge Chamber	0.14
15	TRT	0.18
16	TRT Gate Shaft	0.02
17	TRT Outfall	0.1
18	MAT	0.07
19	CAT	0.04
20	Adits	0.08
	Total	3.398
	Total (Say)	**3.4 MCM**
	Swelling Factor	1.65
Total Muck generated from excavation of project components = 5.05 MCM		

For disposal of above estimated muck, 14 numbers of Dumping areas/muck disposal areas have been identified in the vicinity of project area. The capacity of each muck disposal yard has been calculated based on the average cross-sections generated using available 20m contour interval topographical map. The total estimated capacity of identified muck dumping yards is about 5.05 MCM. The details about the muck disposal area are given in Table-2.8.

Table-2.8: Details of Muck Disposal Areas

S. No.	Description	Area in Ha
1	Dumping Area /Muck Disposal Area – 1	15.0
2	Dumping Area /Muck Disposal Area – 2	7.0
3	Dumping Area /Muck Disposal Area – 3	3.5
4	Dumping Area /Muck Disposal Area – 4	3.5
5	Dumping Area /Muck Disposal Area – 5	5.0
6	Dumping Area /Muck Disposal Area – 6	1.25
7	Dumping Area /Muck Disposal Area – 7	1.0
8	Dumping Area /Muck Disposal Area – 8	1.5
9	Dumping Area /Muck Disposal Area – 9	1.0
10	Dumping Area /Muck Disposal Area – 10	4.25
11	Dumping Area /Muck Disposal Area – 11	9.0
12	Dumping Area /Muck Disposal Area – 12	1.0
13	Dumping Area /Muck Disposal Area – 13	2.0
14	Dumping Area /Muck Disposal Area – 14	4.0
	Total	**59.0**

2.14 Workshops and Parking Space

Two (2) separate base workshops have been proposed for earth moving, concreting and drilling equipment's one each at both the dam locations and one near to the powerhouse area. However, to cater for day to day maintenance and running repairs, small shops would be set up near portals of the various adits. Since all the work would be highly mechanized, adequate and self-sufficient repair and service facilities would be set up at the project site. There are no outside services or facilities of mechanical nature available near the project area.

Separate workshops would be set up for:

- Earth moving machinery mounted on tracks like excavators, dozers, etc.,
- Earth moving machines mounted on tyres like dumpers, loaders, graders, etc.
- Pneumatic equipment, concreting equipment like boomers, wet shotcrete machines, concrete pumps, etc.
- Transport equipment like buses, trucks, transit mixers, ambulances, light vehicles, etc.,
- A penstock fabrication yard near the powerhouse area.

Every workshop would have partly covered area in addition to open area. Equipment requiring major overhaul/repairs would normally be parked under cover. The open areas would provide parking space for the equipment under minor repair. A store to stock the spares for the equipment, an office and toilet facilities would be provided under the covered space. One first aid post would be provided at each work site which would also cater to the requirements of the workshop crew.

2.15 Construction Materials

The estimated quantities of major item of works that are likely to be involved for construction of various project components are listed in Table-2.9.

Table-2.9: Estimated Quantities of Major Item of Works

S. No.	Name of Component	Common Excavation (m^3)	Rock Excavation (m^3)	Fill Materials (m^3)	Concrete ($m^{3)}$	Reinforcement (MT)	Steel Liner (MT)
1		11,96,400	1,13,833	-	8,40,797	1,921	-
2		2,96,845	3,80,157	-	8,60,815	1,967	-
3	U/S Diversion Tunnel	1,500	29,588	-	6,007	70	-
4	D/S Diversion Tunnel	1,500	31,749	-	6,205	70	-
5	U/S & D/S Coffer Dams (For Upper Dam)	4,613	-	22,509	6,551	393	-
6	U/S & D/S Coffer Dams (For Lower Dam)	2,768	-	13,506	3,931	236	-
7	Intake	1,03,917	11,804	-	31,912	2,282	-
8	HRT Gate Shaft	20	14,906	-	2,647	122	-

S. No.	Name of Component	Common Excavation (m^3)	Rock Excavation (m^3)	Fill Materials (m^3)	Concrete (m^3)	Reinforcement (MT)	Steel Liner (MT)
9	Headrace Tunnel	-	2,29,051	-	48,490	2,784	-
10	HRT Surge Shaft	-	24,125	-	5,521	459	-
11	Pressure Shaft	-	26,496	-	11,701	-	7,484
12	Power House	-	2,09,010	-	36,909	399	-
13	Transformer Hall	-	104,139	-	11,672	163	-
14	TRT Surge Chamber	-	1,42,774	-	9,229	185	-
15	Tail Race Tunnel	-	1,81,504	-	41,310	2,124	-
16	TRT Gate Shaft	20	16,567	-	2,862	122	-
17	TRT Outfall	4,175	91,593	-	33,021	2,298	-

The key construction materials like stone pitching, Coarse Aggregate & fine aggregate will be transported from quarries in Coimbatore district. The muck generated from Headrace Tunnel (HRT), Tailrace Tunnel (TRT) and Underground Caverns shall also be used for fill material, coarse aggregates and fine aggregates.

2.16 Construction Equipment

The equipment required for construction of various project components is given in Tables-2.10 to 2.20.

Table-2.10: Equipment required for Construction of Diversion Tunnel per face

S. No.	Equipment	Quantity
1	2-Boom Drill Jumbo	1 No.
2	Front End Loader	1 No.
3	Hydraulic Excavator 3cum	1 No.
4	Wagon Drill	4 Nos.
5	Compressor 500 cfm	2 Nos.
6	Compressor 1000 cfm	2 Nos.
7	25T capacity dumpers	5 Nos.
8	Jack Hammer (120 cfm capacity)	10 Nos.
9	Dozers 90 HP	2 Nos.
10	Gantry shutters	1 No.
11	Concrete pump 40cum/ hr	1 No.

12	Hydraulic Platform/Truck Jumbo	1 No.
13	Concrete Placer 1cum	1 No.
14	Transit Mixers (6 cum capacity)	5 Nos.
15	Needle Vibrators (65 mm dia. Needle)	lot
16	Grout Pump	1 No.
17	Shotcrete Machine	1 No.
18	Welding sets	1 Set
19	Rib Bending Machine	1 Set
20	Blasting Accessories	Lot
21	Dewatering pumps of different capacity	1 Set.
22.	Ventilation Blower (110 kW) (One set in front of each face)	1 Set
23.	JBC backhoe loader (to excavate trench for laying gantry track)	1 No.

Table-2.11: Equipment required for Abutment Stripping of Upper Dam

S. No.	Equipment	Quantity
1.	Wagon Drills	2 no.
2.	Jack Hammers and Pusher – legs	6 no.
3.	Rock bolter (for anchoring on slopes)	2 no.
4.	Hydraulic Excavators (3 cum)	4 no.
5.	Rear End dumpers (25T)	20 no.
6.	Dozer (324 HP)	1 no.
7.	Motor Graders	1 no.
8.	Tyre Dozers	1 no.
9.	Water Sprinkler	1 no.
10.	Diesel compressor 1600 cfm (1000 + 600 cfm)	1 no.
11.	D.G. Set 1010 KVA	2 no.

Table-2.12: Equipment required for Riverbed Excavation

S. No.	Equipment	Quantity
1.	Wagon Drills	3 nos.
2.	Jack Hammers and Pusher- legs	12 nos.
3.	Rock bolter (for anchoring on slopes)	2 no.
4.	Hydraulic Excavators (3 cum)	4 nos.

S. No.	Equipment	Quantity
5.	Rear End dumpers (25T)	20 nos.
6.	Dozer (324 HP)	2nos
7.	Motor Graders	2 nos.
8.	Tyre Dozers	2 nos.
9.	Water Sprinkler	2 nos.
10.	Dewatering pumping equipment	Lot.
11.	Diesel Compressors 1600cfm	same as above
12.	D.G. Set	same as above

Table-2.13: Probable Requirement of Equipment for Construction of Intake structure & Gate Shafts (Two (2) Nos.)

S. No.	Name of Equipment	Quantity [No.]
A	**Intake Structure**	
1	Hyd. Excavator,2cum	4
2	Wagon Drill	4
3	Jack Hammer	8
4	Wheel Loader,3.0 cum	4
5	RE Dumper,18t	8
B.1.	**Construction of Pilot Shaft**	
1	Raise borer	4
2	Jack hammer	8
3	Wheel Loader, 2cum	4
4	RE Dumpers, 18t	4
B.2.	**Enlargement of Pilot Shaft upto Full section**	
1	Winch with Trolley & accessories	4
2	Jack Hammers	20
3	Wheel Loader, 3.0cum	8
4	RE Dumper,18t	32
5	Dozer, 180 hp	4
6	Shotcrete Machine, 15 cum/hr	4
7	Concrete Pump, 6cum/hr	4

S. No.	Name of Equipment	Quantity [No.]
8	Transit Mixture,6cum	4
9	Air Compressor, 1000cfm	4

Table-2.14: Probable Requirement of Equipment for construction of MAT

S. No.	Name of Equipment	Quantity [Nos.]
1	2 Boom Jumbo Drill	1
2	Side Dump Loader,3.0 cum	1
3	Crawler Drill	4
4	Compressor 500 cfm	1
5	Compressor 1000 cfm	1
6	FE Dumper, 25MT	3
7	Jackhammer	3
8	Shotcrete Machine,15cum /hr	1
9	Gantry shutters	1 set
10	Dozer,180 HP at Disposal Area & pushing at work Site	2
11	Rock bolting Machine	1
12	Concrete pump	1
13	Concrete placer	1
14	Transit mixers (6 cum capacity)	4
15	Needle Vibrators	Lot
16	Grout pump	1
17	Welding machine	1
18	Blasting accessories	Lot
19	Rib bending machine	1set
20	Dewatering pumps of different capacities	1 set

Table-2.15: Probable requirement of equipment for construction of HRT

S. No.	Name of Equipment	Quantity [Nos.]
1	2 Boom Jumbo Drill	2
2	Side Dump Loader,3.0 cum	2
3	Crawler Drill	8
4	Compressor 500 cfm	2
5	Compressor 1000 cfm	2
6	FE Dumper, 25MT	8
7	Jackhammer	4
8	Shotcrete Machine,15cum /hr	2
9	Gantry shutters	2 set

S. No.	Name of Equipment	Quantity [Nos.]
10	Dozer,180 HP at Disposal Area & pushing at work Site	4
11	Rock bolting Machine	2
12	Concrete pump	2
13	Concrete placer	2
14	Transit mixers (6 cum capacity)	8
15	Needle Vibrators	Lot
16	Grout pump	2
17	Welding machine	2
18	Blasting accessories	Lot
19	Rib bending machine	2 set
20	Dewatering pumps of different capacities	2set

Table -2.16: Probable Requirement of Equipment for Construction of Surge Shaft

S. No	Name of Equipment	Quantity [No.]
1	**Open excavation**	
2	Excavator 2 cum	1
3	Dumper 25 T	4
4	Dozers	1
5	**Construction of Surge shaft**	
6	Raise borer	1
7	Jack hammer	8
8	Wheel Loader, 2cum	2
9	RE Dumpers, 18t	6
10	Winch with Trolley & accessories	1
11	Wagon drill	2
12	Dozer, 180 hp	2
13	Shotcrete Machine, 15 cum/hr	2
14	Concrete Pump, 6cum/hr	1
15	Transit Mixture,6cum	2
16	Air Compressor, 1000cfm	4
17	Needle Vibrators	2
18	Blasting accessories	1 set

S. No	Name of Equipment	Quantity [No.]
19	Gantry Crane	1
20	Mobile Crane	1
21	Dewatering pumps of different capacities	1 set

Table-2.17: Probable Requirement of Equipment for Construction of Pressure Shaft

S. No.	Name of Equipment	Quantity [No]
1	Two boom hydraulic drill jumbo	6
2	Wheel Loader, 3cum	6
3	Raise borer	2
4	Dumper, 25T	6
5	Jack Hammers (120 cfm)	16
6	Air Compressor, 500cfm	4
7	Dumper,18T	4
8	Crawler Dozer (90 HP)	6
9	Shotcrete Machine, 15 cum/hr	4
10	Transit Mixture,6cum	6
11	Concrete placer	3
12	Dewatering of pumps of sort	4 (sets)
13	Mobile crane (40T capacity)	4
14	Welding sets	2
15	Flexi shaft needle vibrators	8
16	Winch (10T capacity)	2
17	Winch (30T capacity)	2
18	Rib bending Machine	2 (sets)
19	Penstock fabrication yard	2
20	Testing equipment’s (Ultrasound, radiography, X-ray)	2 (sets)
21	Blasting accessories	4 (sets)
22	Hydraulic platform/Truck jumbo	4
23	Grout pump	4
24	Sand blasting equipment	2 (sets)

Table-2.18: Probable Requirement of Equipment for Construction of Surge Chamber

S. No.	Name of Equipment	Quantity [Nos.]
1	Two Boom Jumbo Drill Jumbo	2
2	Wagon drills	4
3	Back Hoe Excavator, 1.84 cum	2
4	Rear End Dumper (25 T)	10
5	Robojet Shotcreting Machine	2
6	Transit Mixtures 6 cum	4
7	Air Compressor 600 cfm	2
8	DG sets (1000 kva)	1
9	Dozer 90 HP	1

Table-2.19: Probable Requirement of Equipment for concreting of D/s Surge Chamber

S. No.	Name of Equipment	Quantity [Nos.]
1	Steel shutters 10m long X 2.10m high with stiffeners and bailers, complete	4
2	Concrete pump 40 cum/hr capacity	1
3	Hydra crane	1

Table – 2.20: Probable Requirement of Equipment for Construction of TRT

S.. No.	Name of Equipment	Quantity [Nos.]
1	Two Boom Jumbo Drill	2
2	Backhoe Loader	2
3	Wagon Drill	4
4	Air Compressor, 500 cfm	4
5	Air Compressor, 1000 cfm	2
6	Dumpers 25T	8
7	Jack Hammers (120 cfm)	10
8	90 hp Dozer	2
9	Gantry shutters	1 set
10	Concrete Pump, 40 cum/hr	1
11	Hydraulic platform	1
12	Concrete placer	1
13	Transit Mixture, 6cum	6
14	Needle vibrators (65 mm dia)	Lot
15	Grout Pump	1

S.. No.	Name of Equipment	Quantity [Nos.]
16	Shotcrete Machine,15cum /hr	1
17	Welding sets	1 set
18	Blasting accessories	Lot
19	Ventilation blowers	1 set
20	Rib bending machine	1 set
21	Dewatering pumps of different capacities	1 set

2.17 Security & Safety

Security office of suitable size will be located one each at dam and powerhouse sites including security check posts at different work sites. Fire stations of suitable size will be provided one each at dam and powerhouse sites. These fire stations will be fully equipped with modern firefighting equipment and skilled fire fighters.

CHAPTER-3
DESCRIPTION OF THE ENVIRONMENT

3.1 General

Before the start of any Environmental Impact Assessment study, it is necessary to identify the baseline levels of relevant environmental parameters which are likely to be affected as a result of the proposed activity. A similar approach has been adopted for conducting the CEIA study for the Sillahalla Pumped Storage Project. Standard methodologies of Environment Impact Assessment were followed for conducting the CEIA study for the proposed Sillahalla Pumped Storage Hydro-electric Project Stage-I. A Scoping Matrix was formulated to identify various issues likely to be affected as a result of the proposed project. Based on the specific inputs likely to accrue in the proposed project, aspects to be covered in the EIA study were identified. The other issues as outlined in the Scoping Matrix were then discarded. Thus, planning of baseline survey commenced with the shortlisting of impacts and identification of parameters for which the data needs to be collected.

3.2 Study Area

The Study Area covered as a part of the CEIA study is as below:

- Land to be acquired for various project appurtenances including reservoir submergence
- 10 km on either side from the periphery of reservoir submergence
- Area within 10 km on either side of various project appurtenances

The Study Area map is enclosed as Figure - 3.1.

Based on the specific inputs likely to accrue in the proposed project, aspects to be covered in the CEIA study were identified. Planning of baseline survey commenced with the shortlisting of impacts and identification of parameters for which the data needs to be collected. The baseline status has been divided into following three categories:

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

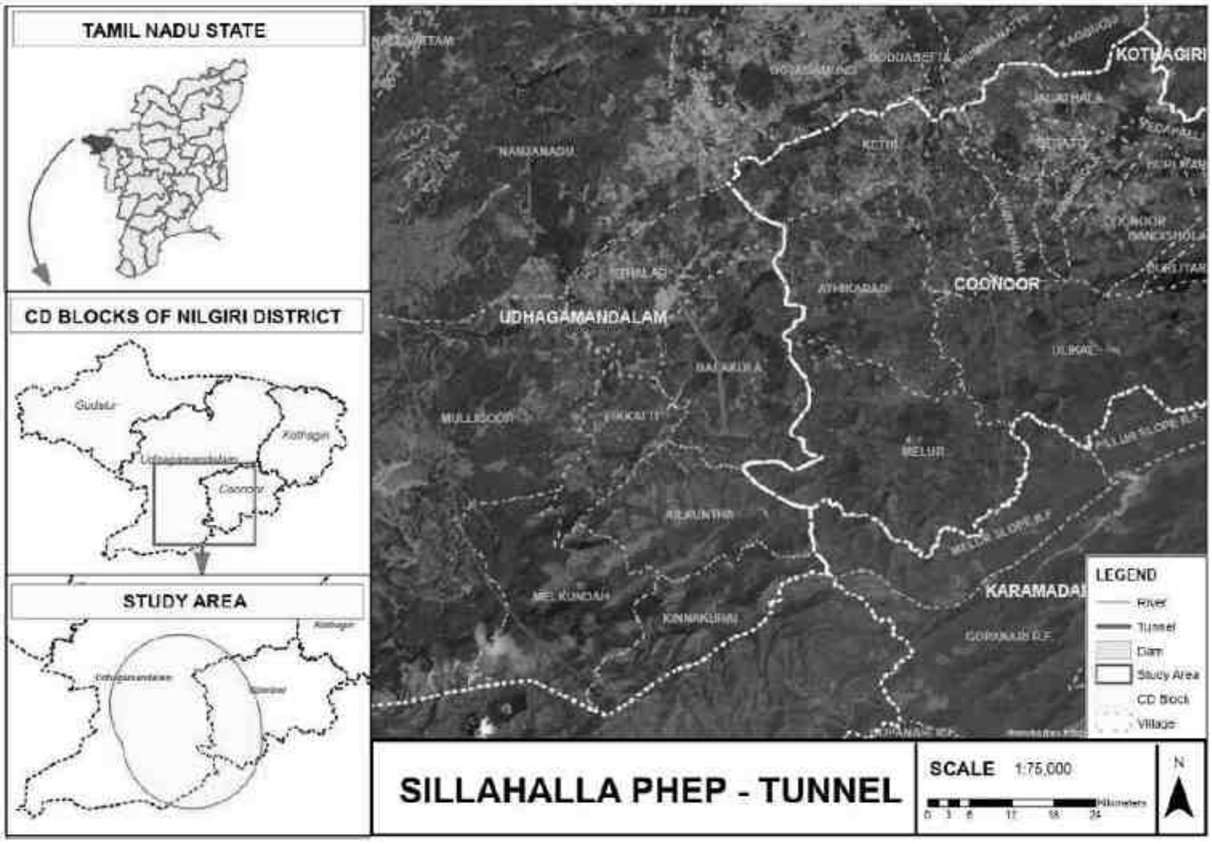


Figure - 3.1: Study Area Map

3.3 Physico-Chemical Aspects

3.3.1 Meteorology

The project area experiences semi-arid climate characterized by mild summer and mild winter. The summer season lasts from March to middle of June, followed by the south-west monsoon season from mid June to the end of September. October to December constitute the north-east monsoon season. The winter season lasts from December to February.

The nearest Indian Meteorological Department (IMD) station from the project site is Coonoor. The Climatological data of Coonoor (11° 21’ N and 76° 48’E), published by the IMD, based on daily observations at 08:30 and 17:30 hour IST has been used to assess meteorological conditions of the region, and is summarized in **Table-3.1**.

Table-3.1: Average Meteorological Conditions

Month	Temperature (^oC)		Monthly Total rainfall (mm)	Relative Humidity (%)
	Maximum	Minimum		
January	23.0	5.6	52.4	64
February	24.5	7.0	66.9	63
March	25.9	9.2	111.6	56
April	26.6	11.7	109.9	64
May	27.4	13.3	85.7	63
June	25.7	13.0	61.3	70
July	24.1	12.8	79.5	74
August	23.9	12.6	89	73
September	24.2	11.6	148.9	73
October	23.9	10.5	309.3	78
November	22.9	6.7	296.2	79
December	22.6	5.7	180	74
Total			**1590.7**	
Average	**27.6**	**5.2**		**69**

Source: India Meteorological Department station at Coonoor

Temperature

The maximum temperature observed throughout the year ranges from 22.6ºC to 27.4ºC. April and May are the hottest months of the year. The minimum temperature ranges from 5.6ºC to 13.3ºC with lowest temperatures and is observed in the months of December and January. The month wise temperature variations in the project area is desricted in **Figure-3.2**.

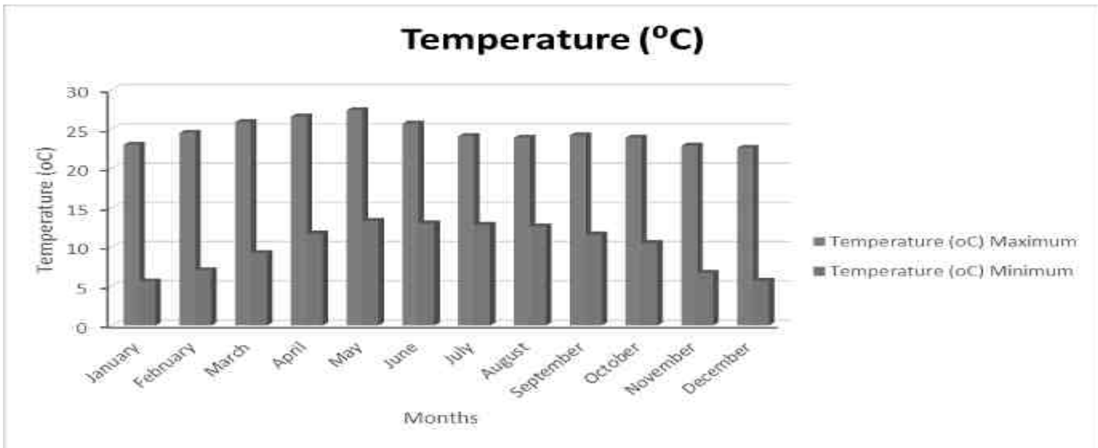


Figure-3.2: Month-wise Variations of Maximum and Minimum Temperature

Rainfall

The mean annual rainfall for the period 2001- 2010 at Coonoor is 1590.7 mm. The monthwise rainfall received at IMD station Coonoor is depicted in **Figure-3.3**. Maximum rainfall is observed in the months of October to December, under the influence of north-east monssons. Some rainfall is also received under the influence of south-west monsoons.

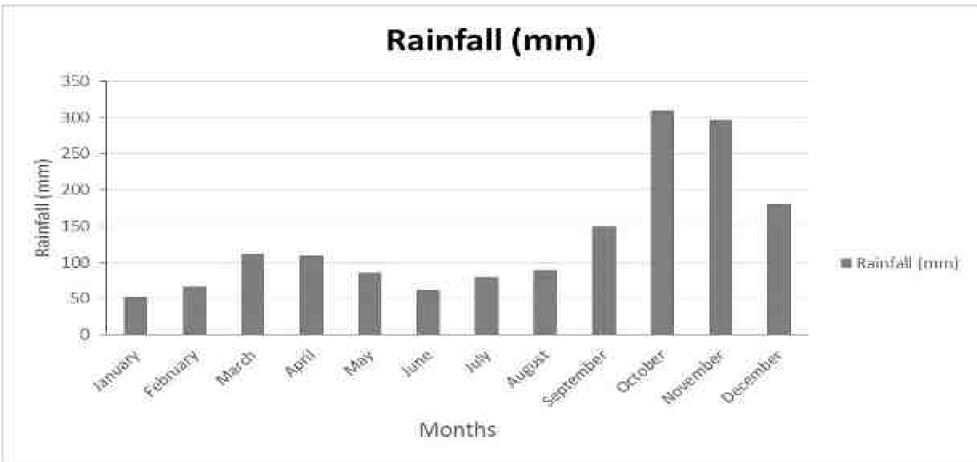


Figure-3.3: Month wise Rainfall Received in the Project Area

Humidity

Mean yearly relative humidity is 69%. The monthly average humidity is lowest in March (56%) and highest in November (79%). The monthwise relative humidity observed at IMD station Coonoor is depicted in **Figure-3.4.**

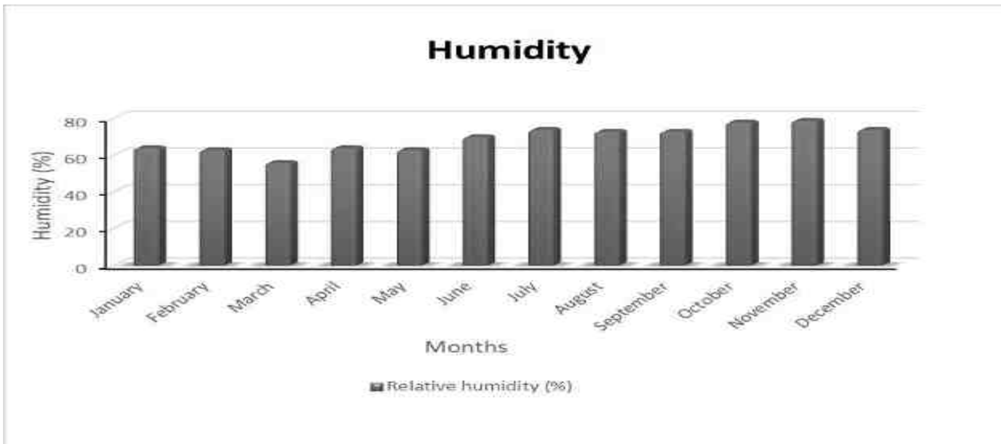


Figure-3.4: Month-wise Variations in Humidity in the Project Area

Wind

The wind pattern in the Nilgiris district of Tamil Nadu, India is affected by the Indian monsoon:

Northeast monsoon: Brings rainfall in July

Southwest monsoon: Brings rainfall between November and January

The Indian monsoon blows from the northeast during cooler months and from the southwest during warmer months. The Windrose diagram is enclosed as **Figure-3.5**.

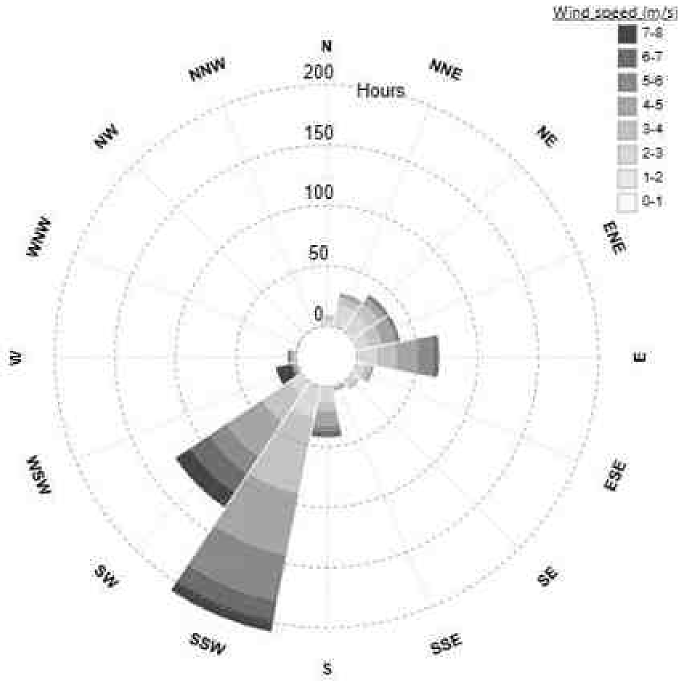


Figure-3.5: Windrose Diagram

3.3.2 Topography

The Nilgiris is situated at an elevation of 900 to 2636 meters above MSL. Its latitudinal and longitudinal dimensions being 130 km. The Nilgiris is bounded on North by Karnataka State on the East by Coimbatore District, Erode District, South by Coimbatore District and Kerala State and as the West by Kerala State. In Nilgiris District the topography is rolling and steep. About 60% of the cultivable land falls under the slopes ranging from 16 to 35% The highest point in the district is Doddabetta Peak, which is 2,637 meters tall. Other nearby peaks include Kolaribetta, Makurni, Hecuba, Kattadadu, and Kulkudi.

The Slope Map of Study Area is enclosed as **Figure-3.6.**

The Digital Elevation Model (DEM) map of the Study Area is enclosed as **Figure-3.7.**

The Triangulated Irrregular Network (TIN) imap of the Study Area is enclosed as **Figure-3.8.**

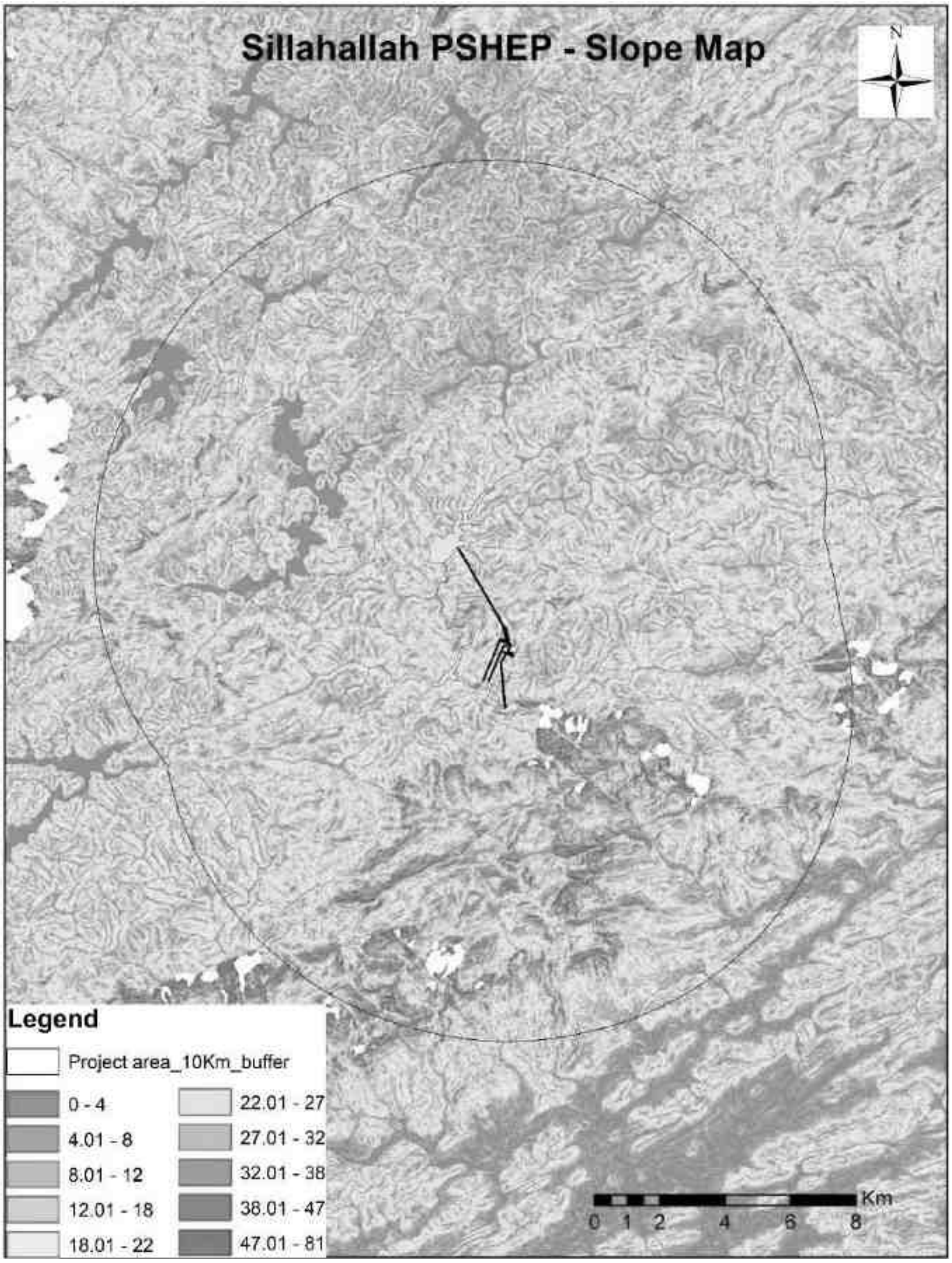


Figure-3.6: Slope Map of Study Area

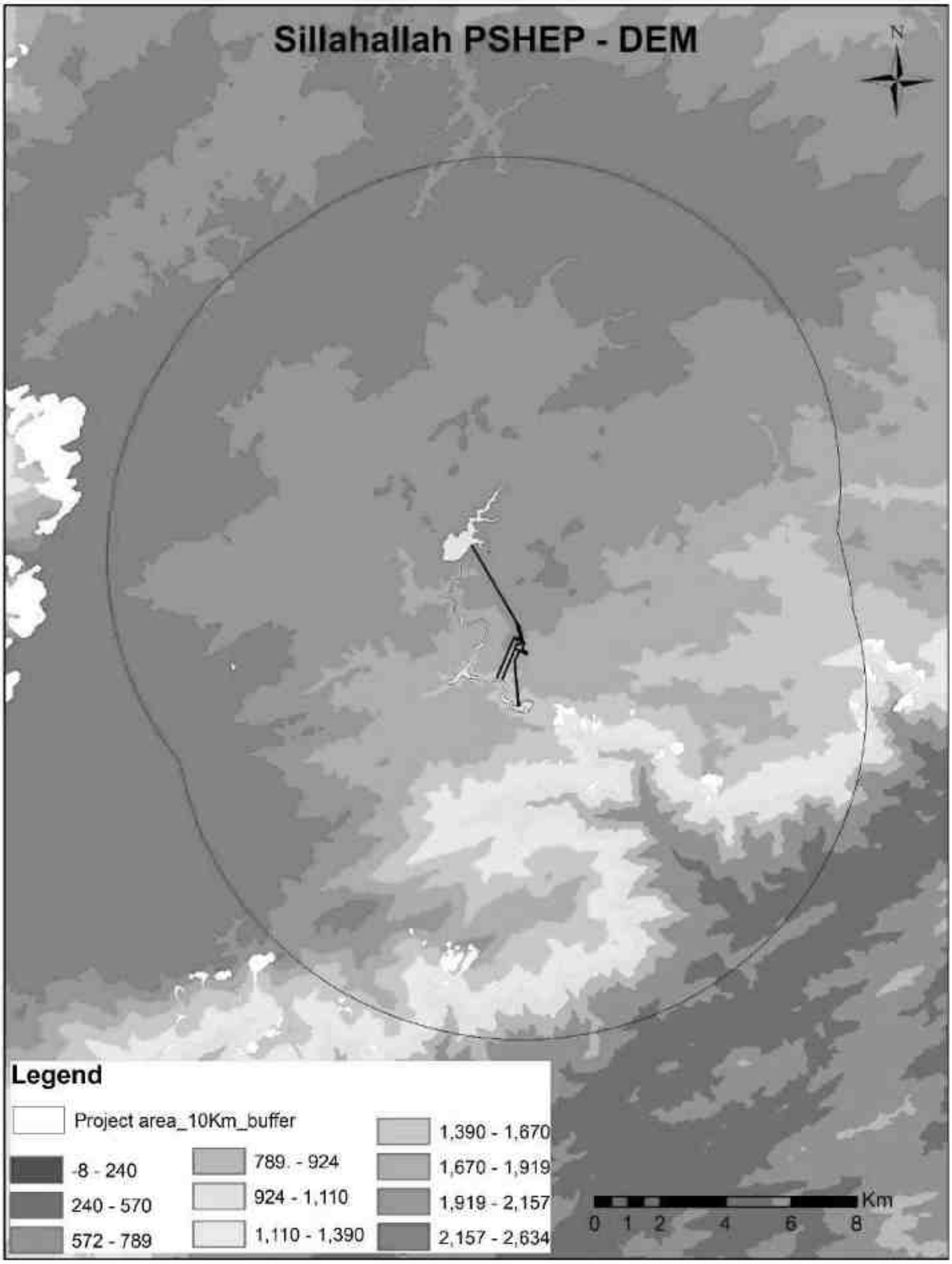


Figure-3.7: Digital Elevation Model Map of Study Area

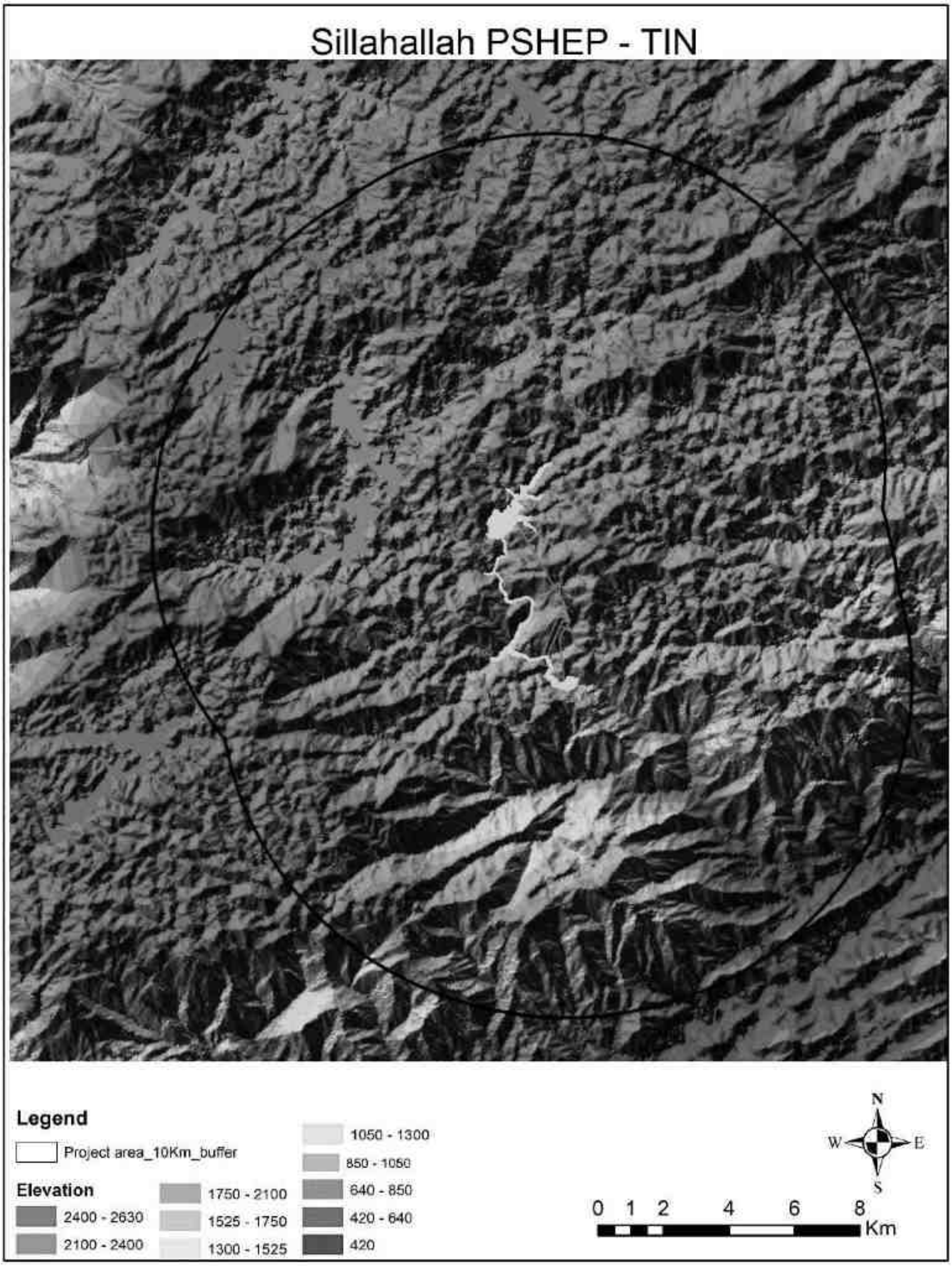


Figure-3.8: Triangulated Irrregular Network (TIN) imap of the Study Area

3.3.3 Geology

The major geological features of the State of Tamil Nadu are given as below:

- Archean Formations including Sathyamangalam Group, Bhavani Gneissic Complex, Khondalite Group, Kolar Group and Anorthosite Complex
- Archean to Proterozoic including Charnockite Group, Granites, Migmatic Complex.
- Proterozoic including Ultramafic, Alkaline rocks and Carbonatites, Granites,
- Palaeozoic to Mesozoic including Gondwana Plant beds, Cretaceous
- Tertiary Sediments including Lignite, Petrified Wood of Thiruvakkarai Cuddalore Sandstone Conjeevaram Gravels, Cenozoic and Quarternary Sediments

The Geological Map of Tamil Nadu is enclosed as Figure-3.9.

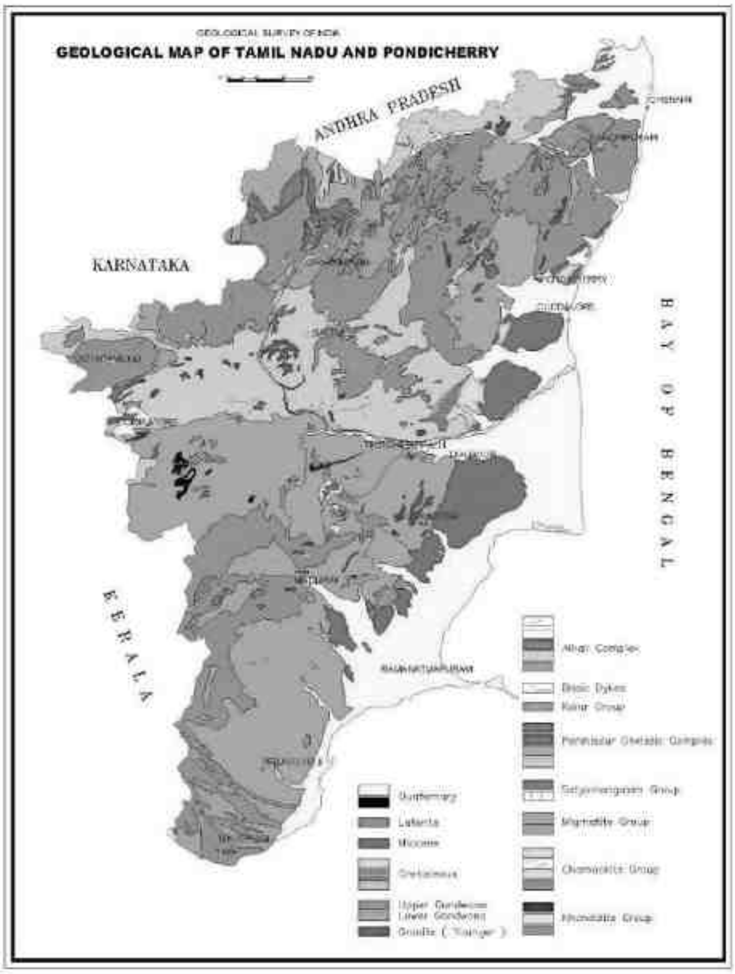


Figure-3.9: Geological Map of Tamil Nadu

The Sillahalla Pumped Storage Project is located in Nilgiris district, located in Charnockite Group for the period Archean to Proterozoic. It consists of Hypersthene bearing minerals and blue Quartz imparts the blue colour to the rock and hence called Blue Metal. This rock types occur in Gneissic terrain in most parts of Tamil Nadu predominantly in the Nilgiris and Palani Hills.

The Nilgiris district exposes Charnockite group of rocks with associated migmatites and Bhavani Group along with the enclaves of Satyamangalam Schist Complex. The Stratigraphic Succession of the region is given in Table-3.2.

Table-3.2: Stratigraphic Succession of the Region

Lithology	Group	Age
Laterite	-	Cainozoic
Felsite	Younger intrusive	Proterozoic
Dolerite/Gabbro	Basic intrusives	
Fissile hornblende biotite gneiss	Bhavani Group (Penninsular Gneissic Complex)	
Ultramafic complex	Satyamangalam Schist Complex	Archaean
Quartz-sericite or mica schist Banded magnetite quartzite		
Hornblende biotite gneiss	Migmatite complex	
Pyroxene granulite	Charnockite Group	
Charnockite/Magnetite quartzite		

The Charnockitic Group is represented by charnockite and pyroxen granulite and covers a major part of the district in the southern part, which is popularly known as “Nilgiri Massif”. A number of dolerite dykes have been intruded in this group of rocks.

The Bhavani Group (Peninsular Gneissic complex) comprises fissile hornblende biotite gneiss and occurs in the northern part of the district. The Satyamangalam Schist complex is represented by quartz-sericite/mica schist, ultamafics and banded magnetite quartzite. The Nilgiri Massif is capped by aluminous laterite at a number of places indicating adeep zone of weathering.

The regional foliation of the rocks varies from ENE-WSW to NE-SW with steep to subvertical dips. Three sets of steeply dipping joints trending NNE-SSW, NNW-SSE and E-W are prominent. All the prominent escarpments on the hills are developed along one or more of these joint planes. Zones of brecciating in a ENE-WSW direction are noted in the charnockite terrain on either side of the Bhavani Reservoir. NW-SE to NNW-SSE trending faults are noted west of Gudalur in the Bhavani Gneissic terrain.

Rocks inthe greater part of the district are deeply weathered and development of a thick soil profile attaining a thickness upto 40m with lithomarge at the bottom partis a common feature. The erosional surfaces such as Dodabetta, Ootacamund, Coonoor and Moyar are recorded in the district. All these erosional surfaces are capped by residual laterite. The low gradient of slope in Ootacamund, promotes stagnation of surface water as bogs and swamps.

The Geological Mapping of Sillahalla PSP is enclosed as Figure-3.10.

3.3.4 Geomorphology and Geohydrology

The project is located in the south-western part of Nilgiris Hills. Nilgiris Hills represent a plateau which is steeply sloping into Mysore Plateau in the north and gradually merges with the Western Ghat hill ranges in the north-western and south western parts. The Hydrogeological map of the state of Tamil Nadu is enclosed as Figure-3.11. The Geomorphological and Geohydrological map of the project area is enclosed as Figure-3.12.

The region has limited groundwater potential, and has compact formations, with less inter-granular posrosity and fractures. The yiels of well in the area is < 1 lps.

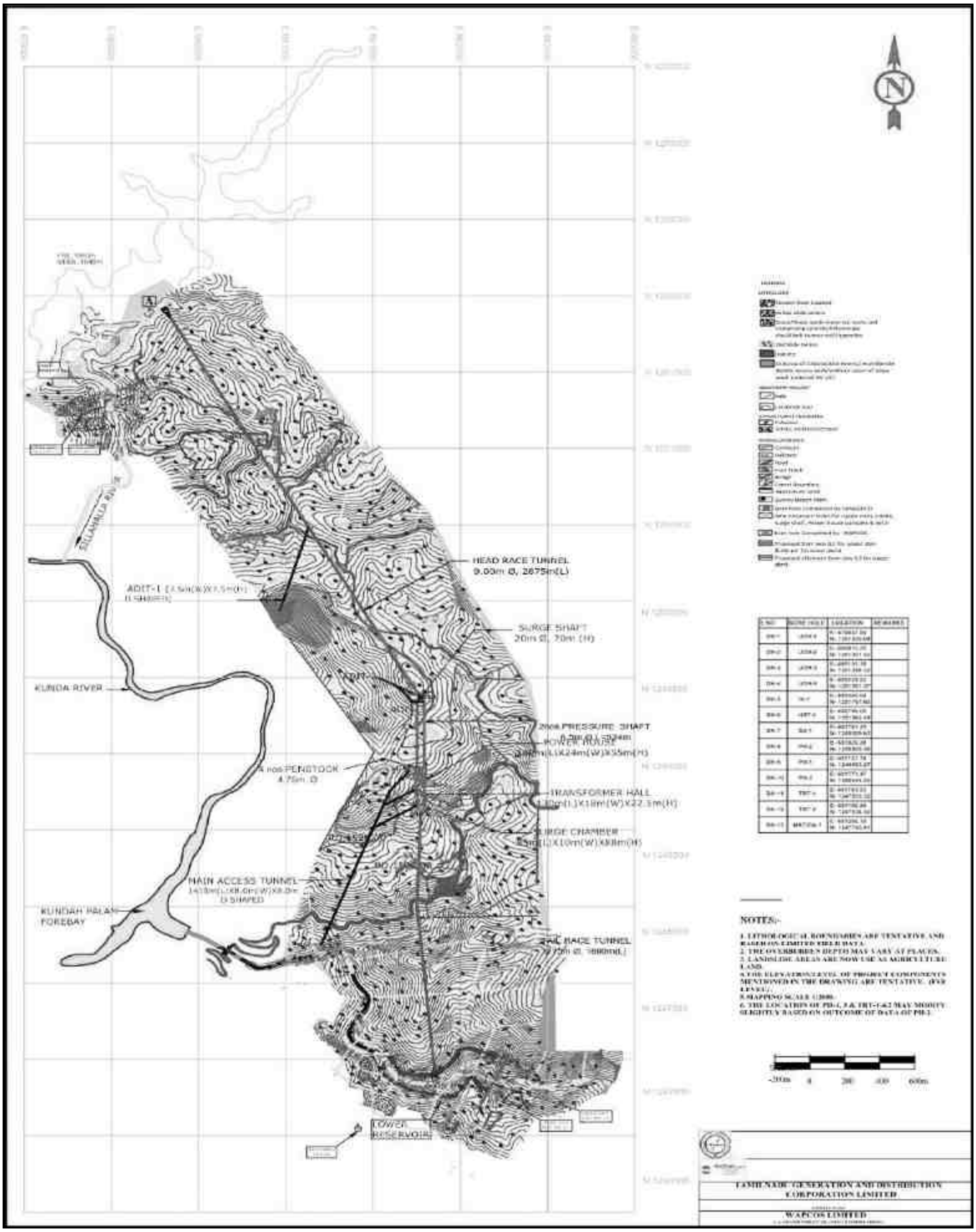


Figure-3.10: Surface Geological Mapping of Sillahalla PSP

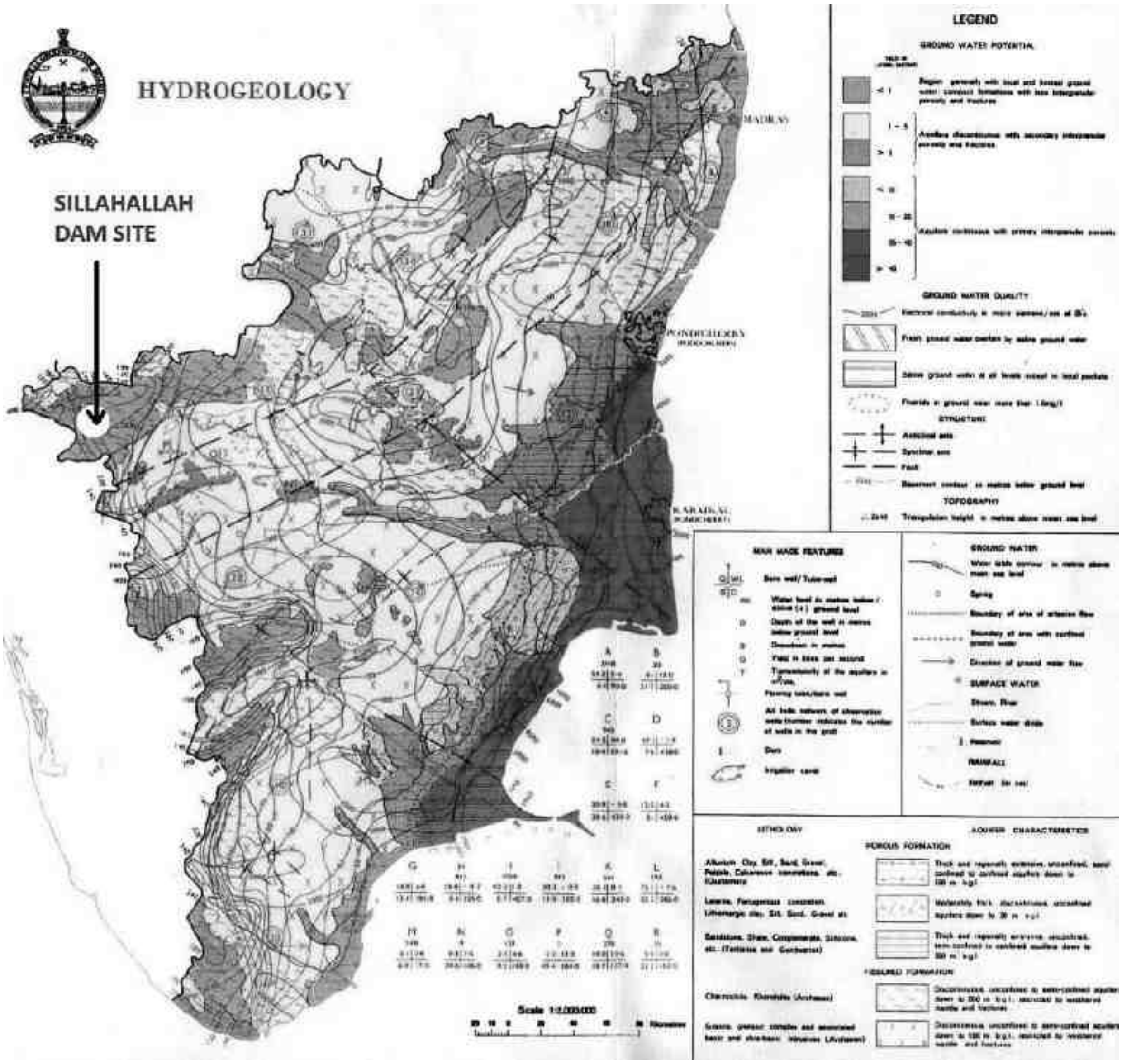


Figure-3.11: Hydrogeological Map of Project Area

Figure-3.12: Geomorphological and Geohydrological Map

The Nilgiris Hills rise abruptly from the surrounding plains to an elevation of 1370m above MSL. They are surrounded by the Coimbatore plains (EL.411.0m) in the southeast. Bhavani plains (EL.173.0m) in the northeast, Moyar valley (EL.431.0-585.0m) in the north and Gudalur plateau (EL.1072.0m) in the northwest. The prominent hills are Ooty, Dodabetta, Kodaibetta, Bhavni Betta and Devabetta. Dodabetta is the highest peak (EL.2637.0m) in Tamilnadu. The other high peaks are Mukkurthi, Vellari Mala and Mukkali Mudi further west of the Project area.

The principal rivers that drain the area are Bhavani, Kundah in the south, Pykara towards north and Coonoor to further east of the project area. One of the major tributaries of Kundah River is Sillahalla stream – a perennial stream across which construction of the upper dam is contemplated, whereas the lower dam is proposed across Kundah River.

The Dodabetta Surface includes landform as high peaks, structural hills, and rocky escarpment with or without soil cover around which prominent drainage is developed. The Oatacamund and Coonoor surfaces include gentle mounds with soil cover, stream meanderings and gentle smoothening of the hills. The latter abuts against the former at many places, with break in the slope.

Geo-hydrologically the area forms a part of the Cauvery River Basin, having two sub-basins i.e. Moyar sub-basin in the north and Bhavani sub basin in the south. Ground water occurs under discontinuous, unconfined to semi confined aquifers, down to 200m b.g.l. in the charnockitic terrain and 150m b.g.l. in the gneissic country and is restricted to weathered mantle and fractures. The specific yield from charnockitic terrain is <1ltr/second and in the gneissic country the yield varies from <1ltr/second to 1-5ltrs/second. The quality of ground water is generally good for both irrigation and domestic purposes.

Nilgiri district is underlain entirely by Archaean Crystalline formations with recent alluvial and colluvial deposits. The occurrence and movement of ground water are controlled by various factors such as physiography, climate, geology and structural features. Weathered, fissured and fractured crystalline rocks and the Recent alluvial and colluvial formations constitute the important aquifer systems in the district.

The porous formations in the district are represented by alluvium, colluvium. The alluvial deposits comprising sand with admixtures of silt and clay are confined to the major river and stream courses only. It has been reported that the wells tapping river alluvium remain dry during drought years and in the year of less rainfall. The colluvial materials comprising the sands and gravels are seen in the valley portions.

Ground water is developed by dug wells and occurs under phreatic conditions. The depth range of these shallow aquifers ranging from 5.00 to 20 m. The crystalline rocks of gneisses and charnockites represent weathering, fissures and fractures. Ground water occurs under phreatic conditions in the weathered mantle and under semi-confined conditions in the fractured zones. The thickness of the weathered mantle is varying from less than a meter to as much as 20.00 m. The depth of the wells ranged from 5.00 to 15.00 m bgl. The weathered mantle followed by the jointed and fractured rocks constitute the shallow water table aquifer and it occurs in the major part of the district with in the depth of 20 – 25 m in general.

The Specific capacity of large diameter wells tested in crystalline rocks varying from 100 to 200 lpm / m. of draw down. The saturated thickness of the aquifer varies from 2 to 5 m only. The yield characteristics of wells vary considerably depending on the topographic set-up, lithology and the degree of weathering.

The yield of bore wells drilled down to a depth of 45 to 100 m, by various state agencies mainly for domestic purposes ranged from 60 to 100 lpm. The depth to water level in the district varied between 1.20 and 17.06 m bgl during pre-monsoon (May 2006) and it varied between 1.28 and 16.60 m bgl during post monsoon (Jan 2007). The seasonal fluctuation shows a rise in water level in the range of 0. 35 to 3.05 m bgl and fall in the range 0.08 to0.73 m bgl. The piezometric head is 2.48 m bgl during pre monsoon (May 2006) and 2.94 bgl during post (Jan 2007).

The long-term water level fluctuation for the period 1998-2007 indicates rise in water level in the range of 0.1249- 0.2327m/year. The fall in water level ranging between 0.0030 and 0.1213 m/year. The estimation of groundwater resources for the district has shown that all the 4 blocks of Nigiliris district are under Safe category

3.3.5 Seismicity

Sillahalla Pumped Storage Project is located within Charnockite Group of rocks of Archaean age on Nilgiri Plateau. The area falls under seismic zone-II as per Seismic Zonation Map of India (Figure-3.13). A number of escarpments (lineaments) represented mainly by master joints trending NNE-SSW, NNW-SSE and E-W are reported. Zones of brecciations along ENE-WSW direction are noted in the charnockite terrain on either side of the Bhavani Reservoir. NW-SE to NNW-SSE trending faults are noted west of Gudalur in the Bhavani Gneissic terrain.

Historical record says that no high magnitude earthquake greater than 5 Ms have been reported in the area, except a historical magnitude of 6.0 have been reported in Coimbatore area, Tamil Nadu in the year 1900. The seismic status of the region has been provided in the Seismotectonic Atlas of India and its environs in SEISAT-38 (Refer Figure-3.14).

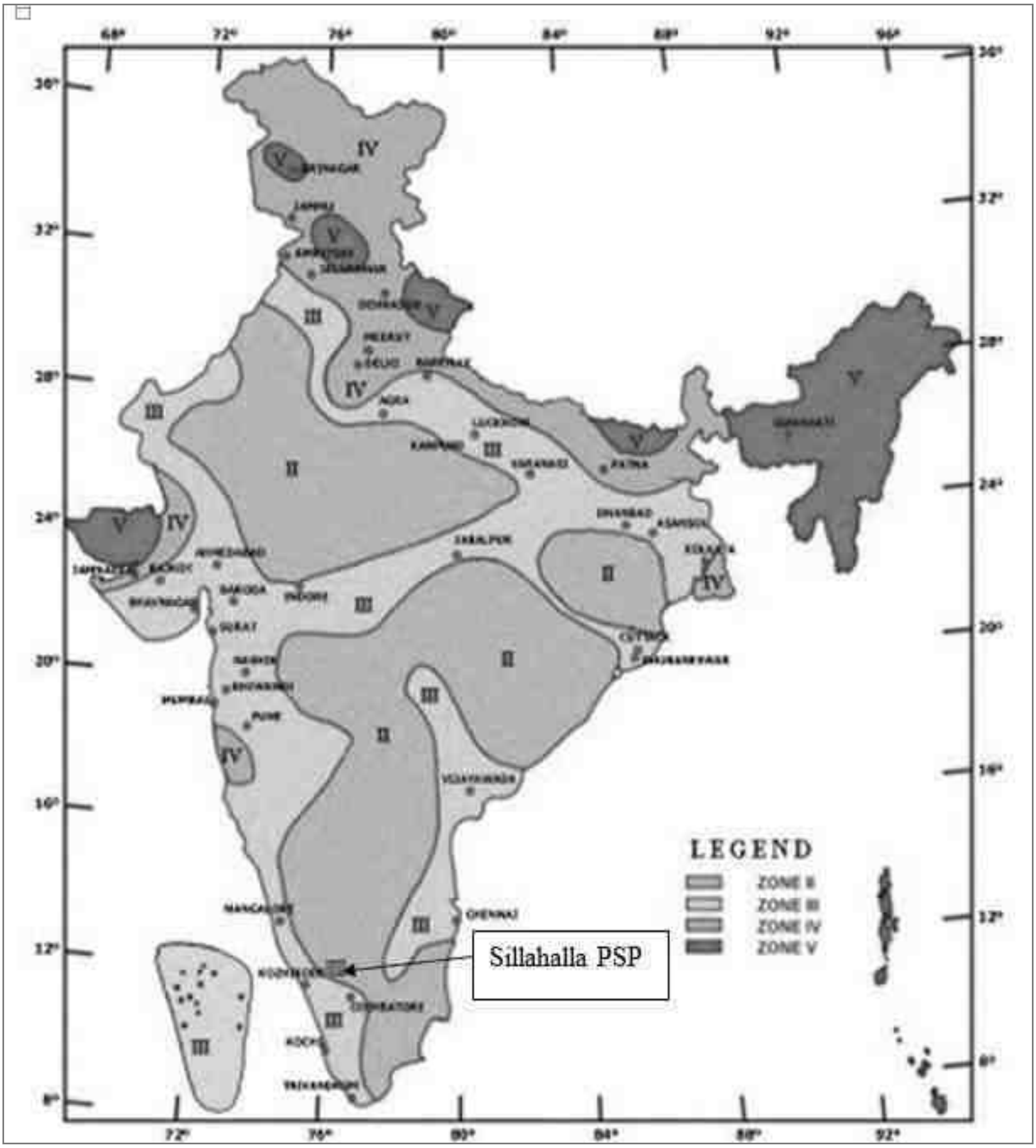


Figure-3.13: Seismic Zonation map of India showing project area

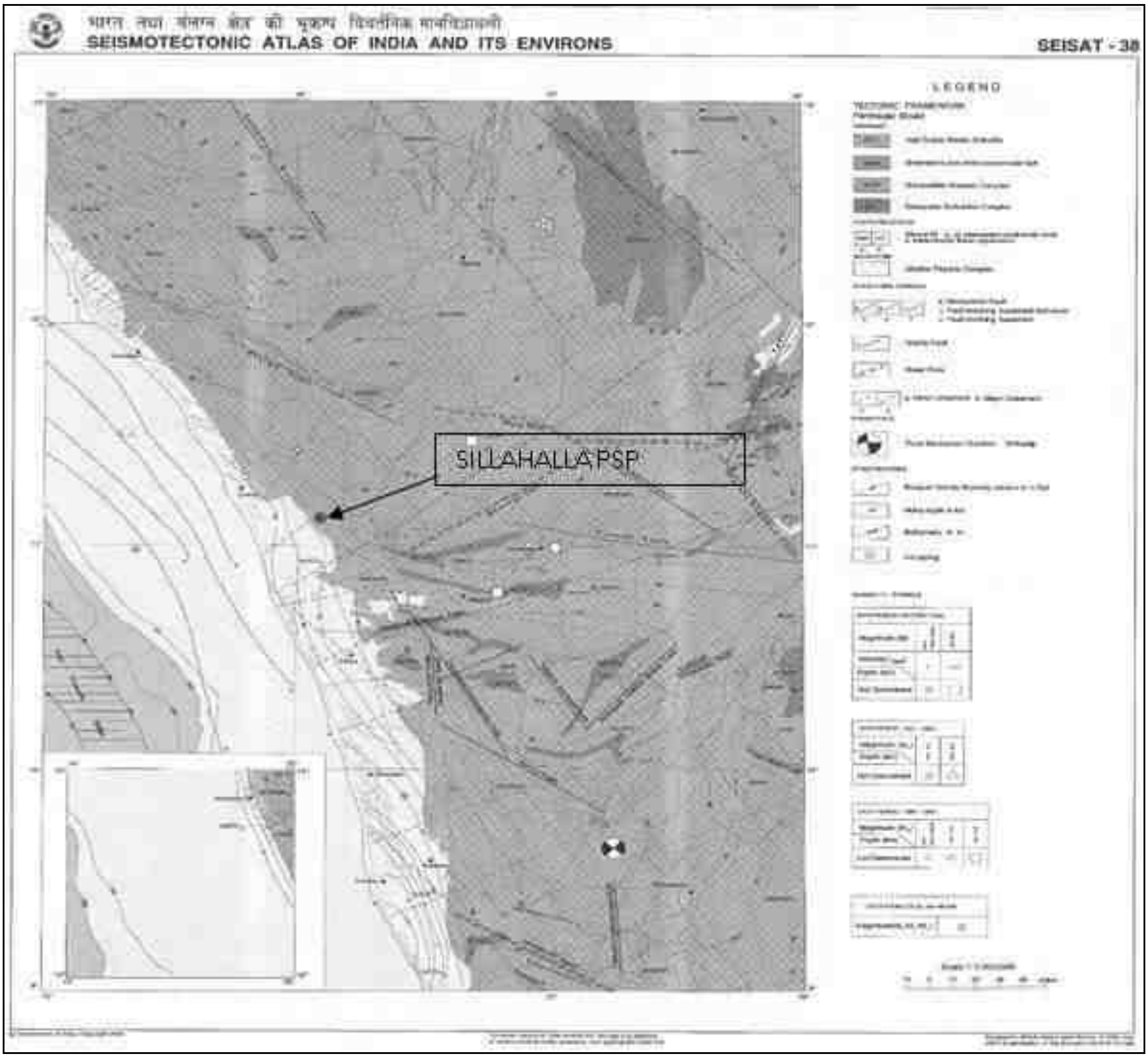


Figure-3.14: Seismotectonic Atlas of India and its Environ, 2000, showing project area (Source: GSI)

The details study of the past earthquake for seismic design parameters will be carried out by CWPRS, Pune and will be incorporated into the design of civil structures before finalization of the civil drawings.

3.3.6 Landuse Pattern

Landuse describes how a patch of land is used (e.g. for agriculture, settlement, forest), whereas land cover describes the materials (such as vegetation, rocks or buildings) that are present on the surface. Accurate land use and land cover identification is the key to most of the planning processes. The land use pattern of the study area has been studied through digital satellite imagery data. The land use pattern has been studied through satellite imagery data. The data was processed through ERDAS software package available with WAPCOS. Ground truth studies were conducted in the area to validate various signals in the satellite images and correlate them with different land use domains.

The classified image of submergence area Upper and Lower Reservoirs is enclosed as Figures-3.15 and 3.16 respectively. The land use pattern of the submergence area of Uper and Lower Reservoirs is enclosed as Tables-3.3 and 3.4 respecively.

The Classified imagery of the Study Area rea given in Figure-3.17. The landuse pattern of the study Area is summarized in Table-3.5

Table-3.3 : Landuse pattern of submergence area of Upper Reservoir of Sillahalla PSP

Landuse Category	Description	Area (ha)	Area (%)
Agriculture Area	Agriculture and Fallow land	75.52	56.4%
Bare earth	Exposed Earth	45.99	34.3%
Built-up	Residential, Commercial, Mixed built-up	0.42	0.3%
High Dense Vegetation	Forest, Dense Plantation	5.99	4.5%
Low Dense Vegetation	Shrubs, Sparse vegetation	2.40	1.8%
Tea Plantation	Tea Plantation	1.02	0.8%
Waterbodies	Reservoir, River, Pond and Canal	2.62	2.0%
Total		**133.96**	**100.0%**

The major landuse category in the submergence area of Upper Reservoir of Sillahalla PSP is Agriculture Area, as it accounts for about 56.4% of the submergence area, followed by bare area (34.3%). The area under vegetation is 6.3% of the submergence area. Settlements and water bodies account for 0.3% and 2.0% respectively of submergence area. About 0.8% of the submergence area is under Tea Plantation.

Table-3.4 : Landuse pattern of submergence area of Lower Reservoir of Sillahalla PSP

Landuse Category	Description	Area (ha)	Area (%)
Agriculture Area	Agriculture and Fallow land	0.31	1.1
Bare earth	Exposed Earth	11.55	40.7
High Dense Vegetation	Forest, Dense Plantation	11.86	41.7
Low Dense Vegetation	Shrubs, Sparse vegetation	1.57	5.5
Waterbodies	Reservoir, River, Pond and Canal	3.10	10.9
Total		**28.39**	**100%**

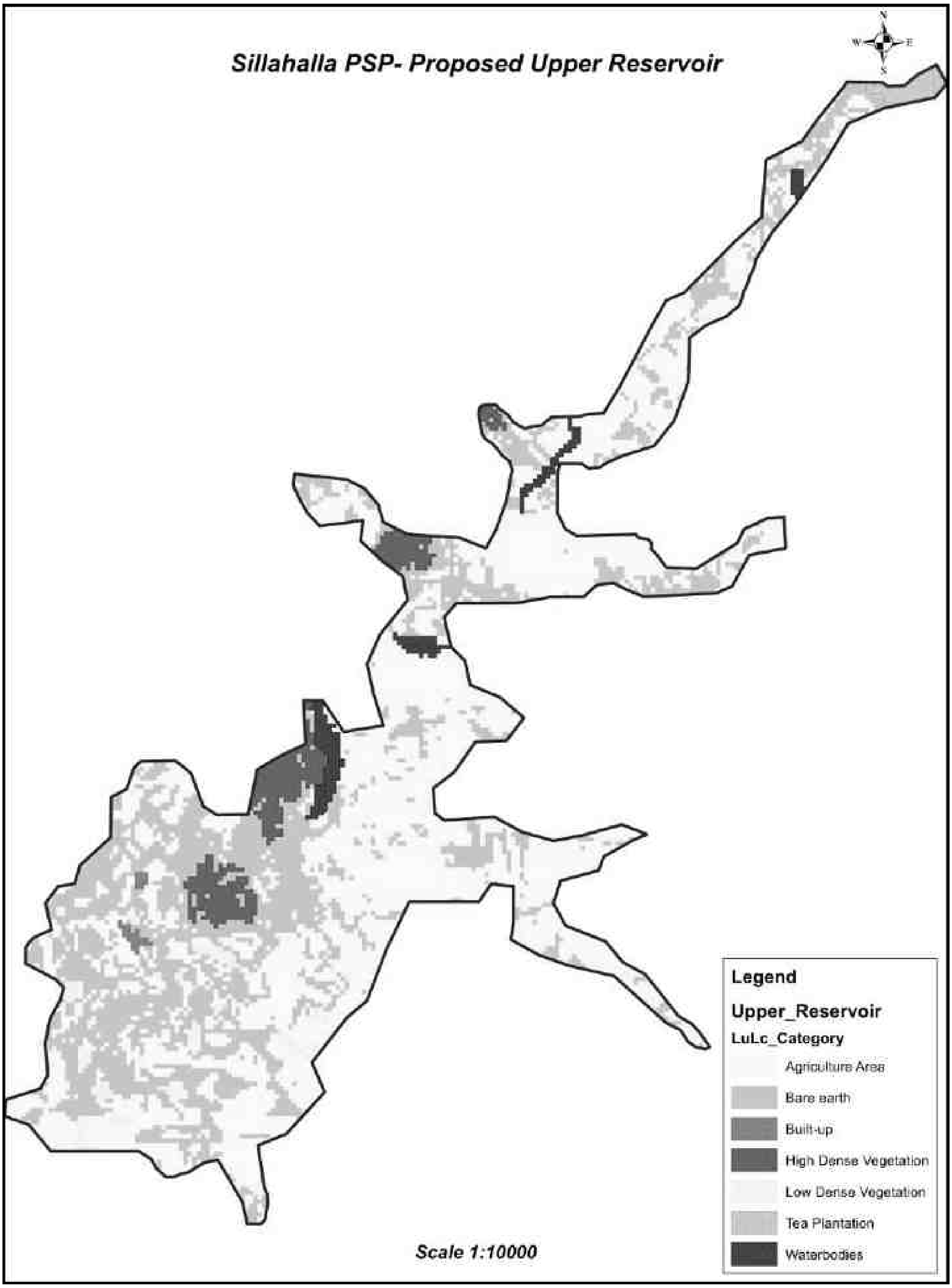


Figure-3.15: Land Use Pattern for Upper Reservoir of Sillahalla PSP

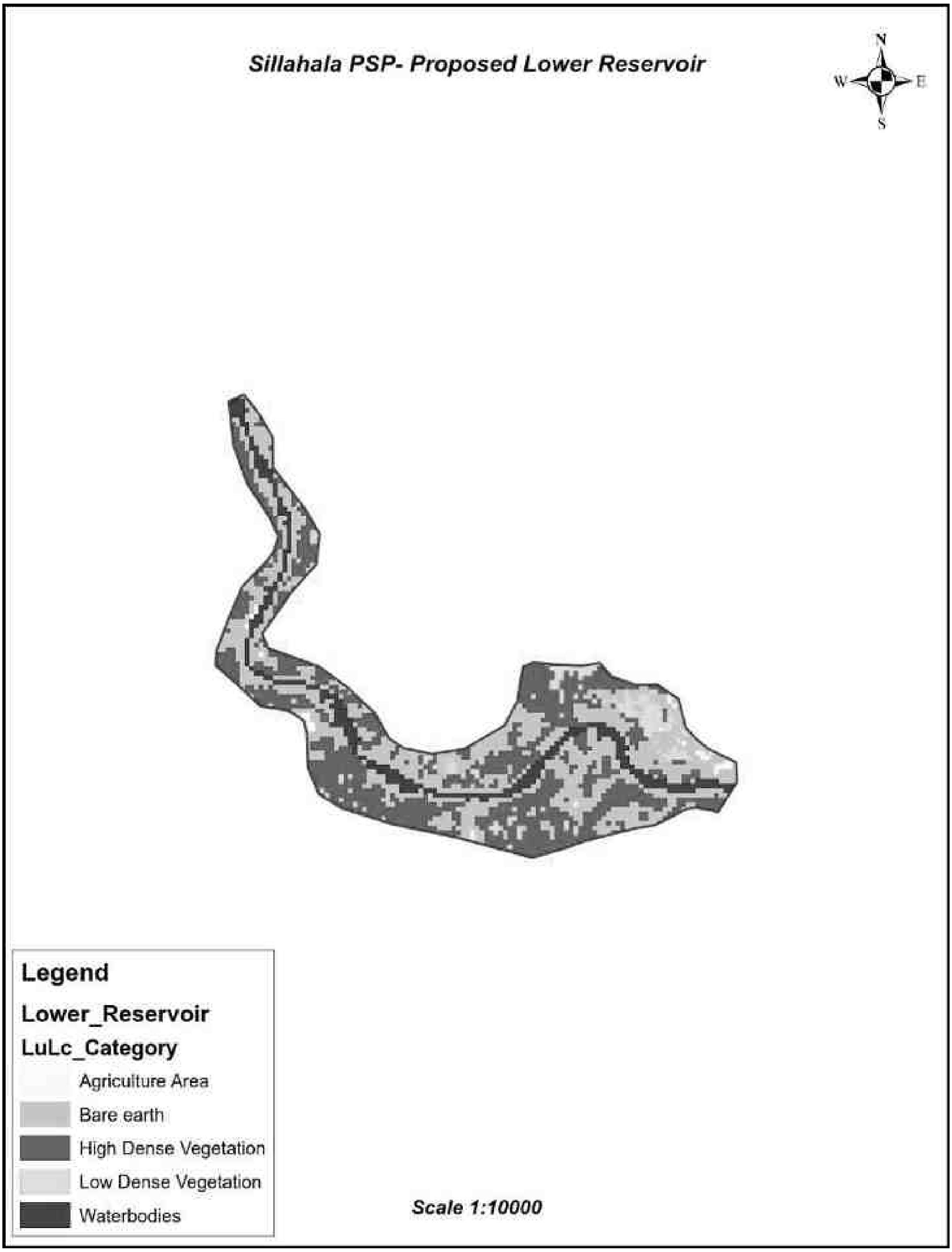


Figure-3.16: Land Use Pattern for Lower Reservoir of Sillahalla PSP

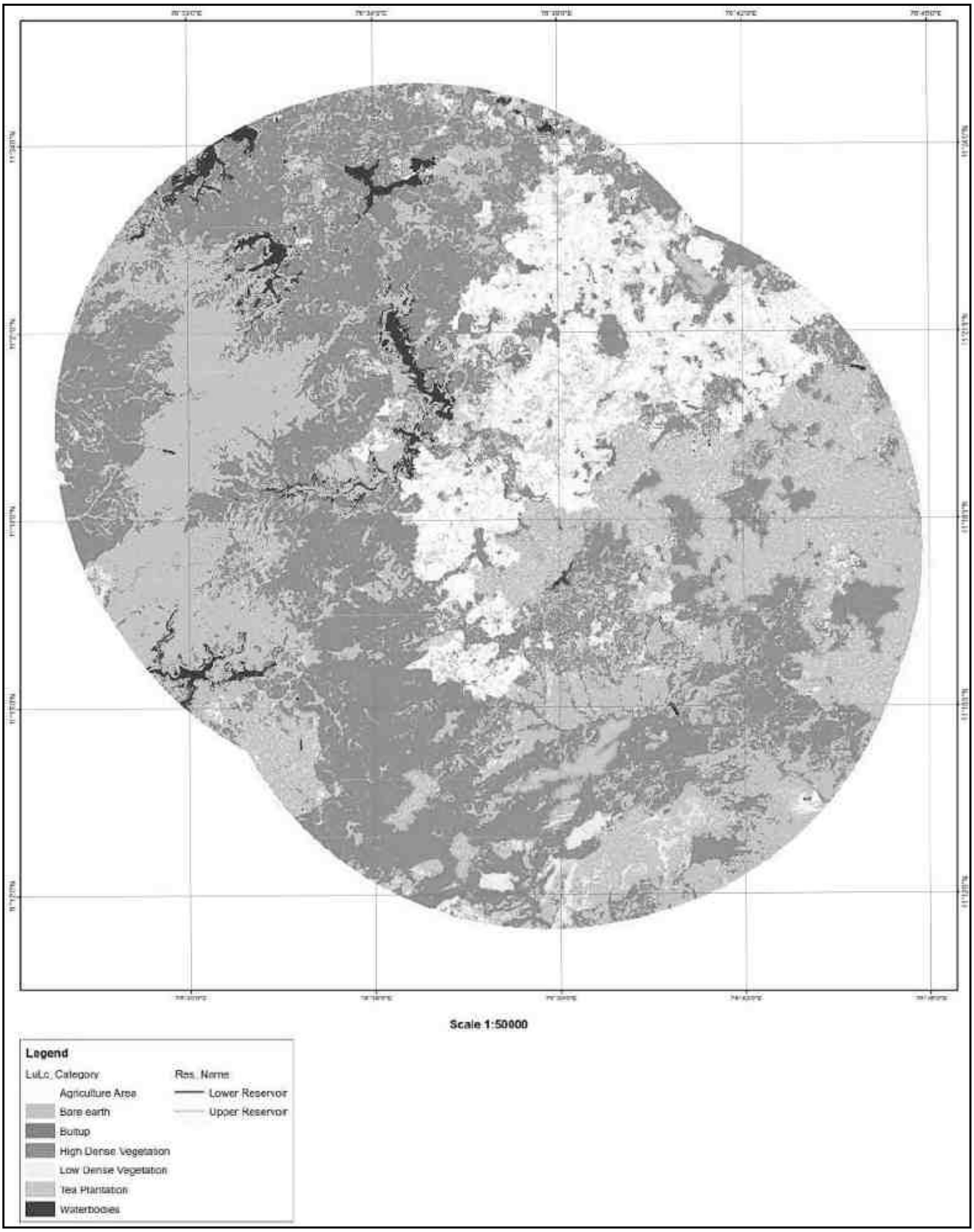


Figure-3.17: Land Use Pattern of Sillahalla PSP

The major landuse category in the submergence area of Lower Reservoir of Sillahalla PSP is Forest Area, as it accounts for about 47.2% of the submergence area, followed by bare area (40.7%). The area under agriculture is 1.1% of the submergence area. Water bodies account for 10.9% of submergence area.

Table-3.5: Landuse pattern of Study Area of Sillahalla Pumped Storage Project

Landuse Category	Description	Area (ha)	Area (%)
Agriculture Area	Agriculture and Fallow land	5266.8	11.1%
Bare earth	Exposed Earth	14699	31.0%
Buitup	Residential, Commercial, Mixed built-up	619.3	1.3%
High Dense Vegetation	Forest, Dense Plantation	19502.3	41.1%
Low Dense Vegetation	Shrubs, Sparse vegetation	1299.9	2.7%
Tea Plantation	Tea Plantation	4975.2	10.5%
Waterbodies	Reservoir, River, Pond and Canal	1035.8	2.2%
Total		**47398.3**	**100.0%**

The major landuse category in the Study Area of Sillahalla PSP is Forest Area, as it accounts for about 43.8% of the Study Area, followed by bare earth (31.0%). The area under agriculture is 11.1% of the Study Area. Built-up area and water bodies account for 1.3% and 2.2% respectively of the Study Area. About 10.5% of the Study Area is under Tea Plantation.

3.3.7 Soil Quality

The soils of Nilgiri district can be broadly classified into 5 major soils types viz., Lateritic soil, Red sandy soil, Red loam, black soil, Alluvial and Colluvial soil. Major part of the district covered by Lateritic soil. The Red sandy soil and Red loams are occurring as small patches. Block soil is developed in the valleys. The alluvial and colluvial soils are seen along the Valleys and major river courses respectively.

The major soil types in Study Area are Alfisols , Inceptisols and Hill Soils. The soil map of Study Area ks enclosed as Figure-3.18.

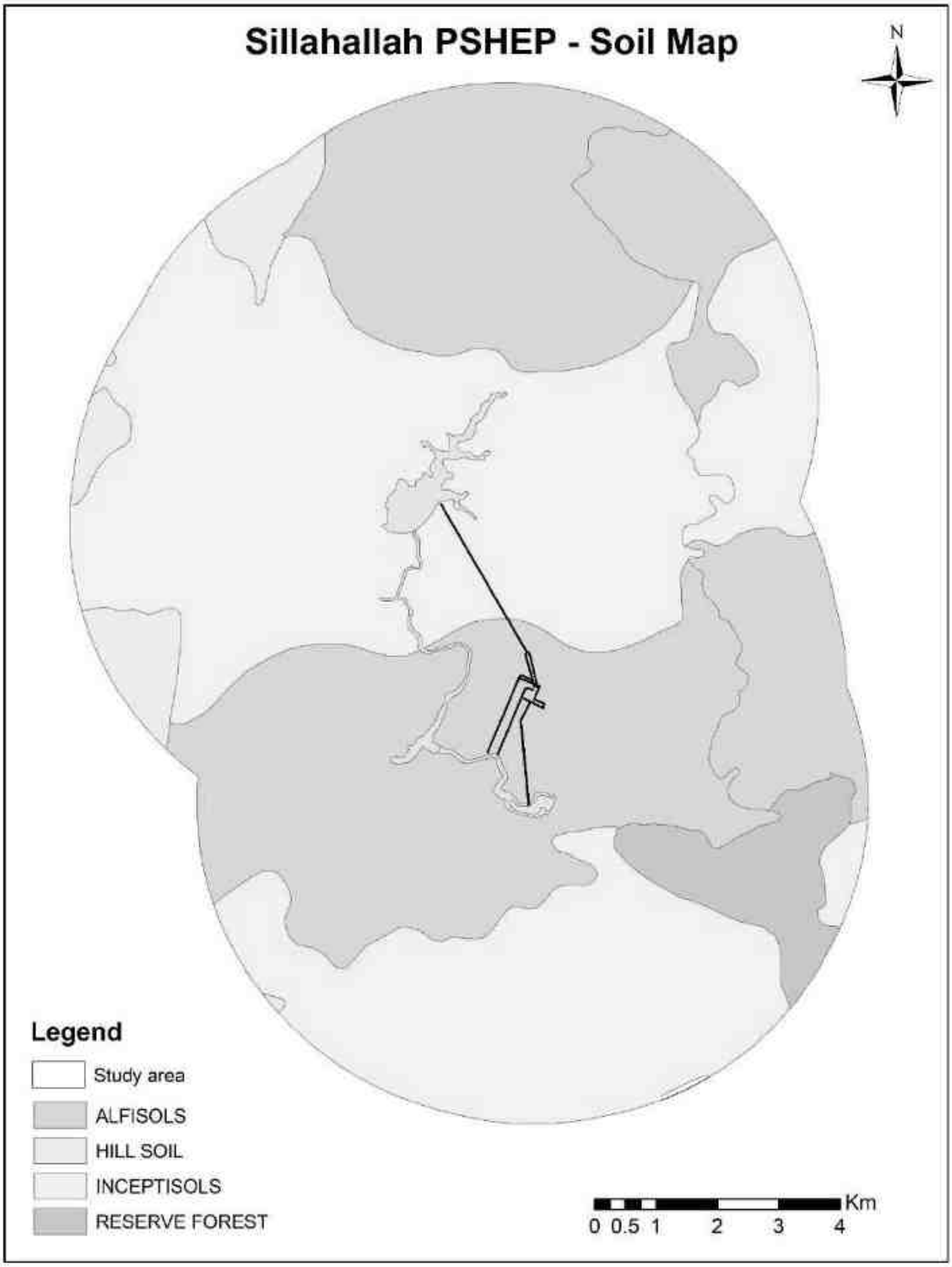


Figure-3.18: Soil Quality Map of Study Area

The Soil quality quality was monitored for three seasons listed below:

- Monsoon season : October - November 2021
- Post-monsoon season : February 2022 – March 2022
- Pre-monsoon season : May 2022 – June 2022

Soil samples were collected from various locations in the study area (refer Table-3.6) and the results of analysis of soil samples for various seasons are given in Tables-3.7 to 3.9. The soil sampling Location Map is enclosed as Figure-3.19.

Table-3.6: Details of Soil Sampling Locations

Sampling Location	Village Name	Latitude	Longitude
S1	Edakadu	11°18'3.78"N	76°38'25.66"E
S2	Bellathi	11°16'11.67"N	76°40'3.00"E
S3	Mary Land	11°17'23.70"N	76°40'2.91"E
S4	Near Bigili Bridge	11°18'17.94"N	76°38'33.03"E
S5	Near Gunda Dam	11°16'57.93"N	76°39'2.65"E
S6	Sriram Nagar	11°18'53.45"N	76°38'55.85"E

Figure-3.19: Soil Sampling Location Map

Table-3.7: Soil Quality in the Study Area in Monsoon Season

S.No.	Parameters	Unit	S1	S2	S3	S4	S5	S6
1	pH	-	6.1	6.2	6.2	6.1	7.6	6.6
2	Conductivity	μs/cm	76	54	101	68	225	95
3	Available Nitrogen	mg/kg	302	284	188	156	122	145
4	Bulk Density	g/cm^3	1.39	1.42	1.45	1.21	1.46	1.41
5	Porosity	%	28	34	30	38	36	34
6	Organic Matter	%	0.93	0.77	0.67	1.21	0.40	0.81
7	Cation Exchange Capacity	meq/100g	9.3	7.8	7.8	23.7	11.4	8.5
8	Available Moisture	%	16.62	11.6	13.94	21.88	7.11	14.69
9	Available Potassium	mg/kg	18.6	30.7	23.4	19.8	24.5	28.4
10	Available Phosphorous	mg/kg	21.8	16.8	15.4	21.8	8.7	12.5
11	Total Organic Carbon	%	0.54	0.45	0.39	0.7	0.23	0.47
12	Texture	-	Silt	Silt	Silt	Clay	Silt	Silt
13	Sodium as Na	mg/kg	133	151	133	156	267	132
14	Magnesium as Mg	mg/kg	11	22	20	16	29	14
15	Calcium as Ca	mg/kg	42	140	191	104	240	104
16	Chloride as Cl	mg/kg	120	122	118	92	115	93
17	Exchangeable Sodium	%	6.23	8.46	7.41	2.86	10.1	6.70
18	Sodium Absorption Ratio	-	4.71	3.12	2.44	3.75	4.32	3.21
19	Cadmium as Cd	mg/kg	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)
20	Molybdenum as Mo	mg/kg	BDL(DL:10.0)	BDL(DL:10.0)	BDL(DL:10.0)	BDL(DL:10.0)	BDL(DL:10.0)	BDL(DL:10.0)
21	Nickel as Ni	mg/kg	54.1	61.4	65.8	50.6	78.2	62.3
22	Manganese as Mn	mg/kg	688.5	723.0	468.51	262.3	623.6	172.0

S.No.	Parameters	Unit	S1	S2	S3	S4	S5	S6
23	Copper as Cu	mg/kg	59.1	58.2	57.6	38.2	75.8	60.9
24	Zinc as Zn	mg/kg	52.2	46.6	43.9	28.4	53.2	51.8
25	Chromium as Cr	mg/kg	161.4	172.3	204.2	119.5	214.7	171.5
26	Mercury as Hg	mg/kg	BDL(DL:0.2)	BDL(DL:0.2)	BDL(DL:0.2)	BDL(DL:0.2)	BDL(DL:0.2)	BDL(DL:0.2)
27	Arsenic as As	mg/kg	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
28	Lead as Pb	mg/kg	BDL(DL:5.0)	BDL(DL:5.0)	BDL(DL:5.0)	BDL(DL:5.0)	BDL(DL:5.0)	8.42

Table-3.8: Soil Quality in the Study Area in Post-Monsoon Season

S.No.	Parameters	Unit	S1	S2	S3	S4	S5	S6
1	pH	-	6.5	6.3	6.7	6.2	6.2	6.3
2	Conductivity	µs/cm	84	226	93	74	164	106
3	Available Nitrogen	mg/kg	328	252	238	296	212	247
4	Bulk Density	g/cm^3	1.43	1.45	1.43	1.42	1.43	1.45
5	Porosity	%	32	30	28	34	32	36
6	Organic Matter	%	0.61	0.58	0.49	0.63	0.62	0.58
7	Cation Exchange Capacity	meq/100g	7.2	7.6	6.9	5.7	8.5	8.3
8	Available Moisture	%	11.04	3.78	4.02	19.86	6.90	7.71
9	Available Potassium	mg/kg	31.5	29.4	34.5	31.7	26.4	30.1
10	Available Phosphorous	mg/kg	18.9	15.6	17.2	20.4	14.9	16.8

S.No.	Parameters	Unit	S1	S2	S3	S4	S5	S6
11	Total Organic Carbon	%	0.35	0.34	0.28	0.36	0.35	0.33
12	Texture	-	Loam	Loam	Loam	Loam	Loam	Loam
13	Sodium as Na	mg/kg	148	184	192	177	229	182
14	Magnesium as Mg	mg/kg	26	41	37	29	25	34
15	Calcium as Ca	mg/kg	80	74	81	164	116	106
16	Chloride as Cl	mg/kg	177	139	147	152	174	152
17	Exchangeable Sodium	%	7.48	9.23	8.52	6.40	12.6	8.20
18	Sodium Absorption Ratio	-	6.21	5.47	3.65	4.36	5.61	4.63
19	Cadmium as Cd	mg/kg	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)
20	Molybdenum as Mo	mg/kg	BDL(DL:10.0)	BDL(DL:10.0)	BDL(DL:10.0)	BDL(DL:10.0)	BDL(DL:10.0)	BDL(DL:10.0)
21	Nickel as Ni	mg/kg	41.82	54.93	68.72	78.24	86.38	75.41
22	Manganese as Mn	mg/kg	812.4	538.72	562.35	442.96	624.87	593.4
23	Copper as Cu	mg/kg	53.70	57.01	42.34	71.49	61.05	49.5
24	Zinc as Zn	mg/kg	85.57	65.02	70.56	78.82	81.87	98.56
25	Chromium as Cr	mg/kg	172.84	218.72	190.54	149.72	193.65	220.2
26	Mercury as Hg	mg/kg	BDL(DL:0.2)	BDL(DL:0.2)	BDL(DL:0.2)	BDL(DL:0.2)	BDL(DL:0.2)	BDL(DL:0.2)
27	Arsenic as As	mg/kg	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
28	Lead as Pb	mg/kg	BDL(DL:5.0)	BDL(DL:5.0)	BDL(DL:5.0)	BDL(DL:5.0)	BDL(DL:5.0)	BDL(DL:5.0)

Table-3.9: Soil Quality in the Study Area in Pre-Monsoon Season

S.No.	Parameter	Unit	S1	S2	S3	S4	S5	S6
1	pH	-	6.1	6.4	6.2	6.7	6.5	6.4
2	Conductivity	µs/cm	110	289	106	98	159	99
3	Available Nitrogen	mg/kg	376	326	416	388	472	462
4	Bulk Density	g/cm^3	1.42	1.48	1.51	1.47	1.49	1.43
5	Porosity	%	28	34	32	30	35	32
6	Organic Matter	%	0.64	0.49	0.67	0.52	0.58	0.72
7	Cation Exchange Capacity	meq/100g	5.7	5.4	8.3	6.8	6.9	7.4
8	Available Moisture	%	9.48	5.67	9.41	7.64	5.20	22.37
9	Available Potassium	mg/kg	26.3	35.8	52.6	97	41.2	42
10	Available Phosphorous	mg/kg	16.2	21	29	36	19.7	11.4
11	Total Organic Carbon	%	0.37	0.28	0.38	0.30	0.33	0.42
12	Texture	-	Loam	Loam	Loam	Loam	Loam	Loam
13	Sodium as Na	mg/kg	166	176	210	192	247	224
14	Magnesium as Mg	mg/kg	27	57	44	32	38	46

S.No.	Parameter	Unit	S1	S2	S3	S4	S5	S6
15	Calcium as Ca	mg/kg	94	102	120	178	132	154
16	Chloride as Cl	mg/kg	119	163	162	166	182	216
17	Exchangeable Sodium	%	8.12	7.98	9.62	7.18	10.7	7.32
18	Sodium Absorption Ratio	-	5.81	5.23	4.72	5.31	3.79	5.91
19	Cadmium as Cd	mg/kg	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)
20	Molybdenum as Mo	mg/kg	BDL(DL:10.0)	BDL(DL:10.0)	BDL(DL:10.0)	BDL(DL:10.0)	BDL(DL:10.0)	BDL(DL:10.0)
21	Nickel as Ni	mg/kg	54.12	73.01	71.73	72.56	87.326	52.16
22	Manganese as Mn	mg/kg	366.04	532.40	578.92	415.73	468.24	296.74
23	Copper as Cu	mg/kg	61.47	68.85	51.23	78.33	72.43	54.69
24	Zinc as Zn	mg/kg	91.26	62.16	82.64	92.61	91.7	95.44
25	Chromium as Cr	mg/kg	193.23	194.21	212.71	164.82	210.3	205.37
26	Mercury as Hg	mg/kg	BDL(DL:0.2)	BDL(DL:0.2)	BDL(DL:0.2)	BDL(DL:0.2)	BDL(DL:0.2)	BDL(DL:0.2)
27	Arsenic as As	mg/kg	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
28	Lead as Pb	mg/kg	5.61	6.81	5.86	6.32	8.21	10.21

The pH in soils of the study area lies within the neutral range, i.e. 6.1 to 7.6. The concentration of Available Nitrogen and Available Phosphorus ranged from 122 to 472 kg/ha, 8.7 to 36 kg/ha. The concentrations of various nutrients indicate low to moderate productivity. The organic carbon in various samples indicates low to moderate productivity. The bulk density ranged from 1.21 to 1.51g/cc. A negative correlation between bulk density and porosity was observed.

3.3.8 Hydrology

River System

The Kundah River is a tributary of the river Bhavani. It flows in the southern side of Ooty. It originates in the high peaks at El. 2629m along the dividing ridge between Tamil Nadu and Kerala of the Western Ghats in the Nilgiris District. Avalanche and Emerald are its two tributaries in the upper reaches and these two run down independently up to El.1920m. Further down, the tributaries Sillahalla, Kanarhalla, Kowarimullihalla join the main river Kundah at about El.1625m.

The Sillahalla River joins Kundah River on the left flank about 1.4 km upstream of Kundah Palam dam constructed across the Kundah River. Kundah Palam dam & Emerald dam surplus water enters Sillahalla Stream in middle of Edakadu. Below Kundah Palam, the river runs entirely in cascades with the Pegumbahallah draining a catchment area of about 41.44sq km joining together at EL. 640m on the right. Further down river Pegumbahallah, another tributary of Kundah originating at El. 2299m joins at El.640m. Then finally the Kundah River joins River Bhavani at El.408m near Pillur in Coimbatore District. The total catchment area of the Kundah basin upto its confluence with Bhavani River is about 285 sq km. The upper reservoir of the proposed Sillahalla Pumped Storage Hydro-Electric Project area is located on Sillahalla stream which is a tributary of Kundah River and the lower reservoir is also located on Kundah River below Kundah Palam forebay dam.

The drainage map of the catchment interceptedat Upper and Lower Reservoirs is enclosed as Figure-3.20.

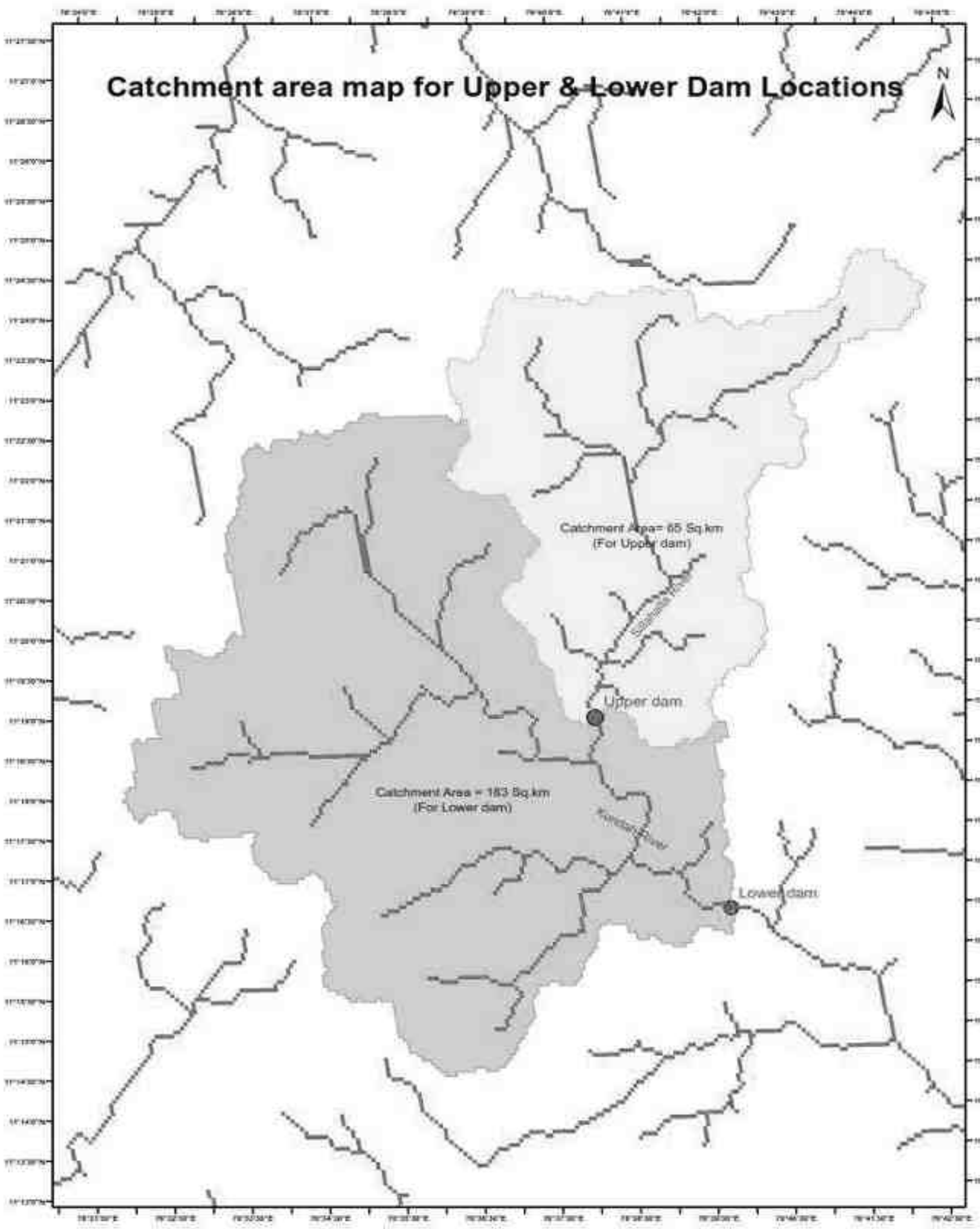


Figure-3.20: Drainage Map of the catchment interceptedat Upper and Lower Reservoirs

Data Availability

As a part of DPR, detailed hydrological studies have been conducted. Long term rainfall data based on gridded rainfall was available from IMD and the same have been utilized to estimate the monthly rainfall for the period 1986-87 to 2016-17.The site specific runoff data at Sillahalla dam site (upper dam site) is available for the period 1986-87 to 2000-01.

The same for this concurrent period of 1986-87 to 2000-01 except 1992-93 has been utilized to develop a rainfall runoff correlation in earlier para. This correlation is then utilized to extend the monthly monsoon runoff for the period 2001-02 to 2016-17. The non-monsoon monthly flows for this period has been assessed based on percentage of average monthly flow to average monsoon flow for the observed period of 1986-87 to 2000-01 except 1992-93.

Since main storage is at Upper dam Sillahalla site, the water as available therein would be utilized for one time filling only and subsequently during operation of pumping operation, the stored water would be recycled thereby ensuring no consumptive use.

The hydrological study was submitted to CWC for their approval and inflows recommended by CWC to be used for planning purpose of the project for river Sillahalal at Upper Dam site are are:

- 50% dependable flow = 27.19 MCM (1992-93)
- 75% dependable flow = 23.22 MCM (2006-07)
- 90% dependable flow = 13.29 MCM (1986-87)

The monthwise runoff of river Sillahalla at Upper dam site is given in Table-3.10.

Table-3.10: Runoff of river Sillahalla at Upper dam site of Sillahalla PSHEP

Month	Year		
	50% Dependable Year 1992-1993 (MCM)	**75% Dependable Year 2006-2007 (MCM)**	**90% Dependable Year 1986-1987 (MCM)**
June	3.21	2.74	1.05
July	3.48	2.97	1.66
August	2.72	2.32	2.90
September	2.65	2.26	2.00
October	4.63	3.95	1.70
November	3.98	3.40	1.91
December	1.40	1.19	0.67
January	0.34	0.29	0.50
February	0.39	0.33	0.31
March	0.77	0.66	0.19
April	1.59	1.36	0.14
May	2.04	1.74	0.27

Month	Year		
	50% Dependable Year 1992-1993 (MCM)	**75% Dependable Year 2006-2007 (MCM)**	**90% Dependable Year 1986-1987 (MCM)**
Annual Runoff	**27.19**	**23.22**	**13.29**

The dependable flows for river Kundah estimated at Lower Dam site are:

- 50% dependable flow = 28.44 MCM (1992-93)
- 75% dependable flow = 24.29 MCM (2005-06)
- 90% dependable flow = 13.90 MCM (2001-02)

The monthwise runoff of river Kundah at Lower dam site is given in Table-3.11.

Table-3.11: Runoff of river Kundah at Lower dam site of Sillahalla PSHEP

Month	Year		
	50% Dependable Year 1992-1993 (MCM)	**75% Dependable Year 2006-2007 (MCM)**	**90% Dependable Year 1986-1987 (MCM)**
June	3.36	2.87	1.10
July	3.64	3.11	1.74
August	2.84	2.43	3.03
September	2.77	2.37	2.09
October	4.84	4.13	1.78
November	4.16	3.55	2.00
December	1.46	1.25	0.70
January	0.36	0.30	0.52
February	0.41	0.35	0.32
March	0.80	0.69	0.20
April	1.67	1.42	0.14
May	2.13	1.82	0.28
Annual Runoff	**28.44**	**24.29**	**13.90**

Design Flood

The 25 year return period flood and PMF computed by CWC are as follows:

For Upper Dam

25 year return period peak flood= 295 cumec
PMF = 1054 Cumec

For Lower Dam

25 year return period peak flood= 760 cumec
PMF = 2702 cumec
The above flood values have been used for planning purpose of this project.

3.3.9 Surface Water Quality

Apart from domestic sources, there are no other sources of pollution in the project area. The area has no major water polluting industries. There could be few small household industries, which do not generate effluent in significant quantity to cause any significant impact on quality of the receiving water body.

As a part of the field studies, surface water quality was monitored for three seasons. The details are given as below:

- Monsoon season : October – November 2021
- Post-monsoon season : February 2022 – March 2022
- Pre-monsoon Season : May 2022 – June 2022

The surface water quality was monitored at various locations (refer Table-3.12) and the results of water quality monitoring for above referred three seasons are given in Tables-3.13 to 3.15. The drinking water quality standards are given in Table-3.16.

Table-3.12: Surface Water sampling locations monitored as a part of EIA Study

Sampling Location	Village Name	Latitude	Longitude
S1	Sriram Nagar	11°18'43.68"N	76°38'59.50"E
S2	Gunda River [Near Ramaiah Bridge]	11°16'56.84"N	76°39'18.49"E
S3	Near Bigili Bridge	11°18'21.35"N	76°38'28.77"E
S4	Emerald Dam	11°18'18.53"N	76°38'47.04"E
S5	Bellathi	11°16'11.31"N	76°40'2.14"E
S6	Mary Land	11°17'24.33"N	76°40'2.15"E

The water sampling location map is enclosed as Figure-3.21.

Figure-3.21: Water Quality Sampling Location Map

Table-3.13: Surface Water Quality in the Study Area during monsoon season

Parameter	SW1	SW2	SW3	SW4	SW5	SW6
Turbidity	254	3	166	2	1	2
pH @ 25°C	6.8	7.0	6.9	6.5	7.0	6.7
Temperature	27.9	28.1	27.8	28.1	28.2	28.2
Suspended Solids	404	4	384	< 2	< 2	< 2
Conductivity @ 25 °C	189	106	192	120	176	90
Total Hardness as $CaCO_3$	71	36	69	42	61	25
Iron as Fe	23.8	0.63	23.6	0.49	0.04	0.09
Chloride as Cl^-	21	10	20	13	11	14
Fluoride as F	BDL(DL:0.1)	0.11	0.14	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
Total Dissolved Solids	122	74	124	78	118	60
Calcium as Ca	20	11	21	15	16	5
Magnesium as Mg	5	2	4	1	5	3
Sulphate as SO_4)	16	4.4	16	5.7	2.2	3.9
Nitrate as NO_3	21.6	2.8	18.2	4.6	5.5	0.9
Phenolic Compounds as C_6H_5OH	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)
Cyanide as CN	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)
Total Alkalinity as $CaCO_3$	22	30	27	29	67	22
Phosphate as PO_4	0.74	BDL(DL:0.1)	0.89	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
Sodium as Na	10	6	9	6	8	5
Potassium as K	5	2	4	2	2	0.2
Silica as SiO_2	5.1	11.6	9.1	8.1	23.7	12
Dissolved Oxygen	6.4	6.8	6.2	6.7	6.9	7.1

Parameter	SW1	SW2	SW3	SW4	SW5	SW6
Hexavalent Chromium as Cr^{6+}	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)
Biochemical Oxygen Demand (BOD) 3 days @ 27°C	< 2	< 2	< 2	< 2	< 2	< 2
Chemical Oxygen Demand (COD)	< 4	< 4	< 4	< 4	< 4	< 4
Oil & Grease	< 2	< 2	< 2	< 2	< 2	< 2
Nitrogen Ammonia	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
Copper as Cu	BDL(DL:0.02)	BDL(DL:0.02)	BDL(DL:0.02)	BDL(DL:0.02)	BDL(DL:0.02)	BDL(DL:0.02)
Manganese as Mn	0.22	BDL(DL:0.01)	0.19	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)
Mercury as Hg	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)
Cadmium as Cd	BDL(DL:0.002)	BDL(DL:0.002)	BDL(DL:0.002)	BDL(DL:0.002)	BDL(DL:0.002)	BDL(DL:0.002)
Arsenic as As	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)
Lead as Pb	BDL(DL:0.005)	BDL(DL:0.005)	BDL(DL:0.005)	BDL(DL:0.005)	BDL(DL:0.005)	BDL(DL:0.005)
Zinc as Zn	0.09	BDL(DL:0.08)	BDL(DL:0.08)	BDL(DL:0.08)	BDL(DL:0.08)	BDL(DL:0.08)
Total Chromium as Cr	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)
Microbiology:						
Total Coliform	> 1600	50	> 1600	240	< 2	< 2
Faecal Coliform	300	< 2	500	30	< 2	< 2

Table-3.14: Surface Water Quality in the Study Area during post-monsoon season

Parameter	SW1	SW2	SW3	SW4	SW5	SW6
Turbidity	19	< 1	2	30	< 1	2
pH @ 25°C	7.1	7.7	7.1	6.9	6.5	7.2
Temperature	27.9	27.6	27.5	27.8	29.2	29.2
Suspended Solids	37	10	9	24	< 2	7
Conductivity @ 25 °C	177	166	111	162	154	87
Total Hardness as $CaCO_3$	76	55	46	65	62	38
Iron as Fe	2.2	0.43	0.34	2.7	BDL(DL:0.01)	0.06
Chloride as Cl^-	19	18	13	19	11	3
Fluoride as F	0.19	0.15	0.12	0.14	BDL(DL:0.1)	BDL(DL:0.1)
Total Dissolved Solids	120	104	76	110	102	60
Calcium as Ca	19	14	15	18	15	12
Magnesium as Mg	7	5	2	5	6	2
Sulphate as SO_4)	7.5	3.2	2.2	6.4	BDL(DL:1.0)	5
Nitrate as NO_3	9.5	1.4	1.8	7.7	BDL(DL:0.1)	BDL(DL:0.1)
Phenolic Compounds as C_6H_5OH	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)
Cyanide as CN	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)
Total Alkalinity as $CaCO_3$	48	45	35	41	59	34
Phosphate as PO_4	0.5	BDL(DL:0.1)	0.5	1.1	0.13	0.27
Sodium as Na	13	13	9	11	6	2
Potassium as K	1	1	1	1	1	< 1
Silica as SiO_2	11	11	6	9	24	14
Dissolved Oxygen	6.7	6.8	6.8	6.5	7.1	6.8
Hexavalent Chromium as	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)

Parameter	SW1	SW2	SW3	SW4	SW5	SW6
Cr^{6+}						
Biochemical Oxygen Demand (BOD) 3 days @ 27°C	< 2	< 2	< 2	< 2	< 2	< 2
Chemical Oxygen Demand (COD)	< 4	< 4	< 4	< 4	< 4	< 4
Oil & Grease	< 2	< 2	< 2	< 2	< 2	< 2
Nitrogen Ammonia	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
Copper as Cu	BDL(DL:0.02)	BDL(DL:0.02)	BDL(DL:0.02)	BDL(DL:0.02)	BDL(DL:0.02)	BDL(DL:0.02)
Manganese as Mn	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)
Mercury as Hg	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)
Cadmium as Cd	BDL(DL:0.002)	BDL(DL:0.002)	BDL(DL:0.002)	BDL(DL:0.002)	BDL(DL:0.002)	BDL(DL:0.002)
Arsenic as As	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)
Lead as Pb	BDL(DL:0.005)	BDL(DL:0.005)	BDL(DL:0.005)	BDL(DL:0.005)	BDL(DL:0.005)	BDL(DL:0.005)
Zinc as Zn	BDL(DL:0.08)	BDL(DL:0.08)	BDL(DL:0.08)	BDL(DL:0.08)	BDL(DL:0.08)	BDL(DL:0.08)
Total Chromium as Cr	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)
Microbiology:						
Total Coliform	240	< 2	< 2	< 2	< 2	< 2
Faecal Coliform	< 2	< 2	< 2	< 2	< 2	< 2

Table-3.15: Surface Water Quality in the Study Area during pre-monsoon Season

Parameter	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**
Turbidity	72	< 1	10	46	< 1	3
pH @ 25°C	7.5	7.7	7.4	7.7	7.6	7.3
Temperature	30.1	30.1	30.1	30.7	30.1	29.7
Suspended Solids	114	< 2	4	28	< 2	7
Conductivity @ 25 °C	230	230	174	202	254	84
Total Hardness as $CaCO_3$	73	75	57	76	81	23
Iron as Fe	15.7	0.03	1.77	9.41	0.22	0.82
Chloride as Cl^-	23	19	15	23	12	7
Fluoride as F	0.26	0.21	0.6	1.11	BDL(DL:0.1)	0.15
Total Dissolved Solids	140	138	104	121	152	50
Calcium as Ca	26	17	18	24	21	6
Magnesium as Mg	2	8	3	4	7	2
Sulphate as SO_4)	22	7	11	2.7	2.4	3
Nitrate as NO_3	7.4	5.7	8.9	8.3	3.2	4.1
Phenolic Compounds as C_6H_5OH	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)
Cyanide as CN	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)
Total Alkalinity as $CaCO_3$	30	65	34	30	76	17
Phosphate as PO_4	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
Sodium as Na	15	13	11	16	8	5
Potassium as K	2	2	2	3	1	< 1
Silica as SiO_2	8.5	18	8	11	34	9.8
Dissolved Oxygen	6.1	6.7	6.4	6.2	7.0	6.8
Hexavalent Chromium as Cr^{6+}	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)
Biochemical Oxygen	< 2	< 2	< 2	< 2	< 2	< 2

Parameter	SW1	SW2	SW3	SW4	SW5	SW6
Demand (BOD) 3 days @ 27°C						
Chemical Oxygen Demand (COD)	< 4	< 4	< 4	< 4	< 4	< 4
Oil & Grease	< 2	< 2	< 2	< 2	< 2	< 2
Nitrogen Ammonia	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
Copper as Cu	0.03	BDL(DL:0.02)	BDL(DL:0.02)	BDL(DL:0.02)	BDL(DL:0.02)	BDL(DL:0.02)
Manganese as Mn	0.46	0.02	0.08	0.32	BDL(DL:0.01)	BDL(DL:0.01)
Mercury as Hg	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)
Cadmium as Cd	BDL(DL:0.002)	BDL(DL:0.002)	BDL(DL:0.002)	BDL(DL:0.002)	BDL(DL:0.002)	BDL(DL:0.002)
Arsenic as As	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)
Lead as Pb	BDL(DL:0.005)	BDL(DL:0.005)	BDL(DL:0.005)	BDL(DL:0.005)	BDL(DL:0.005)	BDL(DL:0.005)
Zinc as Zn	BDL(DL:0.08)	BDL(DL:0.08)	BDL(DL:0.08)	BDL(DL:0.08)	BDL(DL:0.08)	BDL(DL:0.08)
Total Chromium as Cr	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)
Microbiology:						
Total Coliform	90	< 2	< 2	23	< 2	< 2
Faecal Coliform	12	< 2	< 2	< 2	< 2	< 2

Table-3.16: Drinking Water Quality Standards

Characteristics	*Acceptable	**Cause for Rejection
Turbidity (units on JTU scale)	2.5	10
Colour (Units on platinum cobalt scale)	5.0	25
Taste and Odour	Unobjectionable	Unobjectionable
pH	7.0 to 8.5	<6.5 or >9.2
Total Dissolved Solids (mg/l)	500	1500
Total hardness (mg/l) (as $CaCO_3$)	200	600
Chlorides as CD (mg/l)	200	1000
Sulphates (as SO_4)	200	400
Fluorides (as F) (mg/l)	1.0	1.5
Nitrates (as NO_3) (mg/l)	45	45
Calcium (as Ca) (mg/l)	75	200
Magnesium (as Mg) (mg/l) If there are 250 mg/l of sulphates, Mg content can be increased to a maximum of 125 mg/l with the reduction of sulphates at the rate of 1 unit per every 2.5 units of sulphates	30	150
Iron (as Fe) (mg/l)	0.1	1.0
Manganese (as Mn) (mg/l)	0.05	0.5
Copper (as Cu) (mg/l)	0.05	1.5
Zinc (as Zn) (mg/l)	5.0	15.0
Phenolic compounds (as phenol) (mg/l)	0.001	0.002
Anionic detergents (as MBAS) (mg/l)	0.2	1.0
Mineral Oil (mg/l)	0.01	0.3
Toxic materials		
Arsenic (as As) (mg/l)	0.05	0.05
Cadmium (as Cd) (mg/l)	0.01	0.01
Chromium (as hexaalent Cr) (mg/l)	0.05	0.05
Cyanides (as CN) (mg/l)	0.05	0.05
Lead (as Pb) (mg/l)	0.1	0.1
Selenium (as Se) (mg/l)	0.01	0.01
Mercury (total as Hg) (mg/l)	0.001	0.001
Polynuclear Aromatic Hydrocarbons (PAH)	0.2 μg/l	0.2 μg/l

Notes:-

**1. The figures indicated under the column `Acceptable' are the limits up to which water is generally acceptable to the consumers*

***2 Figures in excess of those mentioned under `Acceptable render the water not acceptable, but still may be tolerated in the absence of alternative and better source but upto the limits indicated under column "Cause for Rejection" above which are supply will have to be rejected.*

The pH level in various seasons ranged from 6.5 to 7.0, 6.5 to 7.7 and 7.3 to 7.7 in monsoon, post-monsoon and pre-monsoon seasons respectively which is within the permissible limit of 7.0 to 8.5, specified for meeting domestic water requirements after disinfection (Class C, as per IS:2296).

The TDS level ranged from 60 to 124 mg/l, 60 to 120 mg/l and 50 to 152 mg/l in monsoon, post-monsoon and pre-monsoon seasons. The TDS levels were well within the permissible limit of 500 mg/l specified for meeting drinking water requirements. The EC levels were well below the permissible limit of 2250 µS/cm specified for irrigation water requirements as per IS:2296. This trend of TDS level is also reflected by the fact that the concentration of most of the cations and anions were below the permissible limit.

The concentration of chlorides in various seasons in surface water samples was well below the permissible limit of 200 mg/l (refer Table-3.4). The sulphates level were well below the permissible limit of 200 mg/l (refer Table-3.4).

The BOD values are well within the permissible limits, which indicates the absence of organic pollution loading. This is mainly due to the low population density and absence of industries in the area. The low COD values also indicates the absence of chemical pollution loading in the area. The concentration of various heavy metals was below the detectable limits in various seasons, indicating the suitability of water for meeting domestic requirements. Likewise, concentration of cyanides and phenolic compounds was also below the detectable limits.

3.3.10 Ambient Air Quality

The ambient air quality with respect to the study zone of 10 km radius around the proposed site forms the baseline information. There are no major sources of air pollution in the project area. The sources of air pollution in the region are dust emissions from unpaved village roads and domestic fuel burning. The ambient air quality was monitored at following locations in the study area listed as below:

- Bellathi
- Mary Land

- Manjoor
- Edakadu
- Sriram Nagar
- Kanneri

The ambient air quality monitoring location map is enclosed as Figure-3.22.

Figure-3.22: Ambient Air Quality Monitoring Station Map

The parameters monitored are listed as below:

- Sulphur Dioxide
- Nitrogen Dioxide
- Particulate Matter less than 2.5 microns ($PM_{2.5}$)
- Particulate Matter less than 10 microns (PM_{10})

The frequency of sampling was twice a week for four consecutive weeks per season. The monitoring was conducted for the following seasons:

- Monsoon season : October – November 2021
- Post-monsoon season : February 2022 – March 2022
- Pre-monsoon Season : May 2022 – June 2022

The results of ambient air quality monitoring are summarized in Tables-3.17 to 3.22. The ambient air quality standards are given in Table-3.23.

Table-3.17: Ambient Air Quality Status– Bellathi Station

S.No.	Parameters monitored (µg/m^3) (Monsoon Season)				Parameters monitored (µg/m^3) (Post-Monsoon Season)				Parameters monitored (µg/m^3) (Pre-Monsoon Season)			
	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	$PM_{2.5}$
1	BDL(DL:3.0)	5.3	28.5	12.5	3.4	9.5	38.2	17.6	5.2	12.1	40.7	19.5
2	BDL(DL:3.0)	5.8	26.2	11.1	BDL(DL:3.0)	8.4	35.7	14.5	BDL(DL:3.0)	9.7	35.5	16.2
3	BDL(DL:3.0)	4.5	20.1	10.8	3.2	8.1	35.5	14.1	3.5	10.1	38	17.1
4	BDL(DL:3.0)	3.9	18.7	9.6	3.6	10	37	16.4	BDL(DL:3.0)	7.5	36.7	15.8
5	BDL(DL:3.0)	5.6	21.6	10.1	BDL(DL:3.0)	7.5	30.4	12.4	4.8	11.6	42.1	20.2
6	BDL(DL:3.0)	4.2	22.7	11.5	BDL(DL:3.0)	5.1	27.4	11	4.2	10	40.1	19
7	BDL(DL:3.0)	7.5	30.1	14.2	BDL(DL:3.0)	8	32.5	13.4	BDL(DL:3.0)	7.1	35.8	14.1
8	BDL(DL:3.0)	6.2	29.5	13.5	BDL(DL:3.0)	6.5	28.5	12	BDL(DL:3.0)	7.8	36.5	15.6

Table-3.18: Ambient Air Quality Status– Mary Land Station

S.No.	Parameters monitored (µg/m^3) (Monsoon Season)				Parameters monitored (µg/m^3) (Post-Monsoon Season)				Parameters monitored (µg/m^3) (Pre-Monsoon Season)			
	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	$PM_{2.5}$
1	BDL(DL:3.0)	6.1	20.4	10.1	6.7	12.2	45.6	21	7.2	15	45	21.5
2	BDL(DL:3.0)	4.3	19.1	8.7	5.4	10.6	40	19.5	6.1	13.1	42.7	20
3	BDL(DL:3.0)	6.1	20.4	10.1	3.5	7.9	38.9	17.6	6.4	13.5	40.7	19
4	BDL(DL:3.0)	4.3	19.1	8.7	5.5	10.2	40.7	19.8	5.8	12.6	42	20.1
5	BDL(DL:3.0)	6.1	20.4	10.1	3.8	9.6	35.5	16	7	14	46.5	22
6	BDL(DL:3.0)	4.3	19.1	8.7	BDL(DL:3.0)	6.5	30.4	14	3.6	9.7	39.7	18.7

S.No.	Parameters monitored (µg/m^3) (Monsoon Season)				Parameters monitored (µg/m^3) (Post-Monsoon Season)				Parameters monitored (µg/m^3) (Pre-Monsoon Season)			
	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	$PM_{2.5}$
7	BDL(DL:3.0)	6.1	20.4	10.1	3.2	9.1	35	14.8	5.4	10.7	41	19.7
8	BDL(DL:3.0)	4.3	19.1	8.7	4.1	11.5	37	16.5	6.7	13	46.8	21.7

Table-3.19: Ambient Air Quality Status– Manjoor Station

S.No.	Parameters monitored (µg/m^3) (Monsoon Season)				Parameters monitored (µg/m^3) (Post-Monsoon Season)				Parameters monitored (µg/m^3) (Pre-Monsoon Season)			
	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	$PM_{2.5}$
1	BDL(DL:3.0)	6.5	25.1	15.2	7.8	14.2	46.5	22.5	8.7	19	50.5	24.8
2	BDL(DL:3.0)	5.5	23.6	12.3	6.5	12.6	42.2	21.1	7.3	16	47.9	21.5
3	BDL(DL:3.0)	4.7	20.5	11.7	6.1	12.1	40	19.5	7	16.4	46.5	20.7
4	BDL(DL:3.0)	5.0	24.5	13.8	7	13.5	41.2	20.7	7.6	15.8	49	21.8
5	BDL(DL:3.0)	3.6	28.9	14.1	4.1	10.5	38.7	19.6	8.2	17.4	51.1	25
6	BDL(DL:3.0)	6.2	32.4	14.8	3.2	7.6	35.7	17.5	8.9	19	52	25.1
7	BDL(DL:3.0)	7	34.1	15	4.5	11	37.5	18.1	6.4	15.2	48.5	22
8	BDL(DL:3.0)	6.4	31.5	14.2	BDL(DL:3.0)	7	32.4	15	6	14.7	46.8	21.6

Table-3.20: Ambient Air Quality Status– Edakadu Station

S.No.	Parameters monitored (µg/m^3) (Monsoon Season)				Parameters monitored (µg/m^3) (Post-Monsoon Season)				Parameters monitored (µg/m^3) (Pre-Monsoon Season)			
	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	$PM_{2.5}$
1	BDL(DL:3.0)	4.2	18.5	10.1	BDL(DL:3.0)	5.5	25.4	11.2	3.2	7.5	38.4	15.5
2	BDL(DL:3.0)	3.5	17.5	9.2	BDL(DL:3.0)	6	26	11.9	BDL(DL:3.0)	5.5	33	12.5
3	BDL(DL:3.0)	BDL(DL:3.0)	15.6	7.1	BDL(DL:3.0)	6.2	28.9	12.2	BDL(DL:3.0)	6.1	35	13.6
4	BDL(DL:3.0)	3.7	17.1	8.5	BDL(DL:3.0)	7.1	30.5	13	BDL(DL:3.0)	5.8	34.2	12.8
5	BDL(DL:3.0)	BDL(DL:3.0)	16.2	7.3	BDL(DL:3.0)	6.4	31.4	13.2	BDL(DL:3.0)	6.6	36.7	17
6	BDL(DL:3.0)	3.8	18.5	7.8	BDL(DL:3.0)	5.8	30	12.5	3.7	8.2	40	18.4
7	BDL(DL:3.0)	4.1	20.5	11	BDL(DL:3.0)	5.7	28.5	10.2	BDL(DL:3.0)	5.5	35.4	16
8	BDL(DL:3.0)	5.4	22.5	11.8	BDL(DL:3.0)	4.5	26.5	9.7	BDL(DL:3.0)	6.2	36	16.8

Table-3.21: Ambient Air Quality Status– Sriram Nagar Station

S.No.	Parameters monitored (µg/m^3) (Monsoon Season)				Parameters monitored (µg/m^3) (Post-Monsoon Season)				Parameters monitored (µg/m^3) (Pre-Monsoon Season)			
	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	$PM_{2.5}$
1	BDL(DL:3.0)	BDL(DL:3.0)	15.2	6.5	BDL(DL:3.0)	5.1	21.5	10.2	BDL(DL:3.0)	4.2	25.4	10
2	BDL(DL:3.0)	3.6	17	8.5	BDL(DL:3.0)	3.5	20.9	9.5	BDL(DL:3.0)	3.2	22.7	8.5
3	BDL(DL:3.0)	BDL(DL:3.0)	12.6	6.5	BDL(DL:3.0)	4.2	20.3	9.1	BDL(DL:3.0)	BDL(DL:3.0)	19.5	8
4	BDL(DL:3.0)	BDL(DL:3.0)	14.5	7.3	BDL(DL:3.0)	5.5	25.3	11.5	BDL(DL:3.0)	3.6	20	9.1
5	BDL(DL:3.0)	3.7	16.1	8	BDL(DL:3.0)	7	32.7	13	BDL(DL:3.0)	5.5	26	10.7
6	BDL(DL:3.0)	3.6	15.3	7.6	BDL(DL:3.0)	5.9	30	11.6	BDL(DL:3.0)	6.1	28.4	11.2
7	BDL(DL:3.0)	BDL(DL:3.0)	16.7	8.2	BDL(DL:3.0)	4.5	25	10	BDL(DL:3.0)	6.4	30	14
8	BDL(DL:3.0)	4.2	19.2	8.9	BDL(DL:3.0)	3.5	24	9.6	BDL(DL:3.0)	4.6	27.5	12.7

Table-3.22: Ambient Air Quality Status– Kanneri Station

S.No.	Parameters monitored (µg/m^3) (Monsoon Season)				Parameters monitored (µg/m^3) (Post-Monsoon Season)				Parameters monitored (µg/m^3) (Pre-Monsoon Season)			
	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	$PM_{2.5}$	SO_2	NO_2	PM_{10}	$PM_{2.5}$
1	BDL(DL:3.0)	6.4	19.2	10.1	4	8.6	38.5	17.5	BDL(DL:3.0)	5.6	26	9
2	BDL(DL:3.0)	5.3	18.5	9.3	BDL(DL:3.0)	5.1	30.5	14.2	BDL(DL:3.0)	7.8	30.7	12.1
3	BDL(DL:3.0)	5.8	20.4	10.7	BDL(DL:3.0)	4.6	30.9	14.6	BDL(DL:3.0)	4.2	28.7	10
4	BDL(DL:3.0)	6.4	22.5	11.2	3.2	7.5	31.4	15	BDL(DL:3.0)	4.9	31.7	12.5
5	BDL(DL:3.0)	4.2	17.6	9	BDL(DL:3.0)	5.5	25.4	10.2	BDL(DL:3.0)	4.1	29.5	9.8
6	BDL(DL:3.0)	6.5	21.5	12.7	BDL(DL:3.0)	4.1	20.9	9.5	BDL(DL:3.0)	3.8	32	13.5
7	BDL(DL:3.0)	8.4	27.5	14.6	BDL(DL:3.0)	4.6	20.5	10.5	BDL(DL:3.0)	3.5	27.8	10
8	BDL(DL:3.0)	7.5	25.3	13.5	BDL(DL:3.0)	3.8	18.1	9	BDL(DL:3.0)	6	33.5	14

Table-3.23: National Ambient Air Quality Standards

S.No.	Pollutant	Time Weighted Average	Industrial, Residential Rural and other area	Ecologically Sensitive area (notified by Central Government)
1.	Sulphur Dioxide (SO_2), µg/m^3	Annual*	50	20
		24 hours **	80	80
2.	Nitrogen Dioxide (NO_2), µg/m^3	Annual*	40	30
		24 hours**	80	80
3.	Particulate Matter less than microns, PM_{10}, µg/m^3	Annual*	60	60
		24 hours **	100	100
4.	Particulate Matter less than 2.5 microns, $PM_{2.5}$, µg/m^3	Annual*	40	40
		24 hours **	60	60

- Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at a uniform intervals.
- 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring

Observation on Ambient SO_2 levels

The average SO_2 levels as observed at various stations in the study area ranged from BDL (DL:3.0), BDL(DL:3.0) to 7.8 µg/m^3 and BDL(DL:3.0) to 8.9 µg/m^3 in monsoon, post-monsoon and pre-monsoon seasons respectively. The highest SO_2 value was recorded as 8.9 µg/m^3 at Manjoor in pre-monsoon season. The SO_2 levels monitored during the field survey were well below the permissible limit of 50 µg/m^3 specified for industrial, residential, rural and other areas (Refer Table-3.23).

Observations on NO_2 levels

The average NO_2 levels as observed at various stations in the study area ranged from BDL (DL: 3.0) to 7.5 µg/m^3, 3.5 µg/m3 to 14.2 µg/m^3 and BDL (DL: 3.0) to 19 µg/m^3 in monsoon, post-monsoon and pre-monsoon seasons respectively. The highest NO_2 value was recorded as 17.4 µg/m^3 at Manjoor in pre-monsoon season. The NO_2 levels monitored during the field survey were well below the permissible limit of 40 µg/m^3 specified for industrial, residential, rural and other areas (Refer Table-3.23).

Observations on PM_{10} levels

The average PM_{10} levels as observed at various stations in the study area ranged from 12.6 µg/m^3 to 34 µg/m^3, 18.1 µg/m^3 to 46.5 µg/m^3 and 19.5 µg/m^3 to 51.1 µg/m^3 in monsoon, post-monsoon and pre-monsoon seasons respectively. The highest PM10 value was recorded as 51.1 µg/m^3 at Manjoor in pre-monsoon season. The PM_{10} levels monitored during the field survey were slightly below the permissible limit of 60 μg/m^3 specified for industrial, residential, rural and other areas (Refer Table-3.23).

Observations on $PM_{2.5}$ levels

The average $PM_{2.5}$ levels as observed at various stations in the study area ranged from 6.5 µg/m^3 to 15.2 µg/m^3, 9 µg/m^3 to 22.5 µg/m^3 and 8 µg/m^3 to 25.1 µg/m^3 in monsoon, post-monsoon and pre-monsoon seasons respectively. The highest $PM_{2.5}$ value was recorded as 25.1 µg/m^3 at Manjoor in pre-monsoon season. The PM_{10} levels monitored during the field survey were well below the permissible limit of 40 μg/m^3 specified for industrial, residential, rural and other areas (Refer Table-3.23).

3.3.11 Ambient Noise Levels

Noise levels monitoring was conducted for two seasons. The noise levels were monitored continuously for day time for 6 AM to 9 PM at each location and hourly equivalent noise level was measured. Sound Pressure Level (SPL) measurement in the ambient environment was made using sound pressure level meter. The sampling locations are given as below:

- Bellathi
- Mary Land
- Manjoor
- Edakadu
- Sriram Nagar
- Kanneri

The ambient noise levels monitoring locations are shown in Figure-3.23.

Figure-3.23: Ambient Noise Monitoring Location Map

The monitoring was conducted for the following seasons:

- Monsoon season : October – November 2021
- Post-monsoon season : February 2022 – March 2022
- Pre-monsoon Season : May 2022 – June 2022

The ambient noise level monitoring results, which were observed during the field survey above referred seasons are givn in Table-3.24.

The monitoring was carried out in day time, at sampling locations, where ambient air quality monitoring was carried out. The day time equivalent noise levels are given in Table-3.25. The noise standards for various categories is given in Table-3.26.

Table-3.24 : Hourly Equivalent Noise Levels

Location	Bellathi	Manjoor	Mary Land	Edakadu	Sriram Nagar	Kanneri
Pre-monsoon (June 2012)						
6-7 AM	39	36	38	39	39	36
7-8 AM	40	40	40	41	40	40
8-9 AM	41	44	41	42	41	44
9-10 AM	40	43	42	42	40	43
10-11 AM	43	42	43	42	43	42
11-12 Noon	42	42	42	42	42	42
12 Noon – 1 PM	42	42	42	42	42	42
1-2 PM	40	40	40	40	40	40
2-3 PM	40	40	40	40	40	40
3-4 PM	42	42	44	42	42	42
4-5 PM	42	42	43	44	42	42
5-6 PM	42	42	42	46	42	42
6-7 PM	43	42	42	44	43	42
7-8 PM	40	40	39	42	40	40
8-9 PM	38	37	38	40	38	37
Monsoon Season (August 2012)						
6-7 AM	39	36	38	39	36	38
7-8 AM	40	38	40	41	38	40
8-9 AM	41	38	42	44	38	42
9-10 AM	42	44	44	44	44	44
10-11 AM	44	42	42	42	42	42
11-12 Noon	44	43	45	42	43	45

Location	Bellathi	Manjoor	Mary Land	Edakadu	Sriram Nagar	Kanneri
12 noon – 1 PM	45	44	45	40	44	45
1-2 PM	44	44	43	42	44	43
2-3 PM	42	44	42	42	44	42
3-4 PM	42	44	43	42	44	43
4-5 PM	45	45	45	45	45	45
5-6 PM	44	44	45	45	44	45
6-7 PM	42	43	44	43	43	44
7-8 PM	40	40	42	41	42	41
8-9 PM	39	39	40	40	40	40
Post- Monsoon Season (December 2012)						
6-7 AM	39	39	39	39	39	39
7-8 AM	40	40	40	40	40	40
8-9 AM	41	41	42	42	41	42
9-10 AM	42	42	42	42	42	42
10-11 AM	44	44	43	43	44	43
11-12 Noon	43	42	42	43	42	42
12 noon – 1 PM	45	44	44	44	44	44
1-2 PM	45	44	44	44	44	44
2-3 PM	45	44	45	44	44	45
3-4 PM	44	44	43	44	44	43
4-5 PM	44	45	44	45	45	44
5-6 PM	44	43	44	44	43	44
6-7 PM	43	42	42	42	42	42

Location	Bellathi	Manjoor	Mary Land	Edakadu	Sriram Nagar	Kanneri
7-8 PM	40	40	40	40	40	40
8-9 PM	39	39	39	39	39	40

Table-3.25: Day Time Equivalent Ambient Noise Levels

Location	Pre-Monsoon Season (June 2012)	Monsoon Season (August 2010)	Post-monsoon season (December 2012)
Bellathi	41.2	42.6	43.0
Manjoor	41.4	42.6	42.6
Mary Land	41.4	43.1	42.6
Edakadu	42.2	42.5	42.7
Sriram Nagar			
Kanneri			

Table-3.26: Ambient Noise Standards

Area Code	Category of Area	Limits in dB(A)Leq	
		Day time	Night time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

Notes : 1. Day time 6 A.M. and 9 P.M.
2. Night time is 9 P.M. and 6 A.M.
3. Silence zone is defined as areas upto 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by competent authority. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
4. Environment (Protection) Third Amendment Rules, 2000 Gazette notification, Government of India, date 14.2.2000.

The day time equivalent noise level at various sampling stations ranged from 41.2 to 42.2 dB (A) and 42.5 to 43.1 dB (A) in pre-monsoon and monsoon seasons respectively. In winter season, the day time equivalent noise level at various sampling stations ranged from 42.6 to 43.0 dB(A) The noise levels were observed to be well within permissible limits specified for residential area (Refer Table-3.23).

3.4 Ecology

3.4.1 Flora

Forest types and composition

The Nilgiris district in Tamil Nadu is recognized for its rich and diverse forest resources, which significantly contribute to the district's economy and the well-being of its local communities. The forests in Nilgiris district are rich in biodiversity and natural resources, playing a crucial role in the lives of the local communities and the overall economy of the district. The Nilgiris district is rich in biodiversity, According to the India State of Forest Report (2019), the Nilgiris district covers a total geographical area of 2,565 square kilometers, of which Very Dense Forest covers 466.72 sq. km, Moderately Dense Forest covers 629.85 sq. km, and Open Forest covers 634.44 sq. km. The types of vegetation found in these forests are influenced by various factors such as climate, soil conditions (edaphic factors), human activities (biotic factors), and altitude. The district's wide range of climate and topography has led to a variety of forest types. The wide variations in climate and topography of the State have resulted in various types of forest growth. According to Champion & Seth (1968) classification of Forest, Nilgiris district forests are classified into various types, including:

- Tropical Evergreen Forests
- Montane Sholas
- Semi-Evergreen Forests
- Moist Deciduous Forests
- Dry Deciduous Forests

Tropical Evergreen Forests: are found in regions with heavy and consistent rainfall and are known for their dense canopy and diverse flora and fauna. They remain lush and green throughout the year, and tree species do not shed their leaves seasonally. These forests thrive in areas with annual rainfall exceeding 200 cm. Temperatures remain consistently warm, typically ranging from 25°C to 30°C throughout the year, with high humidity. They experience no distinct dry season, which allows for continuous plant growth year round. The trees in tropical evergreen forests form multiple layers, with a towering upper canopy that prevents sunlight from reaching the forest floor. The vegetation includes a wide variety of evergreen trees, climbers, epiphytes, and understory plants.

Montane Sholas: (or shola forests) are a unique type of forest ecosystem found in the high-altitude regions of tropical montane environments, particularly in the Western Ghats of southern India. The term "shola" refers to the dense patches of stunted tropical montane forests that are interspersed with grasslands at high elevations. The climate in Montane Shola regions is cool and moist with heavy rainfall, especially during the monsoon season. The temperatures in these areas are typically lower compared to tropical lowland forests, with cool nights and moderate daytime temperatures. Shola forests are dominated by evergreen broad-leaved trees that are adapted to survive in cooler climates and high levels of moisture. Some common tree species include Rhododendron, Syzygium (wild jamun), Mahonia and Microtropis. The grasslands surrounding the shola patches consist of hardy, fast-growing grasses and shrubs that are adapted to high altitudes.

Semi-evergreen forests: Semi-evergreen forests are a transitional type of forest found between tropical evergreen forests and moist deciduous forests. They represent an ecosystem where some trees shed their leaves for a short period during the dry season, while others remain green throughout the year. These forests are characterized by a combination of species from both evergreen and deciduous forests. These forests thrive in areas with rainfall between 200 to 300 cm annually. However, they experience a more pronounced dry season than tropical evergreen forests. The temperature remains warm, ranging from 25°C to 30°C, but seasonal variation is greater than in evergreen forests. The vegetation in semi-evergreen forests is a mixture of evergreen trees that retain their leaves throughout the year and deciduous trees that shed their leaves during the dry season.

Moist Deciduous Forests: are one of the most widespread forest types in tropical and subtropical regions, characterized by trees that shed their leaves seasonally, especially during the dry season. These forests are intermediate between tropical evergreen forests and dry deciduous forests, found in areas with seasonal rainfall and a more pronounced dry period than evergreen forests. These forests occur in areas with an annual rainfall of 100 to 200 cm, which is less than that of evergreen forests but more than that of dry deciduous forests. They experience a distinct dry season lasting several months, during which many trees shed their leaves to conserve water. Temperatures are typically warm, ranging from 24°C to 30°C throughout the year, though there can be some seasonal variation. Some common species include Alnus nepalensis, Syzygium cumini, Shisham (Dalbergia sissoo) and Eucalyptus.

Dry Deciduous Forests: are characterized by trees that shed their leaves during the dry season to conserve water. These forests thrive in regions with pronounced dry periods and moderate to low rainfall. While they experience a loss of foliage during the dry season, they regrow leaves once the rainy season arrives, creating a marked seasonal change in their appearance. These forests occur in areas with annual rainfall between 70 to 100 cm. The dry season can last several months, and during this period, most trees lose their leaves. Temperatures can range from 25°C to 35°C, with warmer and drier conditions compared to moist deciduous forests.

Field Studies

In the present study a total 108 Plant Species in Monsoon season, 184 species in Post-monsoon and Pre-monsoon were recorded in the Study Area. It was observed that the flora, which includes herbs, climbers, shrubs, trees, were distributed more densely. The details of number of families and the species are given in Tables-3.27 to 3.29.

Table-3.27: Quantitative studies on plant species in Study Area (Monsoon Season)

S. No.	Plant Name	Family	Total No. of Ind.	% Freq.	Freq. Class	Abun.	Den.	Rel. Den.	Rel. freq.
1	*Acacia mearnsii* De Wild.	Fabaceae	59	80	D	7.37	5.9	1.87	7.4
2	*Achyranthes aspera* var. *Rubrofusca*	Amaranthaceae	53	20	A	27	5.3	1.68	1.85
3	*Adiantum* Sp.	Adiantaceae	38	20	A	19	3.8	1.21	1.85
4	*Ageratina adenophora* (Spreng.) King & H.Rob.	Asteraceae	29	10	A	29	2.9	0.92	0.92
5	*Ageratum conyzoides* L.	Asteraceae	146	40	B	3.5	14.6	4.63	3.7
6	*Alloteropsis cimicina* (L.) Stapf	Poaceae	18	10	A	18	1.8	0.57	0.92
7	*Alnus nepalensis* D.Don	Betulaceae	10	10	A	10	1	0.32	0.92
8	*Aloe arborescens* Mill.	Asphodelaceae	34	10	A	34	3.4	1.08	0.92
9	*Alstonia venenata* R. Br.	Apocynaceae	12	10	A	12	1.2	0.38	0.92
10	*Andropogon lividus* Thwaites	Poaceae	27	10	A	27	2.7	0.86	0.92
11	*Aphloia theiformis* (Vahl) Benn.	Flacourtiaceae	9	20	A	4.5	0.9	0.28	1.85
12	*Argreia coonoorensis* W. W. Smith and Ramos.	Convolvulaceae	8	10	A	8	0.8	0.25	0.92
13	*Arisaema leschenaultii* Blume	Araceae	34	40	B	8.5	3.4	1.08	3.7
14	*Arundinella ciliata* (Roxb.) Nees ex Miq.	Poaceae	61	30	B	20.33	6.1	1.93	2.7
15	*Arundinella*	Poaceae	31	10	A	31	3.1	0.98	0.92

S. No.	Plant Name	Family	Total No. of Ind.	% Freq.	Freq. Class	Abun.	Den.	Rel. Den.	Rel. freq.
	mesophylla Nees ex Steud.								
16	*Asparagus fysonii* J.F.Macbr.	Asparagaceae	17	40	B	4.25	1.7	0.54	3.7
17	*Berberis tinctoria* Leschen	Berberidaceae	11	10	A	11	1.1	0.35	0.92
18	*Bidens pilosa* L.	Asterraceae	164	50	C	32.8	16.4	5.2	4.6
19	*Celastrus paniculatus* Willd.	Celastraceae	7	30	B	2.33	0.7	0.22	6.5
20	*Celtis tetrandra* Roxb.	Ulmaceae	4	10	A	4	0.4	0.13	0.92
21	*Cenchrus biflorus* Roxb.	Poaceae	16	10	A	16	1.6	0.51	0.92
22	*Cestrum aurantiacum* Lindl.	Solanaceae	95	30	B	31.66	9.5	3.01	2.7
23	*Chamaemelum nobile* (L.) All.	Asteraceae	124	40	B	31	12.4	3.94	3.7
24	*Chionanthus ramiflorus* Roxb.	Oleaceae	5	10	A	5	0.5	0.16	0.92
25	*Chrysopogon zeylanicus* (Steud.) Thwaites	Poaceae	31	10	A	31	3.1	0.98	0.92
26	*Cirsium wallichii* DC	Asterraceae	24	10	A	24	2.4	0.76	0.92
27	*Clematis zeylanica* (L.) Poir.	Ranunclulaceae	7	20	A	3.5	0.7	0.22	1.85
28	*Commelina clavate* C. B. Clarke	Commelinaceae	16	10	A	16	1.6	0.51	0.92
29	*Commelina hirsuta* (Wight) Bedd.	Commelinaceae	86	80	D	10.75	8.6	2.73	7.4
30	*Cotula australis* (Sieber ex	Asteraceae	80	30	B	26.66	8	2.54	2.7

S. No.	Plant Name	Family	Total No. of Ind.	% Freq.	Freq. Class	Abun.	Den.	Rel. Den.	Rel. freq.
	Spreng.) Hook.								
31	*Cryptocarya lawsonii* Gamble	Lauraceae	4	10	A	4	0.4	0.13	0.92
32	*Cupressus funebris* Endl.	Cupressaceae	12	10	A	12	1.2	0.38	0.92
33	*Cyanthillium cinereum* (Carl Linnaeus) H.Rob	Asteraceae	121	40	B	30.25	12.1	3.84	3.7
34	*Cymbopogon citratus (DC.) Stapf*	Poaceae	43	10	A	43	4.3	1.36	0.92
35	*Cyperus difformis* L.	Cyperaceae	31	10	A	31	3.1	0.98	0.92
36	*Cyperus rotundus* L.	Cyperaceae	77	20	A	38.5	7.7	2.44	1.85
37	*Cyperus stoloniferus Retz.*	Cyperaceae	55	20	A	27.5	5.5	1.74	1.85
38	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	27	10	A	27	2.7	0.85	0.92
39	*Daphniphyllum neilgherrense* (Wight) K. Rosenthal	Daphniphyllaceae	11	20	A	5.5	1.1	0.35	1.85
40	*Digrocephala integerifolia* (L. f.) Kuntze	Asteraceae	18	10	A	18	1.8	0.57	0.92
41	*Dodonaea viscosa* Jacq.	Sapindaceae	27	10	A	27	2.7	0.86	0.92
42	*Elaeagnus kolaga* Schltdl.	Elaeagnaceae	10	10	A	10	1	0.32	0.92
43	*Elaeocarpus tuberculatus* Roxb.	Elaeocarpaceae	2	10	A	2	0.2	0.06	0.92
44	*Elaeocarpus variabilis* Zmarzty	Elaeocarpaceae	19	40	B	4.75	1.9	0.6	3.7
45	*Elatostema*	Urticaceae	84	30	B	28	8.4	2.66	2.7

S. No.	Plant Name	Family	Total No. of Ind.	% Freq.	Freq. Class	Abun.	Den.	Rel. Den.	Rel. freq.
	sessile J.R. Forster & G. Forster								
46	*Eleusine indica* (L.) Gaertn.	Poaceae	23	10	A	23	2.3	0.73	0.92
47	*Eucalyptus grandis* W. Hill.	Myrtaceae	20	40	B	5	2	0.63	3.7
48	*Eucalyptus tereticornis* Sm.	Myrtaceae	38	80	D	4.75	3.8	1.2	7.4
49	*Euphorbia pulcherrima* Willd. ex Klotzsch	Euphorbiaceae	4	10	A	4	0.4	0.13	0.92
50	*Euphorbia rothiana* Spreng.	Euphorbuiaceae	29	10	A	29	2.9	0.92	0.92
51	*Galinsoga parviflora* Cav.	Asteraceae	17	10	A	17	1.7	0.54	0.92
52	*Gardneria ovata* Wall.	Loganiaceae	6	10	A	6	0.6	0.19	0.92
53	*Gnetum ula* Brongn.	Gnetaceae	4	10	A	4	0.4	0.13	0.92
54	*Goniothalamus wynaadensis* (Bedd.) Bedd.	Annonaceae	6	10	A	6	0.6	0.19	0.92
55	*Grevillea robusta A.Cunn. ex R.Br.*	Proteaceae	3	10	A	3	0.3	0.09	0.92
56	*Hedyotis swertioides* Hook. f.	Rubiaceae	107	70	D	15.28	10.7	3.39	6.5
57	*Hydrocotyle conferta* Wight	Apiaceae	35	20	A	17.5	3.5	1.11	1.85
58	*Ipomea cairica* (L.) Sweet	Convolvulaceae	7	30	B	2.33	0.7	0.22	2.7
59	*Jasminum brevilobum* DC	Oleaceae	4	20	A	2	0.4	0.13	1.85
60	*Lactuca serriola* L.	Asteraceae	18	10	A	18	1.8	0.57	0.92
61	*Lantana*	Verbinaceae	88	50	C	17.6	8.8	2.79	4.6

S. No.	Plant Name	Family	Total No. of Ind.	% Freq.	Freq. Class	Abun.	Den.	Rel. Den.	Rel. freq.
	camera L.								
62	*Leucas aspera* (Willd.) Link	Lamiaceae	12	10	A	12	1.2	0.38	0.92
63	*Leucas chinensis* (Retz.) Sm.	Lamiaceae	17	10	A	17	1.7	0.54	0.92
64	*Listea floribunda* (Bl.) Gamble	Lauraceae	2	10	A	2	0.2	0.06	0.92
65	*Litsea glabrata* (Wall ex Nees.) Hook. Fil.	Lauraceae	7	20	A	3.5	0.7	0.22	1.85
66	*Litsea wightiana* (Nees) Benth & Hook. Fil.	Lauraceae	7	20	A	3.5	0.7	0.22	1.85
67	*Mahonia napaulensis* DC.	Berberidaceae	3	10	A	3	0.3	0.09	0.92
68	*Memecylon edule* Roxb.	Melastomataceae	7	20	A	3.5	0.7	0.22	1.85
69	*Michelia nilagirica* Zenker	Magnoliaceae	5	10	A	5	0.5	0.16	0.92
70	*Mikania micarantha* Kunth	Asteraceae	3	10	A	3	0.3	0.09	0.92
71	*Mitragyna speciosa (Korth.) Havil.*	Rubiaceae	5	10	A	5	0.5	0.16	0.92
72	*Myrsine wightiana* Wall.	Myrsinaceae	12	20	A	6	1.2	0.38	1.85
73	*Neolistsea foliosa (*Nees) Gamble	Lauraceae	8	20	A	4	0.8	0.25	1.85
74	*Neolitsea cassia* (L.) Kosterm.	Lauraceae	17	40	B	4.25	1.7	0.54	3.7
75	*Nephrolipis* Sp.	Nephrolepidaceae	21	10	A	21	2.1	0.67	0.92
76	*Osbeckia branchystemon* Naud.	Melastomataceae	15	10	A	15	1.5	0.48	0.92

S. No.	Plant Name	Family	Total No. of Ind.	% Freq.	Freq. Class	Abun.	Den.	Rel. Den.	Rel. freq.
77	*Osbeckia reticulata* Bedd.	Melastomataceae	7	10	A	7	0.7	0.22	0.92
78	*Oxalis corniculata* L.	Oxalidaceae	126	50	C	25.2	12.6	4	4.6
79	*Parsonsia alboflavescens* (Dennst.) Mabb.	Apocynaceae	5	10	A	5	0.5	0.16	0.92
80	*Peperomia tetraphylla* (G.Forst.) Hook. & Arn.	Piperaceae	19	10	A	19	1.9	0.6	0.92
81	*Peperomina blanda* (Jacq.) Kunth	Piperaceae	28	20	A	7	2.8	0.89	1.85
82	*Photinia integrifolia* Lindl. var. sub-*lanceolata* Miq.	Rosaceae	2	10	A	2	0.2	0.06	0.92
83	*Phytolacca icosandra* L.	Phytolacaceae	53	30	B	17.66	5.3	1.68	2.7
84	*Piper mullesua* Buch.-Ham. ex D. Don	Piperaceae	8	10	A	8	0.8	0.25	0.92
85	*Piper wightii* Miq.	Piperaceae	6	10	A	6	0.6	0.19	0.92
86	*Pittosporum neelgherrense* Wight & Arn.	Pittosporaceae	3	10	A	3	0.3	0.09	0.92
87	*Pogostemon wightii* Benth.	Lamiaceae	40	30	B	13.33	4	1.27	2.7
88	*Polygala arillata Buch.*-Ham. ex D. Don	Polygalaceae	11	10	A	11	1.1	0.35	0.92
89	*Polystricum* Sp.	Polytrichaceae	42	20	A	21	4.2	1.33	1.85
90	*Psidium guajava* L.	Myrtaceae	4	10	A	4	0.4	0.13	0.92
91	*Rapanea wightiana (*Wall. ex A. DC.) Mez.	Myrsinaceae	4	10	A	4	0.4	0.13	0.92
92	*Rubus ellipticus* Sm.	Rosaceae	7	10	A	7	0.7	0.22	0.92

S. No.	Plant Name	Family	Total No. of Ind.	% Freq.	Freq. Class	Abun.	Den.	Rel. Den.	Rel. freq.
93	*Rubus fairholmianus* Gardn.	Rosaceae	15	30	B	5	1.5	o.48	2.7
94	*Ruta graveolens* L.	Rutaceae	7	10	A	7	0.7	0.22	0.92
95	*Schefflera capitata* (Wight & Arn.) Harms	Araliaceae	5	10	A	5	0.5	0.16	0.92
96	*Schefflera racemosa* (Wight) Harms	Araliaceae	16	30	B	5.33	1.6	0.51	2.7
97	*Senna septemtrionalis* (Viv.) H. S. Irwin & Bameby	Fabaceae	8	20	A	4	0.8	0.25	1.85
98	*Simlax aspera L.*	Smilacaceae	10	20	A	5	1	0.32	1.85
99	*Solanum mauritianum* Scop.	Solanaceae	153	60	C	25.5	15.3	4.85	5.55
100	*Solanum virginianum* L.	Solanaceae	16	10	A	16	1.6	0.51	0.92
101	*Strobilanthes cansanguinea* (Nees) T. Anders.	Acanthaceae	27	10	A	27	2.7	0.86	0.92
102	*Strobilanthus lanata* Nees	Acanthaceae	31	20	A	15.5	3.1	0.98	1.85
103	*Symplocos cochinchinensis* Moore subsp. *Laurina (Retz.)*	Symplocaceae	3	10	A	3	0.3	0.09	0.92
104	*Syzygium cumini* (L.) Skeels.	Myrtaceae	19	50	C	3.8	1.9	0.6	4.6
105	*Syzygium denisflorum* Wall ex Wt. & Arn.	Myrtaceae	12	40	B	3.5	1.2	0.38	3.7
106	*Thunbergia fragrans* Roxb.	Acanthaceae	6	10	A	6	0.6	0.19	0.92

S. No.	Plant Name	Family	Total No. of Ind.	% Freq.	Freq. Class	Abun.	Den.	Rel. Den.	Rel. freq.
107	*Xerochrysum bracteatum* (Vent.) Tzvelev	Asteraceae	96	40	B	24	0.4	3.04	3.7
108	*Zanthoxylum asiaticum* (L.) Appelhans, Groppo & J.Wen	Rutaceae	15	20	A	7.5	1.5	0.48	1.85

Table-3.28: Quantitative Data of Plant Species in All Study sites (Post-monsoon Season)

S. No	Plant Name	Family	Total no of Individuals	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
1.	*Acacia mearnsii* De Wild.	Fabaceae	127	90	E	14.1	12.7	1.81	1.5
2.	*Achyranthes aspera* var. *Rubrofusca* (Wight) Hook. f.	Amaranthaceae	65	40	B	16.25	6.5	0.93	0.68
3.	*Adiantum* Sp.	Pteridophytes	119	60	C	19.83	11.9	1.7	1.02
4.	*Ageratina adenophora* (Spreng.) King & H.Rob.	Asteraceae	71	20	A	35.5	7.1	1.01	0.34
5.	*Ageratum conyzoides* L.	Asteraceae	109	50	C	21.8	10.9	1.56	0.85
6.	*Ageratum houstonianum* Mill.	Asteraceae	34	20	A	17	3.4	0.49	0.34
7.	*Alloteropsis cimicina* (L.) Stapf	Poaceae	49	20	A	24.5	4.9	0.7	0.34
8.	*Alnus nepalensis* D.Don	Betulaceae	14	30	B	4.6	1.4	0.2	0.51
9.	*Aloe arborescens* Mill.	Asphodelaceae	66	30	B	22	6.6	0.95	0.51
10.	*Alstonia venenata* R. Br.	Apocynaceae	13	20	A	6.5	1.3	0.19	0.34
11.	*Andrographis alata* (Vahl.) Nees	Acanthaceae	31	30	B	10.33	3.1	0.44	0.51

S. No	Plant Name	Family	Total no of Individuals	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
12.	*Andropogon lividus* Thwaites	Poaceae	103	40	B	25.75	10.3	1.5	0.68
13.	*Aphloia theiformis* (Vahl) Benn.	Flacourtiaceae	28	40	B	7	2.8	0.4	0.68
14.	*Argreia coonoorensis* W. W. Smith and Ramos.	Convolvulaceae	5	20	A	2.5	0.5	0.07	0.34
15.	*Argyreia hirsuta* Wight & Arn.	Convolvulaceae	10	50	C	2	1	0.14	0.85
16.	*Arisaema leschenaultii* Blume	Araceae	45	50	C	9	4.5	0.644	0.85
17.	*Artemisia nilagarica* (Clarke) Pamp.	Asteraceae	21	10	A	21	2.1	0.3	0.17
18.	*Arundinella ciliata* (Roxb.) Nees ex Miq.	Poaceae	63	30	B	21	6.3	0.9	0.51
19.	*Arundinella mesophylla* Nees ex Steud.	Poaceae	117	50	C	23.4	11.7	1.7	0.85
20.	*Asparagus fysonii* J.F.Macbr.	Asparagaceae	24	50	C	4.8	2.4	0.34	0.85
21.	*Beilschmiedia wightii* (Nees) Benth. ex Hook. f.	Lauraceae	5	20	A	2.5	0.5	0.07	0.34
22.	*Berberis tinctoria* Leschen	Berberidaceae	19	30	B	6.3	1.9	0.27	0.51
23.	*Bidens pilosa* L.	Asterraceae	228	60	C	38	22.8	3.26	1.02
24.	*Caesalpinia decapetala (Roth) Alston*	Fabaceae	14	10	A	14	1.4	0.2	0.17
25.	*Canthium neilgerrense* Wight	Rubiaceae	7	10	A	7	0.7	0.1	0.17
26.	*Casearia zeylanica* Thwaites	Salicaceae	4	10	A	4	0.4	0.05	0.17
27.	*Cassine paniculata* (Wight & Arn.) Lobr.-Callen	Celastraceae	8	20	A	4	0.8	0.11	0.34
28.	*Celastrus paniculatus* Willd.	Celastraceae	13	40	B	3.25	1.3	0.19	0.68
29.	*Celtis tetrandra* Roxb.	Ulmaceae	9	20	A	4.5	0.9	0.13	0.34

S. No	Plant Name	Family	Total no of Individuals	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
30.	*Cenchrus biflorus* Roxb.	Poaceae	115	30	B	38.33	11.5	1.65	0.51
31.	*Centella asiatica* (L.) Urb.	Apiaceae	231	50	C	46.2	23.1	3.31	0.85
32.	*Cestrum aurantiacum* Lindl.	Solanaceae	116	40	B	29	11.6	1.66	0.68
33.	*Chamaemelum nobile* (L.) All.	Asteraceae	60	40	B	15	6	0.86	0.68
34.	*Chionanthus ramiflorus* Roxb.	Oleaceae	6	20	A	3	0.6	0.08	0.34
35.	*Chrysopogon zeylanicus* (Steud.) Thwaites	Poaceae	55	30	B	18.33	5.5	0.79	0.51
36.	*Cinanammom sulpharatum* Nees	Lauraceae	12	30	B	4	1.2	0.17	0.51
37.	*Cinnamomum wightii* Meisner	Lauraceae	10	30	B	3.33	1	0.14	0.51
38.	*Cirsium wallichii* DC	Asterraceae	32	20	A	16	3.2	0.46	0.34
39.	*Cissampelopsis corymbosa* (Wall. ex DC.) C.Jeffrey & Y.L.Chen	Asteraceae	13	30	B	6.5	1.3	0.19	0.51
40.	*Cissampelopsis walkeri* (Arn.) C. Jeffrey & Y.L. Chen	Asteraceae	8	20	A	4	0.8	0.11	0.34
41.	*Clematis zeylanica* (L.) Poir.	Ranunculaceae	24	40	B	6	2.4	0.34	0.68
42.	*Commelina clavate* C. B. Clarke	Commelinaceae	29	20	A	14.5	2.9	0.42	0.34
43.	*Commelina hirsuta* (Wight) Bedd.	Commelinaceae	76	80	D	9.5	7.6	1.09	1.37
44.	*Conyz bonariensis* (L.) Cronquist	Asteraceae	80	30	B	26.66	8	1.15	0.51
45.	*Cotula australis* (Sieber ex Spreng.) Hook.	Asteraceae	65	20	A	32.5	6.5	0.93	0.34
46.	*Crassocephalum crepidioides* (Benth) S. Moore	Asteraceae	55	60	C	9.16	5.5	0.79	1.02
47.	*Crotalaria formosa* Graham ex Wight & Arn.	Fabaceae	13	20	A	6.5	1.3	0.19	0.34

S. No	Plant Name	Family	Total no of Individuals	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
48.	*Cryptocarya lawsonii* Gamble	Lauraceae	14	20	A	7	1.4	0.2	0.34
49.	*Cupress* sp.	Gymnosperm	10	20	A	5	1	0.14	0.34
50.	*Cyanotis arachnoidea* Clarke	Commelinaceae	91	60	C	15.16	9.1	1.3	1.02
51.	*Cyanthillium cinereum* (Carl Linnaeus) H.Rob	Asteraceae	106	50	C	21.2	10.6	1.52	0.85
52.	*Cymbopogon citratus* (DC.) Stapf	Poaceae	58	20	A	29	5.8	0.83	0.34
53.	*Cyperus difformis* L.	Cyperaceae	79	20	A	39.5	7.9	1.13	0.34
54.	*Cyperus rotundus* L.	Cyperaceae	121	40	B	30.25	12.1	1.73	0.68
55.	*Cyperus stoloniferus Retz.*	Cyperaceae	181	40	B	45.25	18.1	2.59	0.68
56.	*Cystisus scoparius* (L.) Link	Fabaceae	17	10	A	17	1.7	0.24	0.17
57.	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	79	20	A	39.5	7.9	1.13	0.34
58.	*Daphniphyllum neilgherrense* (Wight) K. Rosenthal	Daphniphyllaceae	18	20	A	9	1.8	0.26	0.34
59.	*Debregeasia longifolia* (Burm. f.) Wedd	Urticaceae	7	10	A	7	0.7	0.1	0.17
60.	*Decalepis nervosa* (Wight & Arn.) Venter	Apocynaceae	21	30	B	7	2.1	0.3	0.51
61.	*Decaloba leschenaultii* (DC.) M. Roem.	Passifloraceae	51	50	C	10.2	5.1	0.73	0.85
62.	*Dendrophthoe neelgherrensis* (Wight & Arn.) Tiegh.	Loranthaceae	10	20	A	5	1	0.14	0.34
63.	*Digrocephala integerifolia* (L. f.) Kuntze	Asteraceae	18	10	A	18	1.8	0.26	0.17
64.	*Dodonaea viscosa*	Sapindaceae	33	20	A	16.5	3.3	0.47	0.34

S. No	Plant Name	Family	Total no of Individuals	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
	Jacq.								
65.	*Drymaria cordata* (L.) Willd. ex Roem & Schult.	Caryophyllaceae	15	10	A	15	1.5	0.21	0.17
66.	*Elaeagnus kolaga* Schltdl.	Elaeagnaceae	29	40	B	7.25	2.9	0.42	0.68
67.	*Elaeocarpus munroii* Mast.	Elaeocarpaceae	12	30	B	4	1.2	0.17	0.51
68.	*Elaeocarpus tuberculatus* Roxb.	Elaeocarpaceae	3	10	A	3	0.3	0.04	0.17
69.	*Elaeocarpus variabilis* Zmarzty	Elaeocarpaceae	40	80	D	5	4	0.57	1.37
70.	*Elatostema sessile* J.R. Forster & G. Forster	Urticaceae	160	40	B	40	16	2.29	0.68
71.	*Eleusine indica* (L.) Gaertn.	Poaceae	26	10	A	26	2.6	0.37	0.17
72.	*Erigeron karvinskianus* DC	Asteraceae	133	40	B	33.25	13.3	1.9	0.68
73.	*Eucalyptus grandis* W. Hill.	Myrtaceae	47	40	B	11.75	4.7	0.67	0.68
74.	*Eucalyptus tereticornis* Sm.	Myrtaceae	65	90	E	7.22	6.5	0.93	1.54
75.	*Euonymus crenulatus* Wall. ex Wight & Arn.	Celastraceae	10	20	A	5	1	0.14	0.34
76.	*Euphorbia pulcherrima* Willd. ex Klotzsch	Euphorbiaceae	6	10	A	6	0.6	0.09	0.17
77.	*Euphorbia rothiana* Spreng.	Euphorbuiaceae	40	20	A	20	4	0.57	0.34
78.	*Fagraea ceilanica* Thumb.	Genitanaceae	4	10	A	4	0.4	0.06	0.17
79.	*Ficus drupacea* Thunb.	Moraceae	1	10	A	1	0.1	0.01	0.17
80.	*Flacourtia indica* (Burm. F) Merr.	Salicaceae	6	20	A	3	0.6	0.09	0.34
81.	*Galinsoga parviflora* Cav.	Asteraceae	102	30	B	34	10.2	1.46	0.51
82.	*Gardneria ovata* Wall.	Loganiaceae	11	30	B	3.66	1.1	0.16	0.51
83.	*Glochidion*	Euphorbiacea	4	20	A	2	0.4	0.06	0.34

S. No	Plant Name	Family	Total no of Individuals	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
	ellipticum Wight	e							
84.	*Gnetum ula* Brongn.	Gnetaceae	4	10	A	4	0.4	0.06	0.17
85.	*Gomphandra coriacea* Wight.	Stemonuraceae	7	20	A	3.5	0.7	0.1	0.34
86.	*Goniothalamus wynaadensis* (Bedd.) Bedd.	Annonaceae	8	20	A	4	0.8	0.11	0.34
87.	*Grevillea robusta* A.Cunn. ex R.Br.	Proteaceae	3	20	A	1.5	0.3	0.04	0.34
88.	*Hedyotis swertioides* Hook. f.	Rubiaceae	58	60	C	9.66	5.8	0.83	1.02
89.	*Hydrocotyle conferta* Wight	Apiaceae	52	20	A	26	5.2	0.74	0.34
90.	*Hydrocotyle javanica* Thumb.	Apiaceae	122	40	B	30.5	12.2	1.75	0.68
91.	*Hypericum japonicum* Thunb. ex Murr.	Hypericaceae	16	30	B	5.33	1.6	0.23	0.51
92.	*Ilex denticulata* Wall.	Aquifoliaceae	5	20	A	2.5	0.5	0.07	0.34
93.	*Impatiens aquatica* Bhaskar	Balsaminaceae	113	20	A	56.5	11.3	1.62	0.34
94.	*Ipomea cairica* (L.) Sweet	Convolvulaceae	14	50	C	2.8	1.4	0.2	0.85
95.	*Isodon coeste* (Buch.-Ham. ex D. Don) Kudo	Lamiaceae	21	30	B	7	2.1	0.3	0.51
96.	*Isonandra perrottetiana* A. DC.	Sapotaceae	3	20	A	1.5	0.3	0.04	0.34
97.	*Jasminum brevilobum* DC	Oleaceae	5	40	B	1.25	0.5	0.07	0.68
98.	*Jasminum coarctatum* Roxb.	Oleaceae	4	20	A	2	0.4	0.06	0.34
99.	*Justicia japonica Thumb.*	Acanthaceae	89	50	C	17.8	8.9	1.27	0.85
100.	*Kyllinga melanosperma* Nees.	Cyperaceae	12	20	A	6	1.2	0.17	0.34
101.	*Lactuca serriola* L.	Asteraceae	9	10	A	9	0.9	0.13	0.17
102.	*Lantana camera* L.	Verbinaceae	82	60	C	13.66	8.2	1.17	1.02

S. No	Plant Name	Family	Total no of Individuals	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
103.	*Lasianthus acuminates* Wight	Rubiaceae	4	10	A	4	0.4	0.06	0.17
104.	*Leucas aspera* (Willd.) Link	Lamiaceae	114	50	C	22.8	11.4	1.63	0.85
105.	*Leucas chinensis* (Retz.) Sm.	Lamiaceae	34	20	A	17	3.4	0.49	0.34
106.	*Leucas lamiifolia* Dest.	Lamiaceae	8	20	A	4	0.8	0.11	0.34
107.	*Listea floribunda* (Bl.) Gamble	Lauraceae	24	50	C	4.8	2.4	0.34	0.85
108.	*Litsea glabrata* (Wall ex Nees.) Hook. Fil.	Lauraceae	13	40	B	3.25	1.3	0.19	0.68
109.	*Litsea stocksii* (Meisn) Hook.f	Lauraceae	4	30	B	1.33	0.4	0.06	0.51
110.	*Litsea wightiana* (Nees) Benth & Hook. Fil.	Lauraceae	12	40	B	3	1.2	0.17	0.68
111.	*Lobelia leschenaultiana* (Presl.) Skottsb.	Campanulaceae	12	40	B	3	1.2	0.17	0.68
112.	*Magnolia nilagirica* Zenker	Magnoliaceae	24	50	C	4.8	2.4	0.34	0.85
113.	*Mahonia napaulensis* DC.	Berberidaceae	9	40	B	2.25	0.9	0.13	0.68
114.	*Meliosma pinnata* (Roxb.) Walp. *ssp. barbulata* (Cufod.) Beus.	Sabiaceae	5	40	B	1.25	0.5	0.07	0.68
115.	*Memecylon edule Roxb.*	Melastomataceae	5	20	A	2.5	0.5	0.07	0.34
116.	*Memecylon sisparense* Gamble	Melastomataceae	7	20	A	3.5	0.7	0.1	0.34
117.	*Microtropis ramiflora* Wight	Celastraceae	2	20	A	1	0.2	0.03	0.34
118.	*Mikania micarantha* Kunth	Asteraceae	6	20	A	3	0.6	0.08	0.34
119.	*Mitragyna speciosa* (Korth.) Havil.	Rubiaceae	6	20	A	3	0.6	0.08	0.34
120.	*Myrsine wightiana* Wall.	Myrsinaceae	10	50	C	2	1	0.14	0.85
121.	*Neolistsea foliosa*	Lauraceae	18	30	B	6	1.8	0.26	0.51

S. No	Plant Name	Family	Total no of Individuals	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
	(Nees) Gamble								
122.	*Neolitsea cassia* (L.) Kosterm.	Lauraceae	23	50	C	4.6	2.3	0.33	0.85
123.	*Neolitsea scrobiculata* (Meisner) Gamble.	Lauraceae	8	40	B	2	0.8	0.11	0.68
124.	*Neonatis monosperma* (Wight & Arn.) W.H.Lewis	Rubiaceae	46	50	C	9.2	4.6	0.66	0.85
125.	*Nephrolipis* Sp.	Pteridophytes	82	30	B	27.33	8.2	1.17	0.51
126.	*Osbeckia branchystemon* Naud.	Melastomataceae	18	40	B	4.5	1.8	0.26	0.68
127.	*Osbeckia reticulata* Bedd.	Melastomataceae	15	20	A	7.5	1.5	0.21	0.34
128.	*Oxalis corniculata* L.	Oxalidaceae	273	70	D	39	27.3	3.91	1.19
129.	*Parsonsia alboflavescens* (Dennst.) Mabb.	Apocynaceae	4	20	A	2	0.4	0.06	0.34
130.	*Passiflora mollissima* (Kunth.) Bailey	Passifloraceae	15	30	B	5	1.5	0.21	0.51
131.	*Passiflora subpeltata* Ortega	Passifloraceae	9	40	B	2.25	0.9	0.13	0.68
132.	*Peperomia tetraphylla* (G.Forst.) Hook. & Arn.	Peperaceae	176	40	B	44	17.6	2.5	0.68
133.	*Peperomina blanda* (Jacq.) Kunth	Piperaceae	94	30	B	31.33	9.4	1.3	0.51
134.	*Photinia integrifolia* Lindl. var. sub-*lanceolata* Miq.	Rosaceae	7	20	A	3.5	0.7	0.1	0.34
135.	*Phytolacca icosandra* L.	Phytolacaceae	37	40	B	9.25	3.7	0.53	0.68
136.	*Pinus* Sp.	Gymnosperm	4	10	A	4	0.4	0.06	0.17
137.	*Piper mullesua* Buch.-Ham. ex D. Don	Piperaceae	84	60	C	14	8.4	1.2	1.02

S. No	Plant Name	Family	Total no of Individuals	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
138.	*Piper trichostachyon* (Miq.) C. DC.	Piperaceae	25	30	B	8.33	2.5	0.36	0.51
139.	*Piper wightii* Miq.	Piperaceae	18	40	B	4.5	1.8	0.26	0.68
140.	*Pittosporum neelgherrense* Wight & Arn.	Pittosporaceae	10	40	B	2.5	1	0.14	0.68
141.	*Pogostemon wightii* Benth.	Lamiaceae	88	70	D	12.57	8.8	1.26	1.19
142.	*Polygala arillata Buch.*-Ham. ex D. Don	Polygalaceae	8	20	A	4	0.8	0.11	0.34
143.	*Polystricum* Sp.	Pteridophytes	38	20	A	19	3.8	0.54	0.34
144.	*Prunus ceylanica* (Wight) Miq.	Rosaceae	4	10	A	4	0.4	0.06	0.17
145.	*Psidium guajava* L.	Myrtaceae	4	10	A	4	0.4	0.06	0.17
146.	*Psychotria sohmeri* Kiehn	Rubiaceae	20	40	B	5	2	0.23	0.68
147.	*Rapanea daphnoides* Mez.	Myrsinaceae	10	20	A	5	1	0.14	0.34
148.	*Rapanea wightiana (*Wall. ex A. DC.) Mez.	Myrsinaceae	7	20	A	3.5	0.7	0.1	0.34
149.	*Rhododendron arb oreum* Sm. ssp. *nilagiricum* (Ze nker) Tagg	Ericaceae	13	40	B	3.25	1.3	0.19	0.68
150.	*Rhodomyrtus tomentosa* (Aiton) Hassk.	Myrtaceae	6	10	A	6	0.6	0.08	0.17
151.	*Rosa leshenaultiana* Red & Thory ex Wight & Arn	Rosaceae	5	40	B	1.25	0.5	0.07	0.68
152.	*Rotala rotundifolia* (Bunch.-Ham. Ex Roxb) Koehne.	Lythraceae	47	20	A	23.5	4.7	0.67	0.34
153.	*Rubia cordifolia* L.	Rubiaceae	24	40	B	6	2.4	0.34	0.68
154.	*Rubus ellipticus* Sm.	Rosaceae	12	30	B	4	1.2	0.17	0.51
155.	*Rubus fairholmianus*	Rosaceae	15	50	C	3	1.5	0.21	0.85

S. No	Plant Name	Family	Total no of Individuals	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
	Gardn.								
156.	*Rubus racemosus* Roxb.	Rosaceae	6	20	A	3	0.6	0.08	0.34
157.	*Ruta graveolens* L.	Rutaceae	9	20	A	4.5	0.9	0.13	0.34
158.	*Sarcococca saligna* Muell. Arg	Buxaceae	3	20	A	1.5	0.3	0.04	0.34
159.	*Schefflera capitata* (Wight & Arn.) Harms	Araliaceae	8	20	A	4	0.8	0.11	0.34
160.	*Schefflera racemosa* (Wight) Harms	Araliaceae	29	50	C	5.8	2.9	0.41	0.85
161.	*Schefflera rostrata* (Whight) Harms	Araliaceae	6	10	A	6	0.6	0.08	0.17
162.	*Senna septemtrionalis* (Viv.) H. S. Irwin & Bameby	Fabaceae	15	30	B	5	1.5	0.21	0.51
163.	*Simlax aspera L.*	Smilacaceae	20	50	C	4	2	0.29	0.85
164.	*Smilax wightii* A. D.C.	Smilacaceae	5	30	B	1.66	0.5	0.71	0.51
165.	*Solanum laxum* Spreng.	Solanaceae	6	40	B	1.5	0.6	0.086	0.68
166.	*Solanum mauritianum* Scop.	Solanaceae	45	60	C	7.5	4.5	0.64	1.02
167.	*Solanum pseudo-capsicum* L.	Solanaceae	27	20	A	13.5	2.7	0.39	0.34
168.	*Solanum sisymbrifolium* Lam.	Solanaceae	41	20	A	20.5	4.1	0.59	0.34
169.	*Solanum virginianum* L.	Solanaceae	83	60	C	13.83	8.3	1.19	1.02
170.	*Spermacoce ocymoides* Burm. F.	Rubiaceae	40	20	A	20	4	0.57	0.34
171.	*Strobilanthes cansanguinea* (Nees) T. Anders.	Acanthaceae	46	30	B	15.33	4.6	0.66	0.51
172.	*Strobilanthus cuspidatus* (Benth.) Anders	Acanthaceae	6	10	A	6	0.6	0.09	0.17
173.	*Strobilanthus lanata* Nees	Acanthaceae	39	30	B	13	3.9	0.56	0.51

S. No	Plant Name	Family	Total no of Individuals	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
174.	*Symplocos cochinchinensis* Moore subsp. *Laurina (Retz.)*	Symplocaceae	10	20	A	5	1	0.14	0.34
175.	*Symplocos pendula* Wight.	Symplocaceae	8	20	A	4	0.8	0.11	0.34
176.	*Syzygium cumini* (L.) Skeels.	Myrtaceae	27	50	C	5.4	2.7	0.39	0.85
177.	*Syzygium denisflorum* Wall ex Wt. & Arn.	Myrtaceae	15	30	B	5	1.5	0.21	0.51
178.	*Taraxacum javanicum* Soest	Asteraceae	61	30	B	20.33	6.1	0.87	0.51
179.	*Tarenna asiatica* (L.) Kuntze ex K. Schum,. var. asiatica forma rigida (Wight)	Rubiaceae	5	40	B	1.25	0.5	0.07	0.68
180.	*Thunbergia fragrans* Roxb.	Acanthaceae	4	10	A	4	0.4	0.06	0.17
181.	*Ventilago madraspatana* Gaertn.	Rhamnaceae	7	40	B	1.75	0.7	0.1	0.68
182.	*Viburnum erubescens* Wall. Ex.DC	Adoxaceae	4	20	A	2	0.4	0.06	0.34
183.	*Xerochrysum bracteatum* (Vent.) Tzvelev	Asteraceae	117	70	D	25.28	11.7	1.68	1.19
184.	*Zanthoxylum asiaticum* (L.) Appelhans, Groppo & J.Wen	Rutaceae	46	60	C	7.6	4.6	0.66	1.02

Table-3.29: Quantitative Data of Plant Species in All Study sites (Pre-monsoon Season)

S. No.	Plant Name	Family	Total no of Individuals in all quadrate	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
1.	*Acacia mearnsii* De Wild.	Fabaceae	127	90	E	14.1	12.7	1.81	1.5
2.	*Achyranthes aspera* var. *Rubrofusca* (Wight) Hook. f.	Amaranthaceae	65	40	B	16.25	6.5	0.93	0.68
3.	*Adiantum* Sp.	Pteridophytes	119	60	C	19.83	11.9	1.7	1.02
4.	*Ageratina adenophora* (Spreng.) King & H.Rob.	Asteraceae	71	20	A	35.5	7.1	1.01	0.34
5.	*Ageratum conyzoides* L.	Asteraceae	109	50	C	21.8	10.9	1.56	0.85
6.	*Ageratum houstonianum* Mill.	Asteraceae	34	20	A	17	3.4	0.49	0.34
7.	*Alloteropsis cimicina* (L.) Stapf	Poaceae	49	20	A	24.5	4.9	0.7	0.34
8.	*Alnus nepalensis* D.Don	Betulaceae	14	30	B	4.6	1.4	0.2	0.51
9.	*Aloe arborescens* Mill.	Asphodelaceae	66	30	B	22	6.6	0.95	0.51
10.	*Alstonia venenata* R. Br.	Apocynaceae	13	20	A	6.5	1.3	0.19	0.34
11.	*Andrographis alata* (Vahl.) Nees	Acanthaceae	31	30	B	10.33	3.1	0.44	0.51
12.	*Andropogon lividus* Thwaites	Poaceae	103	40	B	25.75	10.3	1.5	0.68
13.	*Aphloia theiformis* (Vahl) Benn.	Flacourtiaceae	28	40	B	7	2.8	0.4	0.68

S. No.	Plant Name	Family	Total no of Individuals in all quadrate	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
14.	*Argreia coonoorensis* W. W. Smith and Ramos.	Convolvulaceae	5	20	A	2.5	0.5	0.07	0.34
15.	*Argyreia hirsuta* Wight & Arn.	Convolvulaceae	10	50	C	2	1	0.14	0.85
16.	*Arisaema leschenaultii* Blume	Araceae	45	50	C	9	4.5	0.644	0.85
17.	*Artemisia nilagarica* (Clarke) Pamp.	Asteraceae	21	10	A	21	2.1	0.3	0.17
18.	*Arundinella ciliata* (Roxb.) Nees ex Miq.	Poaceae	63	30	B	21	6.3	0.9	0.51
19.	*Arundinella mesophylla* Nees ex Steud.	Poaceae	117	50	C	23.4	11.7	1.7	0.85
20.	*Asparagus fysonii* J.F.Macbr.	Asparagaceae	24	50	C	4.8	2.4	0.34	0.85
21.	*Beilschmiedia wightii* (Nees) Benth. ex Hook. f.	Lauraceae	5	20	A	2.5	0.5	0.07	0.34
22.	*Berberis tinctoria* Leschen	Berberidaceae	19	30	B	6.3	1.9	0.27	0.51
23.	*Bidens pilosa* L.	Asterraceae	228	60	C	38	22.8	3.26	1.02
24.	*Caesalpinia decapetala (Roth) Alston*	Fabaceae	14	10	A	14	1.4	0.2	0.17
25.	*Canthium neilgerrense* Wight	Rubiaceae	7	10	A	7	0.7	0.1	0.17
26.	*Casearia zeylanica* Thwaites	Salicaceae	4	10	A	4	0.4	0.05	0.17

S. No.	Plant Name	Family	Total no of Individuals in all quadrate	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
27.	*Cassine paniculata* (Wight & Arn.) Lobr.-Callen	Celastraceae	8	20	A	4	0.8	0.11	0.34
28.	*Celastrus paniculatus* Willd.	Celastraceae	13	40	B	3.25	1.3	0.19	0.68
29.	*Celtis tetrandra* Roxb.	Ulmaceae	9	20	A	4.5	0.9	0.13	0.34
30.	*Cenchrus biflorus* Roxb.	Poaceae	115	30	B	38.33	11.5	1.65	0.51
31.	*Centella asiatica* (L.) Urb.	Apiaceae	231	50	C	46.2	23.1	3.31	0.85
32.	*Cestrum aurantiacum* Lindl.	Solanaceae	116	40	B	29	11.6	1.66	0.68
33.	*Chamaemelum nobile* (L.) All.	Asteraceae	60	40	B	15	6	0.86	0.68
34.	*Chionanthus ramiflorus* Roxb.	Oleaceae	6	20	A	3	0.6	0.08	0.34
35.	*Chrysopogon zeylanicus* (Steud.) Thwaites	Poaceae	55	30	B	18.33	5.5	0.79	0.51
36.	*Cinanammom sulpharatum* Nees	Lauraceae	12	30	B	4	1.2	0.17	0.51
37.	*Cinnamomum wightii* Meisner	Lauraceae	10	30	B	3.33	1	0.14	0.51
38.	*Cirsium wallichii* DC	Asterraceae	32	20	A	16	3.2	0.46	0.34
39.	*Cissampelopsis corymbosa* (Wall. ex DC.) C.Jeffrey & Y.L.Chen	Asteraceae	13	30	B	6.5	1.3	0.19	0.51
40.	*Cissampelopsis walkeri* (Arn.)	Asteraceae	8	20	A	4	0.8	0.11	0.34

S. No.	Plant Name	Family	Total no of Individuals in all quadrate	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
	C. Jeffrey & Y.L. Chen								
41.	*Clematis zeylanica* (L.) Poir.	Ranunculaceae	24	40	B	6	2.4	0.34	0.68
42.	*Commelina clavate* C. B. Clarke	Commelinaceae	29	20	A	14.5	2.9	0.42	0.34
43.	*Commelina hirsuta* (Wight) Bedd.	Commelinaceae	76	80	D	9.5	7.6	1.09	1.37
44.	*Conyz bonariensis* (L.) Cronquist	Asteraceae	80	30	B	26.66	8	1.15	0.51
45.	*Cotula australis* (Sieber ex Spreng.) Hook.	Asteraceae	65	20	A	32.5	6.5	0.93	0.34
46.	*Crassocephalum crepidioides* (Benth) S. Moore	Asteraceae	55	60	C	9.16	5.5	0.79	1.02
47.	*Crotalaria formosa* Graham ex Wight & Arn.	Fabaceae	13	20	A	6.5	1.3	0.19	0.34
48.	*Cryptocarya lawsonii* Gamble	Lauraceae	14	20	A	7	1.4	0.2	0.34
49.	*Cupress* sp.	Gymnosperm	10	20	A	5	1	0.14	0.34
50.	*Cyanotis arachnoidea* Clarke	Commelinaceae	91	60	C	15.16	9.1	1.3	1.02
51.	*Cyanthillium cinereum* (Carl Linnaeus) H.Rob	Asteraceae	106	50	C	21.2	10.6	1.52	0.85
52.	*Cymbopogon citratus* (DC.) Stapf	Poaceae	58	20	A	29	5.8	0.83	0.34
53.	*Cyperus*	Cyperaceae	79	20	A	39.5	7.9	1.13	0.34

S. No.	Plant Name	Family	Total no of Individuals in all quadrate	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
	difformis L.								
54.	*Cyperus rotundus* L.	Cyperaceae	121	40	B	30.25	12.1	1.73	0.68
55.	*Cyperus stoloniferus* Retz.	Cyperaceae	181	40	B	45.25	18.1	2.59	0.68
56.	*Cystisus scoparius* (L.) Link	Fabaceae	17	10	A	17	1.7	0.24	0.17
57.	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	79	20	A	39.5	7.9	1.13	0.34
58.	*Daphniphyllum neilgherrense* (Wight) K. Rosenthal	Daphniphyllaceae	18	20	A	9	1.8	0.26	0.34
59.	*Debregeasia longifolia* (Burm. f.) Wedd	Urticaceae	7	10	A	7	0.7	0.1	0.17
60.	*Decalepis nervosa* (Wight & Arn.) Venter	Apocynaceae	21	30	B	7	2.1	0.3	0.51
61.	*Decaloba leschenaultii* (DC.) M. Roem.	Passifloraceae	51	50	C	10.2	5.1	0.73	0.85
62.	*Dendrophthoe neelgherrensis* (Wight & Arn.) Tiegh.	Loranthaceae	10	20	A	5	1	0.14	0.34
63.	*Digrocephala integerifolia* (L. f.) Kuntze	Asteraceae	18	10	A	18	1.8	0.26	0.17
64.	*Dodonaea viscosa* Jacq.	Sapindaceae	33	20	A	16.5	3.3	0.47	0.34
65.	*Drymaria cordata* (L.) Willd. ex Roem & Schult.	Caryophyllaceae	15	10	A	15	1.5	0.21	0.17
66.	*Elaeagnus*	Elaeagnaceae	29	40	B	7.25	2.9	0.42	0.68

S. No.	Plant Name	Family	Total no of Individuals in all quadrate	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
	kolaga Schltdl.								
67.	*Elaeocarpus munroii* Mast.	Elaeocarpaceae	12	30	B	4	1.2	0.17	0.51
68.	*Elaeocarpus tuberculatus* Roxb.	Elaeocarpaceae	3	10	A	3	0.3	0.04	0.17
69.	*Elaeocarpus variabilis* Zmarzty	Elaeocarpaceae	40	80	D	5	4	0.57	1.37
70.	*Elatostema sessile* J.R. Forster & G. Forster	Urticaceae	160	40	B	40	16	2.29	0.68
71.	*Eleusine indica* (L.) Gaertn.	Poaceae	26	10	A	26	2.6	0.37	0.17
72.	*Erigeron karvinskianus* DC	Asteraceae	133	40	B	33.25	13.3	1.9	0.68
73.	*Eucalyptus grandis* W. Hill.	Myrtaceae	47	40	B	11.75	4.7	0.67	0.68
74.	*Eucalyptus tereticornis* Sm.	Myrtaceae	65	90	E	7.22	6.5	0.93	1.54
75.	*Euonymus crenulatus* Wall. ex Wight & Arn.	Celastraceae	10	20	A	5	1	0.14	0.34
76.	*Euphorbia pulcherrima* Willd. ex Klotzsch	Euphorbiaceae	6	10	A	6	0.6	0.09	0.17
77.	*Euphorbia rothiana* Spreng.	Euphorbuiaceae	40	20	A	20	4	0.57	0.34
78.	*Fagraea ceilanica* Thumb.	Genitanaceae	4	10	A	4	0.4	0.06	0.17
79.	*Ficus drupacea* Thunb.	Moraceae	1	10	A	1	0.1	0.01	0.17
80.	*Flacourtia indica* (Burm.	Salicaceae	6	20	A	3	0.6	0.09	0.34

S. No.	Plant Name	Family	Total no of Individuals in all quadrate	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
	F) Merr.								
81.	*Galinsoga parviflora* Cav.	Asteraceae	102	30	B	34	10.2	1.46	0.51
82.	*Gardneria ovata* Wall.	Loganiaceae	11	30	B	3.66	1.1	0.16	0.51
83.	*Glochidion ellipticum* Wight	Euphorbiaceae	4	20	A	2	0.4	0.06	0.34
84.	*Gnetum ula* Brongn.	Gnetaceae	4	10	A	4	0.4	0.06	0.17
85.	*Gomphandra coriacea* Wight.	Stemonuraceae	7	20	A	3.5	0.7	0.1	0.34
86.	*Goniothalamus wynaadensis* (Bedd.) Bedd.	Annonaceae	8	20	A	4	0.8	0.11	0.34
87.	*Grevillea robusta* A.Cunn. ex R.Br.	Proteaceae	3	20	A	1.5	0.3	0.04	0.34
88.	*Hedyotis swertioides* Hook. f.	Rubiaceae	58	60	C	9.66	5.8	0.83	1.02
89.	*Hydrocotyle conferta* Wight	Apiaceae	52	20	A	26	5.2	0.74	0.34
90.	*Hydrocotyle javanica* Thumb.	Apiaceae	122	40	B	30.5	12.2	1.75	0.68
91.	*Hypericum japonicum* Thunb. ex Murr.	Hypericaceae	16	30	B	5.33	1.6	0.23	0.51
92.	*Ilex denticulata* Wall.	Aquifoliaceae	5	20	A	2.5	0.5	0.07	0.34
93.	*Impatiens aquatica* Bhaskar	Balsaminaceae	113	20	A	56.5	11.3	1.62	0.34
94.	*Ipomea cairica* (L.) Sweet	Convolvulaceae	14	50	C	2.8	1.4	0.2	0.85
95.	*Isodon coeste* (Buch.-Ham. ex	Lamiaceae	21	30	B	7	2.1	0.3	0.51

S. No.	Plant Name	Family	Total no of Individuals in all quadrate	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
	D. Don) Kudo								
96.	*Isonandra perrottetiana* A. DC.	Sapotaceae	3	20	A	1.5	0.3	0.04	0.34
97.	*Jasminum brevilobum* DC	Oleaceae	5	40	B	1.25	0.5	0.07	0.68
98.	*Jasminum coarctatum* Roxb.	Oleaceae	4	20	A	2	0.4	0.06	0.34
99.	*Justicia japonica Thumb.*	Acanthaceae	89	50	C	17.8	8.9	1.27	0.85
100.	*Kyllinga melanosperma* Nees.	Cyperaceae	12	20	A	6	1.2	0.17	0.34
101.	*Lactuca serriola* L.	Asteraceae	9	10	A	9	0.9	0.13	0.17
102.	*Lantana camera* L.	Verbinaceae	82	60	C	13.66	8.2	1.17	1.02
103.	*Lasianthus acuminates* Wight	Rubiaceae	4	10	A	4	0.4	0.06	0.17
104.	*Leucas aspera* (Willd.) Link	Lamiaceae	114	50	C	22.8	11.4	1.63	0.85
105.	*Leucas chinensis* (Retz.) Sm.	Lamiaceae	34	20	A	17	3.4	0.49	0.34
106.	*Leucas lamiifolia* Dest.	Lamiaceae	8	20	A	4	0.8	0.11	0.34
107.	*Listea floribunda* (Bl.) Gamble	Lauraceae	24	50	C	4.8	2.4	0.34	0.85
108.	*Litsea glabrata* (Wall ex Nees.) Hook. Fil.	Lauraceae	13	40	B	3.25	1.3	0.19	0.68
109.	*Litsea stocksii* (Meisn) Hook.f	Lauraceae	4	30	B	1.33	0.4	0.06	0.51
110.	*Litsea wightiana* (Nees) Benth &	Lauraceae	12	40	B	3	1.2	0.17	0.68

S. No.	Plant Name	Family	Total no of Individuals in all quadrate	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
	Hook. Fil.								
111.	*Lobelia leschenaultiana* (Presl.) Skottsb.	Campanulaceae	12	40	B	3	1.2	0.17	0.68
112.	*Magnolia nilagirica* Zenker	Magnoliaceae	24	50	C	4.8	2.4	0.34	0.85
113.	*Mahonia napaulensis* DC.	Berberidaceae	9	40	B	2.25	0.9	0.13	0.68
114.	*Meliosma pinnata* (Roxb.) Walp. *ssp. barbulata* (Cufod.) Beus.	Sabiaceae	5	40	B	1.25	0.5	0.07	0.68
115.	*Memecylon edule Roxb.*	Melastomataceae	5	20	A	2.5	0.5	0.07	0.34
116.	*Memecylon sisparense* Gamble	Melastomataceae	7	20	A	3.5	0.7	0.1	0.34
117.	*Microtropis ramiflora* Wight	Celastraceae	2	20	A	1	0.2	0.03	0.34
118.	*Mikania micarantha* Kunth	Asteraceae	6	20	A	3	0.6	0.08	0.34
119.	*Mitragyna speciosa* (Korth.) Havil.	Rubiaceae	6	20	A	3	0.6	0.08	0.34
120.	*Myrsine wightiana* Wall.	Myrsinaceae	10	50	C	2	1	0.14	0.85
121.	*Neolistsea foliosa* (Nees) Gamble	Lauraceae	18	30	B	6	1.8	0.26	0.51
122.	*Neolitsea cassia* (L.) Kosterm.	Lauraceae	23	50	C	4.6	2.3	0.33	0.85
123.	*Neolitsea scrobiculata* (Meisner)	Lauraceae	8	40	B	2	0.8	0.11	0.68

S. No.	Plant Name	Family	Total no of Individuals in all quadrate	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
	Gamble.								
124.	*Neonatis monosperma* (Wight & Arn.) W.H.Lewis	Rubiaceae	46	50	C	9.2	4.6	0.66	0.85
125.	*Nephrolipis* Sp.	Pteridophytes	82	30	B	27.33	8.2	1.17	0.51
126.	*Osbeckia branchystemon* Naud.	Melastomataceae	18	40	B	4.5	1.8	0.26	0.68
127.	*Osbeckia reticulata* Bedd.	Melastomataceae	15	20	A	7.5	1.5	0.21	0.34
128.	*Oxalis corniculata* L.	Oxalidaceae	273	70	D	39	27.3	3.91	1.19
129.	*Parsonsia alboflavescens* (Dennst.) Mabb.	Apocynaceae	4	20	A	2	0.4	0.06	0.34
130.	*Passiflora mollissima* (Kunth.) Bailey	Passifloraceae	15	30	B	5	1.5	0.21	0.51
131.	*Passiflora subpeltata* Ortega	Passifloraceae	9	40	B	2.25	0.9	0.13	0.68
132.	*Peperomia tetraphylla* (G.Forst.) Hook. & Arn.	Peperaceae	176	40	B	44	17.6	2.5	0.68
133.	*Peperomina blanda* (Jacq.) Kunth	Piperaceae	94	30	B	31.33	9.4	1.3	0.51
134.	*Photinia integrifolia* Lindl. var. sub-*lanceolata* Miq.	Rosaceae	7	20	A	3.5	0.7	0.1	0.34
135.	*Phytolacca icosandra* L.	Phytolacaceae	37	40	B	9.25	3.7	0.53	0.68
136.	*Pinus* Sp.	Gymnosperm	4	10	A	4	0.4	0.06	0.17
137.	*Piper mullesua* Buch.-Ham. ex D. Don	Piperaceae	84	60	C	14	8.4	1.2	1.02

S. No.	Plant Name	Family	Total no of Individuals in all quadrate	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
138.	*Piper trichostachyon* (Miq.) C. DC.	Piperaceae	25	30	B	8.33	2.5	0.36	0.51
139.	*Piper wightii* Miq.	Piperaceae	18	40	B	4.5	1.8	0.26	0.68
140.	*Pittosporum neelgherrense* Wight & Arn.	Pittosporaceae	10	40	B	2.5	1	0.14	0.68
141.	*Pogostemon wightii* Benth.	Lamiaceae	88	70	D	12.57	8.8	1.26	1.19
142.	*Polygala arillata Buch.-* Ham. ex D. Don	Polygalaceae	8	20	A	4	0.8	0.11	0.34
143.	*Polystricum* Sp.	Pteridophytes	38	20	A	19	3.8	0.54	0.34
144.	*Prunus ceylanica* (Wight) Miq.	Rosaceae	4	10	A	4	0.4	0.06	0.17
145.	*Psidium guajava* L.	Myrtaceae	4	10	A	4	0.4	0.06	0.17
146.	*Psychotria sohmeri* Kiehn	Rubiaceae	20	40	B	5	2	0.23	0.68
147.	*Rapanea daphnoides* Mez.	Myrsinaceae	10	20	A	5	1	0.14	0.34
148.	*Rapanea wightiana* (Wall. ex A. DC.) Mez.	Myrsinaceae	7	20	A	3.5	0.7	0.1	0.34
149.	*Rhododendron arboreum* Sm. ssp. *nilagiricum* (Zenker) Tagg	Ericaceae	13	40	B	3.25	1.3	0.19	0.68
150.	*Rhodomyrtus tomentosa* (Aiton) Hassk.	Myrtaceae	6	10	A	6	0.6	0.08	0.17
151.	*Rosa leshenaultiana* Red & Thory ex Wight & Arn	Rosaceae	5	40	B	1.25	0.5	0.07	0.68

S. No.	Plant Name	Family	Total no of Individuals in all quadrate	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
152.	*Rotala rotundifolia* (Bunch.-Ham. Ex Roxb) Koehne.	Lythraceae	47	20	A	23.5	4.7	0.67	0.34
153.	*Rubia cordifolia* L.	Rubiaceae	24	40	B	6	2.4	0.34	0.68
154.	*Rubus ellipticus* Sm.	Rosaceae	12	30	B	4	1.2	0.17	0.51
155.	*Rubus fairholmianus* Gardn.	Rosaceae	15	50	C	3	1.5	0.21	0.85
156.	*Rubus racemosus* Roxb.	Rosaceae	6	20	A	3	0.6	0.08	0.34
157.	*Ruta graveolens* L.	Rutaceae	9	20	A	4.5	0.9	0.13	0.34
158.	*Sarcococca saligna* Muell. Arg	Buxaceae	3	20	A	1.5	0.3	0.04	0.34
159.	*Schefflera capitata* (Wight & Arn.) Harms	Araliaceae	8	20	A	4	0.8	0.11	0.34
160.	*Schefflera racemosa* (Wight) Harms	Araliaceae	29	50	C	5.8	2.9	0.41	0.85
161.	*Schefflera rostrata* (Whight) Harms	Araliaceae	6	10	A	6	0.6	0.08	0.17
162.	*Senna septemtrionalis* (Viv.) H. S. Irwin & Bameby	Fabaceae	15	30	B	5	1.5	0.21	0.51
163.	*Simlax aspera L.*	Smilacaceae	20	50	C	4	2	0.29	0.85
164.	*Smilax wightii* A. D.C.	Smilacaceae	5	30	B	1.66	0.5	0.71	0.51
165.	*Solanum laxum*	Solanaceae	6	40	B	1.5	0.6	0.086	0.68

S. No.	Plant Name	Family	Total no of Individuals in all quadrate	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
	Spreng.								
166.	*Solanum mauritianum* Scop.	Solanaceae	45	60	C	7.5	4.5	0.64	1.02
167.	*Solanum pseudo-capsicum* L.	Solanaceae	27	20	A	13.5	2.7	0.39	0.34
168.	*Solanum sisymbrifolium* Lam.	Solanaceae	41	20	A	20.5	4.1	0.59	0.34
169.	*Solanum virginianum* L.	Solanaceae	83	60	C	13.83	8.3	1.19	1.02
170.	*Spermacoce ocymoides* Burm. F.	Rubiaceae	40	20	A	20	4	0.57	0.34
171.	*Strobilanthes cansanguinea* (Nees) T. Anders.	Acanthaceae	46	30	B	15.33	4.6	0.66	0.51
172.	*Strobilanthus cuspidatus* (Benth.) Anders	Acanthaceae	6	10	A	6	0.6	0.09	0.17
173.	*Strobilanthus lanata* Nees	Acanthaceae	39	30	B	13	3.9	0.56	0.51
174.	*Symplocos cochinchinensis* Moore subsp. *Laurina (Retz.)*	Symplocaceae	10	20	A	5	1	0.14	0.34
175.	*Symplocos pendula* Wight.	Symplocaceae	8	20	A	4	0.8	0.11	0.34
176.	*Syzygium cumini* (L.) Skeels.	Myrtaceae	27	50	C	5.4	2.7	0.39	0.85
177.	*Syzygium denisflorum* Wall ex Wt. & Arn.	Myrtaceae	15	30	B	5	1.5	0.21	0.51
178.	*Taraxacum javanicum*	Asteraceae	61	30	B	20.33	6.1	0.87	0.51

S. No.	Plant Name	Family	Total no of Individuals in all quadrate	Freq.	Freq. Class	Abundance	Density	Relative Density	Relative frequency
	Soest								
179.	*Tarenna asiatica* (L.) Kuntze ex K. Schum,. var. asiatica forma rigida (Wight)	Rubiaceae	5	40	B	1.25	0.5	0.07	0.68
180.	*Thunbergia fragrans* Roxb.	Acanthaceae	4	10	A	4	0.4	0.06	0.17
181.	*Ventilago madraspatana* Gaertn.	Rhamnaceae	7	40	B	1.75	0.7	0.1	0.68
182.	*Viburnum erubescens* Wall. Ex.DC	Adoxaceae	4	20	A	2	0.4	0.06	0.34
183.	*Xerochrysum bracteatum* (Vent.) Tzvelev	Asteraceae	117	70	D	25.28	11.7	1.68	1.19
184.	*Zanthoxylum asiaticum* (L.) Appelhans, Groppo & J.Wen	Rutaceae	46	60	C	7.6	4.6	0.66	1.02

Floristic composition

Field survey conducted at Sillahalla Pumped Storage Hydro-Electric Project (PSHEP) in the Nilgiris District of Tamil Nadu, the plant species were recorded across different seasons (Post-Monsoon, Pre-Monsoon, and Monsoon), using both primary (field surveys) and secondary sources (published literature, interviews with locals and stakeholders) listed in Table-3.30 and Graphical analysis shown in Figure-3.24.

Table-3.30: Different life form of the plant species recorded in the study area, during three seasons (Post-Monsoon, Pre-Monsoon & Monsoon)

Habitat	Number of Species
Climbers	20
Ferns	3
Grasses	13
Herbs	47
Shrubs	40
Trees	64
Total	**187**

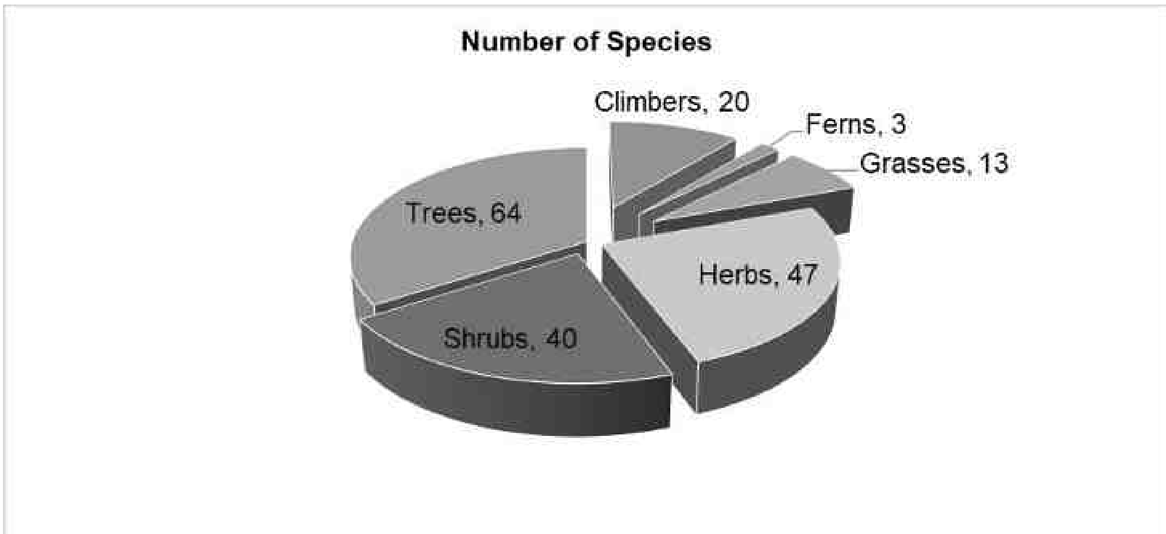


Figure-3.24: Graphical analysis the total number of trees, shrubs, herbs, ferns, grasses and climbers were recorded in the study sites, during three seasons (Post-Monsoon, Pre-Monsoon & Monsoon)

Plant list

From the floristic survey and secondary sources such as published literature, Interviews with local residents, and stakeholders, during three seasons (Post-Monsoon, Pre-monsoon & Monsoon), a total of 187 plant species belong to 71 families recorded from study areas, listed in Table-3.31. The dominant plant families recorded during three seasons (Post-Monsoon, Pre-Monsoon & Monsoon) were Asteraceae (20) followed by Lauraceae (12), Poaceae (13), Cyperaceae &

Rubiaceae (9), Acanthaceae, Rosaceae, Myrtaceae & Solanaceae (6), and Fabaceae, Lamiaceae, & Piperaceae (5), Graphical analysis shown in Figure-3.25.

Table-3.31: Plant species recorded in study areas, during three seasons (Post-Monsoon, Pre-monsoon & Monsoon)

Botanical Name	Family	Local/ Common Name	Habitat	IUCN Status	Division
Angiosperms					
Acacia mearnsii De Wild.	Fabaceae	Karuvel	Tree	-	Dicot
Achyranthes aspera var. *Rubrofusca* (Wight) Hook. f.	Amaranthaceae	Chirchita	Herb	-	Dicot
Ageratina adenophora (Spreng.) King & H.Rob.	Asteraceae	Catweed	Herb	-	Dicot
Ageratum conyzoides L.	Asteraceae	Jangli pudina	Herb	-	Dicot
Ageratum houstonianum Mill.	Asteraceae	Blue mink	Herb	-	Dicot
Alloteropsis cimicina (L.) Stapf	Poaceae	Cockatoo grass	Grass	-	Monocot
Alnus nepalensis D.Don	Betulaceae	Nepalese alder	Tree	LC	Dicot
Aloe arborescens Mill.	Asphodelaceae	Krantz aloe	Shrub	LC	Dicot
Alstonia venenata R. Br.	Apocynaceae	Edakaulapala	Shrub	-	Dicot
Andrographis alata (Vahl.) Nees	Acanthaceae	Bhui-neem	Herb	-	Dicot
Andropogon lividus Thwaites	Poaceae	-	Grass	-	Monocot
Aphloia theiformis (Vahl) Benn.	Flacourtiaceae	-	Shrub	LC	Dicot
Argreia coonoorensis W. W. Smith and Ramos.	Convolvulaceae	Ghav bel	Climber	-	Dicot
Argyreia hirsuta Wight & Arn.	Convolvulaceae	-	Climber	-	Dicot
Arisaema leschenaultii Blume	Araceae	Paambukkodi	Herb	-	Monocot
Artemisia nilagarica (Clarke) Pamp.	Asteraceae	Mugwort	Herb	-	Dicot
Arundinella ciliata (Roxb.) Nees ex Miq.	Poaceae	-	Grass	-	Monocot
Arundinella mesophylla	Poaceae	-	Grass	-	Mon

Botanical Name	Family	Local/ Common Name	Habitat	IUCN Status	Division
Nees ex Steud.					ocot
Asparagus fysonii J.F.Macbr.	Asparagaceae	Shatavari	Herb	-	Dicot
Beilschmiedia wightii (Nees) Benth. ex Hook. f.	Lauraceae	-	Tree	NT	Dicot
Berberis tinctoria Leschen	Berberidaceae	-	Shrub	-	Dicot
Bidens pilosa L.	Asterraceae	Spanish Needles	Herb	-	Dicot
Caesalpinia decapetala (Roth) Alston	Fabaceae	Kingan	Shrub	LC	Dicot
Canthium neilgherrense Wight	Rubiaceae	-	Tree	-	Dicot
Casearia zeylanica Thwaites	Salicaceae	Saptrangi	Shrub	-	Dicot
Cassine paniculata (Wight & Arn.) Lobr.-Callen	Celastraceae	Tanneermaram	Tree	-	Dicot
Celastrus paniculatus Willd.	Celastraceae	Jyotishmati	Climber	-	Dicot
Celtis tetrandra Roxb.	Ulmaceae	Khirk	Tree	LC	Dicot
Cenchrus biflorus Roxb.	Poaceae	Bhurut	Grass	-	Monocot
Centella asiatica (L.) Urb.	Apiaceae	Vallarai	Herb	LC	Dicot
Cestrum aurantiacum Lindl.	Solanaceae		Shrub	LC	Dicot
Chamaemelum nobile (L.) All.	Asteraceae	Chamomile	Herb	LC	Dicot
Chionanthus ramiflorus Roxb.	Oleaceae	-	Tree	DD	Dicot
Chrysopogon zeylanicus (Steud.) Thwaites	Poaceae	-	Grass	-	Monocot
Cinnamomum sulphuratum Nees	Lauraceae	Pinga dalchini	Tree	VU	Dicot
Cinnamomum wightii Meisner	Lauraceae		Tree	EN	Dicot
Cirsium wallichii DC	Asterraceae	Bungsee	Tree	-	Dicot
Cissampelopsis corymbosa (Wall. ex DC.) C.Jeffrey & Y.L.Chen	Asteraceae	-	Shrub	-	Dicot
Cissampelopsis walkeri (Arn.) C. Jeffrey & Y.L.	Asteraceae	-	Climber	-	Dicot

Botanical Name	Family	Local/ Common Name	Habitat	IUCN Status	Divi sion
Chen					
Clematis zeylanica (L.) Poir.	Ranunculaceae	Dhanavalli	Climber	-	Dicot
Commelina clavate C. B. Clarke	Commelinaceae	-	Herb	-	Dicot
Commelina hirsuta (Wight) Bedd.	Commelinaceae	Jalbhu	Herb	-	Dicot
Conyz bonariensis (L.) Cronquist	Asteraceae	Hairy fleabane	Herb	-	Dicot
Cotula australis (Sieber ex Spreng.) Hook.	Asteraceae	-	Herb	-	Dicot
Crassocephalum crepidioides (Benth) S. Moore	Asteraceae	Lalphulnu ghaa	Herb	-	Dicot
Crotalaria formosa Graham ex Wight & Arn.	Fabaceae	-	Herb	LC	Dicot
Cryptocarya lawsonii Gamble	Lauraceae	-	Tree	VU	Dicot
Cyanotis arachnoidea Clarke	Commelinaceae	Spiderdew grass	Herb	-	Dicot
Cyanthillium cinereum (Carl Linnaeus) H.Rob	Asteraceae	Sahadevi	Herb	-	Dicot
Cymbopogon citratus (DC.) Stapf	Poaceae	-	Grass	-	Mon ocot
Cyperus difformis L.	Cyperaceae	Motha	Grass	LC	Mon ocot
Cyperus rotundus L.	Cyperaceae	Nagarmotha	Grass	LC	Mon ocot
Cyperus stoloniferus Retz.	Cyperaceae	Mustaka	Grass	LC	Mon ocot
Cystisus scoparius (L.) Link	Fabaceae	-	Shrub	-	Dicot
Dactyloctenium aegyptium (L.) Willd.	Poaceae	Madana	Grass	-	Mon ocot
Daphniphyllum neilgherrense (Wight) K. Rosenthal	Daphniphyllaceae	-	Tree	-	Dicot
Debregeasia longifolia (Burm. f.) Wedd	Urticaceae	Bichhoo	Shrub	LC	Dicot

Botanical Name	Family	Local/ Common Name	Habitat	IUCN Status	Divi sion
Decalepis nervosa (Wight & Arn.) Venter	Apocynaceae	-	Climber	-	Dicot
Decaloba leschenaultii (DC.) M. Roem.	Passifloraceae	Akasavellari	Climber	-	Dicot
Dendrophthoe neelgherrensis (Wight & Arn.) Tiegh.	Loranthaceae	-	Climber	-	Dicot
Dichrocephala integrifolia (L. f.) Kuntze	Asteraceae	Bicolor buttonhead	Herb	-	Dicot
Dodonaea viscosa Jacq.	Sapindaceae	Vilayti	Herb	LC	Dicot
Drymaria cordata (L.) Willd. ex Roem & Schult.	Caryophyllaceae	-	Herb	-	Dicot
Elaeagnus kolaga Schltdl.	Elaeagnaceae	-	Shrub	-	Dicot
Elaeocarpus munroii Mast.	Elaeocarpaceae	Narebikki	Tree	NT	Dicot
Elaeocarpus tuberculatus Roxb.	Elaeocarpaceae	Rudraksha	Tree	-	Dicot
Elaeocarpus variabilis Zmarzty	Elaeocarpaceae	-	Tree	-	Dicot
Elatostema sessile J.R. Forster & G. Forster	Urticaceae	-	Shrub	LC	Dicot
Eleusine indica (L.) Gaertn.	Poaceae	Jhingari	Grass	LC	Mon ocot
Erigeron karvinskianus DC	Asteraceae		Herb		Dicot
Eucalyptus grandis W. Hill.	Myrtaceae	Eucalyptus	Tree	NT	Dicot
Eucalyptus tereticornis Sm.	Myrtaceae	Forest red gum	Tree	LC	Dicot
Euonymus crenulatus Wall. ex Wight & Arn.	Celastraceae	-	Shrub	-	Dicot
Euphorbia pulcherrima Willd. ex Klotzsch	Euphorbiaceae	Poinsettia	Shrub	LC	Dicot
Euphorbia rothiana Spreng.	Euphorbuiaceae	Spurge	Shrub	-	Dicot
Fagraea ceilanica Thumb.	Genitanaceae	-	Tree	LC	Dicot
Ficus drupacea Thunb.	Moraceae	Mysore fig	Tree	LC	Dicot
Flacourtia indica (Burm. F) Merr.	Salicaceae	Bilangada	Tree	LC	Dicot
Galinsoga parviflora Cav.	Asteraceae	Peepali	Herb	-	Dicot
Gardneria ovata Wall.	Loganiaceae	-	Shrub	-	Dicot
Glochidion ellipticum Wight	Euphorbiaceae	Bhoma	Tree	-	Dicot
Gomphandra coriacea	Stemonuraceae	-	Tree	-	Dicot

Botanical Name	Family	Local/ Common Name	Habitat	IUCN Status	Divi sion
Wight.					
Goniothalamus wynaadensis (Bedd.) Bedd.	Annonaceae	Aanapanal	Shrub	NT	Dicot
Grevillea robusta A.Cunn. ex R.Br.	Proteaceae	Silky oak	Tree	LC	Dicot
Hedyotis swietenioides Hook. f.	Rubiaceae		Shrub		Dicot
Hydrocotyle conferta Wight	Apiaceae	Pennywort	Herb	EN	Dicot
Hydrocotyle javanica Thumb.	Apiaceae	Java pennywort	Herb	LC	Dicot
Hypericum japonicum Thunb. ex Murr.	Hypericaceae	-	Herb	-	Dicot
Ilex denticulata Wall.	Aquifoliaceae	-	Tree	-	Dicot
Impatiens aquatica Bhaskar	Balsaminaceae	-	Herb	-	Dicot
Ipomea cairica (L.) Sweet	Convolvulaceae	-	Climber	-	Dicot
Isodon coeste (Buch.-Ham. ex D. Don) Kudo	Lamiaceae	Himachali	Shrub	-	Dicot
Isonandra perrottetiana A. DC.	Sapotaceae	-	Tree	LC	Dicot
Jasminum brevilobum DC	Oleaceae	-	Shrub	-	Dicot
Jasminum coarctatum Roxb.	Oleaceae	Vanamallige	Shrub	-	Dicot
Justicia japonica Thumb.	Acanthaceae		Herb	-	Dicot
Kyllinga melanosperma Nees.	Cyperaceae	Baranagar motha	Grass	LC	Mon ocot
Lactuca serriola L.	Asteraceae	Kakubha	Herb	-	Dicot
Lantana camera L.	Verbinaceae	Raimuniya	Shrub	-	Dicot
Lasianthus acuminates Wight	Rubiaceae		Tree	-	Dicot
Leucas aspera (Willd.) Link	Lamiaceae	Chota halkkusha	Herb	-	Dicot
Leucas chinensis (Retz.) Sm.	Lamiaceae	-	Herb	-	Dicot
Leucas linifolia Dest.	Lamiaceae	-	Herb	-	Dicot
Listea floribunda (Bl.) Gamble	Lauraceae	-	Tree	-	Dicot
Litsea glabrata (Wall ex Nees.) Hook. Fil.	Lauraceae	-	Tree	LC	Dicot

Botanical Name	Family	Local/ Common Name	Habitat	IUCN Status	Divi sion
Litsea stocksii (Meisn) Hook.f	Lauraceae	-	Tree	NT	Dicot
Litsea stocksii (Meisn) Hook.f	Lauraceae	-	Tree	NT	Dicot
Litsea wightiana (Nees) Benth & Hook. Fil.	Lauraceae	-	Tree	NT	Dicot
Lobelia leschenaultiana (Presl.) Skottsb.	Campanulaceae	-	Shrub	-	Dicot
Lobelia leschenaultiana (Presl.) Skottsb.	Campanulaceae	-	Shrub	-	Dicot
Magnolia nilagirica Zenker	Magnoliaceae	Pila champa	Tree	VU	Dicot
Mahonia napaulensis DC.	Berberidaceae	Jamane mandro	Tree	-	Dicot
Meliosma pinnata (Roxb.)	Sabiaceae	Thagari	Tree	-	Dicot
Memecylon edule Roxb.	Melastomataceae	Anjan	Tree	LC	Dicot
Memecylon sisparense Gamble	Melastomataceae	-	Tree	CR	Dicot
Michelia nilagirica Zenker	Magnoliaceae	Champa	Tree	VU	Dicot
Microtropis ramiflora Wight	Celastraceae	-	Tree	-	Dicot
Mikania micrantha Kunth	Asteraceae	-	Climber	-	Dicot
Mitragyna speciosa (Korth.) Havil.	Rubiaceae	Kratom	Tree	LC	Dicot
Myrsine wightiana Wall.	Myrsinaceae		Tree		Dicot
Neolitsea cassia (L.) Kosterm.	Lauraceae	Belori	Tree	LC	Dicot
*Neolitsea foliosa (*Nees) Gamble	Lauraceae	-	Tree	LC	Dicot
Neolitsea scrobiculata (Meisner) Gamble.	Lauraceae	-	Tree	-	Dicot
Neonatis monosperma (Wight & Arn.) W.H.Lewis	Rubiaceae	-	Tree	-	Dicot
Osbeckia branchystemon Naud.	Melastomataceae	-	Herb	-	Dicot
Osbeckia reticulata Bedd.	Melastomataceae	-	Shrub	-	Dicot
Oxalis corniculata L.	Oxalidaceae	Indian sorrel	Herb	-	Dicot
Parsonsia alboflavescens (Dennst.) Mabb.	Apocynaceae	-	Climber	-	Dicot
Passiflora mollissima	Passifloraceae	-	Climber	-	Dicot

Botanical Name	Family	Local/ Common Name	Habitat	IUCN Status	Divi sion
(Kunth.) Bailey					
Passiflora subpeltata Ortega	Passifloraceae	-	Climber	-	Dicot
Peperomia tetraphylla (G.Forst.) Hook. & Arn.	Piperaceae	-	Herb	-	Dicot
Peperomina blanda (Jacq.) Kunth	Piperaceae	-	Herb	-	Dicot
Photinia integrifolia Lindl. var. sub-*lanceolata* Miq.	Rosaceae	-	Tree	LC	Dicot
Phytolacca icosandra L.	Phytolacaceae	-	Herb	-	Dicot
Piper mullesua Buch.-Ham. ex D. Don	Piperaceae	Wild pepper	Climber	-	Dicot
Piper trichostachyon (Miq.) C. DC.	Piperaceae	Kali Mirch	Climber	-	Dicot
Piper wightii Miq.	Piperaceae	-	Climber	-	Dicot
Pittosporum neelgherrense Wight & Arn.	Pittosporaceae	-	Tree	-	Dicot
Pogostemon wightii Benth.	Lamiaceae	-	Herb	LC	Dicot
Polygala arillata Buch.-Ham. ex D. Don	Polygalaceae	-	Shrub	LC	Dicot
Prunus ceylanica (Wight) Miq.	Rosaceae	Wild cherry	Tree	EN	Dicot
Psidium guajava L.	Myrtaceae	Amrudh	Tree	LC	Dicot
Psychotria sohmeri Kiehn	Rubiaceae	-	Shrub	-	Dicot
Rapanea daphnoides Mez.	Myrsinaceae	-	Tree	-	Dicot
*Rapanea wightiana (*Wall. ex A. DC.) Mez.	Myrsinaceae	-	Tree	-	Dicot
Rhododendron arboreum Sm.	Ericaceae	Burans	Tree	LC	Dicot
Rhodomyrtus tomentosa (Aiton) Hassk.	Myrtaceae	Rose myrtle	Shrub	LC	Dicot
Rosa leschenaultiana Red & Thory ex Wight & Arn	Rosaceae	Kattursoa	Climber	-	Dicot
Rubia cordifolia L.	Rubiaceae	-	Herb	-	Dicot
Rubus ellipticus Sm.	Rosaceae	Hinsal	Shrub	LC	Dicot
Rubus fairholmianus Gardn.	Rosaceae	-	Shrub	-	Dicot
Rubus racemosus Roxb.	Rosaceae	-	Shrub	-	Dicot

Botanical Name	Family	Local/ Common Name	Habitat	IUCN Status	Divi sion
Ruta graveolens L.	Rutaceae	Nagadalli	Herb	-	Dicot
Sarcococca saligna Muell. Arg	Buxaceae	Tiliara	Tree	-	Dicot
Schefflera capitata (Wight & Arn.) Harms	Araliaceae	-	Tree	-	Dicot
Schefflera racemosa (Wight) Harms	Araliaceae	-	Tree	-	Dicot
Schefflera rostrata (Whight) Harms	Araliaceae	-	Tree	-	Dicot
Senna septemtrionalis (Viv.) H. S. Irwin & Bameby	Fabaceae	Baraja	Shrub	LC	Dicot
Simlax aspera L.	Smilacaceae	Kukundara	Climber	-	Mon ocot
Smilax wightii A. D.C.	Smilacaceae	Kumarika	Climber	-	Mon ocot
Solanum laxum Spreng.	Solanaceae	-	Shrub	-	Dicot
Solanum mauritianum Scop.	Solanaceae	-	Shrub	-	Dicot
Solanum pseudo-capsicum L.	Solanaceae	-	Shrub	-	Dicot
*Solanum sisymbriifolium*Lam.	Solanaceae	Red buffalobur	Herb	-	Dicot
Solanum virginianum L.	Solanaceae		Herb	-	Dicot
Spermacoce ocymoides Burm. F.	Rubiaceae	Kuṭal churụkk	Herb	-	Dicot
Strobilanthes consanguinea(Nees) T. Anders.	Acanthaceae	-	Shrub	-	Dicot
Strobilanthes cuspidatus (Benth.) Anders	Acanthaceae	-	Shrub	-	Dicot
Strobilanthus lanata Nees	Acanthaceae	-	Shrub	-	Dicot
Symplocos cochinchinensis (Lour.) S.Moore	Symplocaceae	Sodh	Tree	-	Dicot
Symplocos pendula Wight.	Symplocaceae	Lodha	Tree	LC	Dicot
Syzygium cumini (L.) Skeels.	Myrtaceae	Jamun	Tree	LC	Dicot
Syzygium denisflorum Wall ex Wt. & Arn.	Myrtaceae	Nagay	Tree	-	Dicot

Botanical Name	Family	Local/ Common Name	Habitat	IUCN Status	Divi sion
Taraxacum javanicum Soest	Asteraceae	Baran	Herb	-	Dicot
Tarenna asiatica (L.) Kuntze ex K.Schum	Rubiaceae	Thaerani	Tree	LC	Dicot
Thunbergia fragrans Roxb.	Acanthaceae	Chimine	Climber	-	Dicot
Ventilago madraspatana Gaertn.	Rhamnaceae	Pitti	Shrub	-	Dicot
Viburnum erubescens Wall. Ex.DC	Adoxaceae	-	Herb	-	Dicot
Xerochrysum bracteatum (Vent.) Tzvelev	Asteraceae	-	Herb	-	Dicot
Zanthoxylum asiaticum (L.) Appelhans, Groppo & J.Wen	Rutaceae	-	Shrub	-	Dicot
Gymnosperms					
Cupressus funebris Endl.	Cupressaceae	Morpankhi	Tree	DD	-
Cupressus sp.	Cupressaceae	-	Tree	-	-
Gnetum ula Brongn.	Gnetaceae	Minjau	Tree	LC	-
Pinus sp.	Pinaceae	-	Tree	-	-
Pteridophytes					
Adiantum sp.	Adiantaceae	Fern	Fern	-	-
Nephrolipis sp.	Nephrolepidacea e	Fern	Fern	-	-
Polytrichum sp.	Polytrichaceae	Fern	Fern	-	-

Notes- LC=Least Concern, DD=Data Deficient, CR= Critically Endangered; EN= Endangered; NT=Near Threatened, - = Not Listed, Dicot= Cotyledons and Monocot= Monocotyledons; IUCN= International Union for Conservation of Nature

Source- Primary field survey and secondary sources such as published literature, Interviews with local residents)

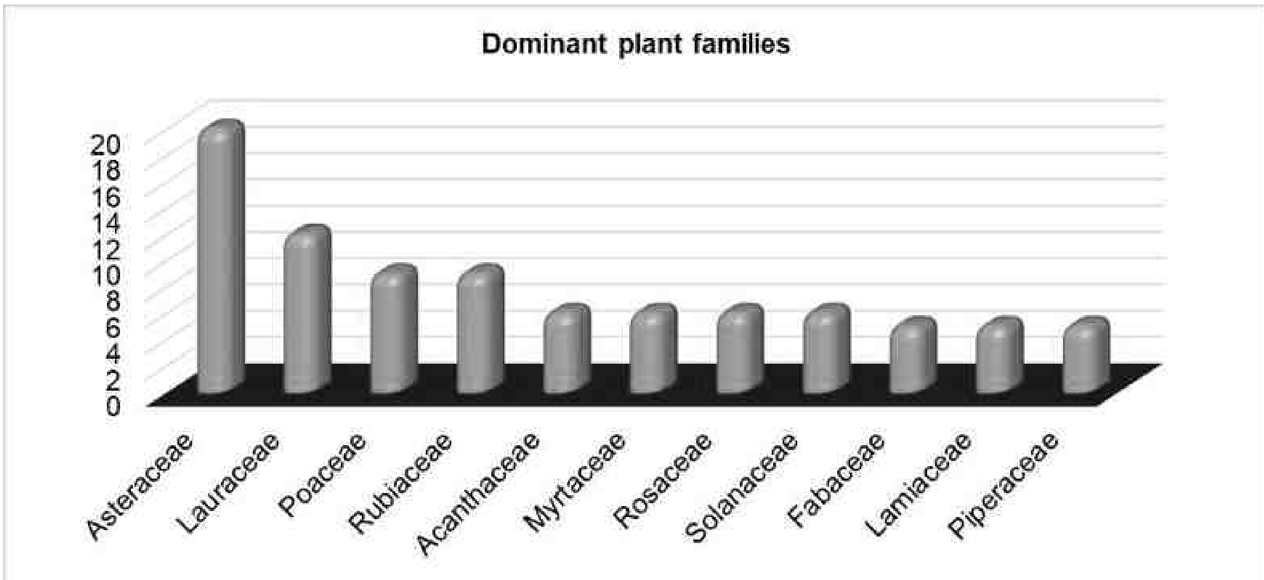


Figure-3.25: The dominant plant families recorded, during three seasons (Post-Monsoon, Pre-Monsoon & Monsoon)

Endemic plant species

The Nilgiri district of Tamil Nadu, part of the Nilgiri Biosphere Reserve, is rich floral diversity. Being a part of the Western Ghats, one of the world's biodiversity hotspots, the area is home to a unique collection of both endemic and non-endemic plant species. The reserve hosts around 3,300 species of flowering plants, with about 132 species identified as endemic. From primary sources (direct field observations) and secondary sources (published literature, interviews, and local citations), some endemic plant species recorded in the study area from field study is listed in **Table-3.32.**

Table-3.32: Endemic plant species recorded in the study area at Sillahalla Pumped Storage Hydro-Electric Project

Botanical Name	Family	Habitat	Local Name
Andrographis lobelioides	Acanthaceae	Herb	Lobelia chiretta
Nilgirianthus papillosus	Acanthaceae	Herb	-
Viburnum hebanthum	Adoxaceae	Herb	Badaga
Baeolepis nervosa	Apocynaceae	Herb	-
Arisaema auriculatum	Araceae	Herb	Cobra lily
Brachystelma maculatum	Asclepiadaceae	Herb	-
Caralluma nilagiriana	Asclepiadaceae	Herb	-
Anaphalis nilgiris	Asteraceae	Herb	Pearl
Commelina tricolor	Commelinaceae	Herb	Dayflower
Carex christii	Cyperaceae	Grass	-
Eriocaulon christopheri	Eriocaulaceae	Herb	-
Syzygium malabaricum	Myrtaceae	Tree	Malabar plum
Biophytum polyphyllum	Oxalidaceae	Herb	-
Andropogon longipes	Poaceae	Grass	Beard grass
Poa gamblei	Poaceae	Grass	Bluegrass
Brachiaria semiundulata	Poaceae	Grass	-
Hedyotis hirsutissima	Rubiaceae	Shrub	-
Pavetta brunonis	Rubiaceae	Shrub	-
Isonandra perrottetiana	Sapotaceae	Tree	Karimpala
Smilax wightii	Smilacaceae	Climber	Kumarika
Symplocos microphylla	Symplocaceae	Tree	Largeleaf sapphire berry
Bupleurum plantaginifolia	Umbelliferae	Shrub	-
Liparis biloba	Orchidaceae	Herb	-
Achyranthes aspera	Amaranthaceae	Herb	Chaff flower
Eriocaulon christopheri	Eriocaulaceae	Herb	-
Dalechampia velutina	Euphorbiaceae	Climber	Spurgecreeper
Loranthus recurvus	Loranthaceae	Tree	Mistletoe

Botanical Name	Family	Habitat	Local Name
Sonerila versicolor	Melastomataceae	Shrub	Colorful sonerila
Corymborkis veratrifolia	Orchidaceae	Herb	white cinnamon orchid

Sources- primary sources (direct field observations) and secondary sources (published literature, interviews, and local citations)

Medicinal Plant reported in the study area

Medicinal plants have been used for centuries by various cultures to treat numerous diseases in both humans and animals. Indigenous people, who live in close association with forests, have accumulated extensive knowledge about the utilization of these plant species. Traditional medicine, a collection of empirical practices, is deeply embedded in the knowledge of social groups and is often passed down orally from generation to generation to address health issues.

Local communities use plant species for their healthcare systems due to their logistical and economic benefits. These plants are used to treat conditions such as stomachic problems, diarrhea, dysentery, cough, cold, fever, asthma, and externally for rheumatism, skin diseases, cuts, boils, fractures, and injuries. The usage of various plant species by locals varies depending on the altitude and availability of resources in their surrounding areas. This traditional knowledge of medicinal plants is also becoming a valuable source of information for the pharmaceutical industry. Present study recorded some medicinal plant species used by Indigenous people in the study area is listed in Table-3.33.

Table-3.33: Medicinal plant species recorded in the study area

Botanical Name	Local/Common Name	Use(s)
Achyranthes aspera	Chirchita	Used to treat dysentery, asthma, hypertension, malarial fever, diabetes, piles, stomach troubles, and wounds
Ageratum conyzoides	Jangli pudina	Used for fever, rheumatism, headache, wounds caused by burns, dyspepsia, and eye problem
Ageratum houstonianum	Blue mink	Used to curing fever, and wound healing

Botanical Name	Local/Common Name	Use(s)
Aloe arborescens	krantz aloe	Used for curing wound healing, anti-bacterial, and anti-inflammatory
Alstonia venenata	Vishagni	Used to treatment of malaria, dysentery, asthma, fever, epilepsy, skin diseases, and snake bites
Andrographis alata	Bhunimbh	Used to curing fever, upper respiratory tract infection, and diarrhea
Artemisia nilagarica	Nagdona	Used to curing skin disorders, epilepsy, nervous disorders, and inflammation, digestive issues
Berberis tinctoria	Chitra	Used to curing skin diseases, jaundice, eye infections, wound healing, diarrhea, and snake bites
Bidens pilosa	Bur marigold	Used for curing diabetes
Centella asiatica	Gotu Kola	Used to heal wounds, improve mental clarity, and treat skin infection
Chamaemelum nobile	Chamomile	Used to curing skin infection, such as eczema
Cinnamomum wightii	Nagakesaram	Used to treatment of wounds, fever, intestinal worms, headaches, and menstrual problems
Clematis zeylanica	Vatamkolli	Used to curing wounds, and worm infections
Conyz bonariensis	Fleabane	Used for curing blisters, boils, bruises, burns, eczema, leprosy, pimples, snake bites, sores, and spider bites
Crassocephalum crepidioides	Fireweed	Used for the treatment of indigestion, and stomachache
Cyanthillium cinereum	Vernonia	Used to heal cuts, scorpion stings, and snake venom
Debregeasia longifolia	Tusara	Used to improve digestion, and ailments like headaches, muscle cramps, and spasms
Flacourtia indica	Cottai-k-kala	Used to treatment of snakebite
Galinsoga parviflora	Marchia	Used to treat a variety of ailments, including malaria, flu, cold,

Botanical Name	Local/Common Name	Use(s)
		colorectal cancer, liver problems, and inflammation
Ipomea cairica	Morning glory	Used to cure inflammations, constipation, dyspepsia, bronchitis, fever, skin diseases, and scabies
Listea floribunda	Pattuthali	Used to curing diarrhea, stomachaches, diabetes, bone pain, and inflammation
Litsea glabrata	Ungakanni	Used to treatment of diarrhea, stomachache, indigestion, gastroenteritis, diabetes, edema, cold, arthritis, asthma, and traumatic injury
Memecylon edule	Anjuni	Used for treatment of dysentery, leucorrhea, gonorrhea, eye ailments, wounds, and diabetes
Mikania micarantha	Hempvine	Used to curing wounds, sores, insect bites, rashes, itches scorpion stings, and insect bites
Neolitsea scrobiculata	Mulakunari	Used for curing pain, and fever
Osbeckia reticulata	Beddome's osbeckia	Used to curing jaundice
Oxalis corniculata	Changeri	Used to treat diarrhea, dysentery, skin infection, headache, and snake bites
Peperomina blanda	Hairy peperomia	Used to treatment of inflammation, gastric ulcers, asthma, pain, and bacterial infections
Photinia integrifolia	Gajaphool	Used for curing indigestion
Pogostemon wightii	Patchouli	Used to curing colds, headaches, fever, nausea, vomiting, diarrhea, abdominal pain, and insect & snake bites
Polygala arillata	Yellow milkwort	Used to wound healing, respiratory issues, chronic bronchitis, and whooping cough
Rhodomyrtus tomentosa	Rose myrtle	Used to curing diarrhea, dysentery and stomachache, and wound healing

Botanical Name	Local/Common Name	Use(s)
Rubia cordifolia	Manjistha	Used to curing skin disorders, and fever
Rubus ellipticus	Ainselu	Used to curing diarrhea, dysentery, ulcers, bronchitis, nausea, and diabetes
Schefflera capitata	Etilamaram	Used to curing liver disorders, skin infection, respiratory infections, cancer, diarrhea, malaria, and paralysis
Senna septemtrionalis	Chakwar	Treatment of snakebites, fever, burns, cholera, hemorrhoids, and pain
Simlax aspera	Kukundara	Used to treatment of diabetes, rheumatism, scabies, skin diseases, and stomachache
Solanum virginianum	Rengni	Used for curing, pain, headache, migraine, hair fall, bronchial asthma, skin problems, and cough
Spermacoce ocymoides	Madanaghanta	Used for curing malaria, diarrhea, digestive problems, skin diseases and fever
Tarenna asiatica	Tarana	Used for curing eye infections, skin problems and abdominal pain
Thunbergia fragrans	Chimine	Used to treat fevers and wounds. The leaves are used as a skin diseases, and the juice can be applied to the head for headaches
Ventilago madraspatana	Pitti	Used to curing skin diseases, eye pain, stomachache and fevers
Viburnum erubescens	Ghodaakhari	Used for relieve a cough and scabies
Zanthoxylum asiaticum	Climbing orange	Used to treatment of back pain, cramps, pulmonary problems, and fevers. Also used as a wash to treat itching skin and swollen joints

3.4.2 Fauna

The list of mammal species recorded for the project area is given in various seasons are given in Tables-3.34 to 3.36.

Table-3.34: List of mammal species alongwith their conservation status recorded during field studies conducted in monsoon season

S. No	Common Name	Scientific Name	IUCN Status	WPA Schedule
1.	Indian Hedgehog	*Hemiechinus micropus (Blyth, 1846)*	LC	IV
2.	House (Grey Musk) Shrew	*Suncus murinus (Linnaeus, 1766)*	LC	Unlisted
3.	Short-nosed Fruit Bat	*Cynopterus sphinx (Vahl, 1797)*	LC	V
4.	Indian Flying Fox	*Pteropus giganteus (Brünnich, 1782)*	LC	V
5.	Indian Pipistrelle	*Pipistrellus coromandra (Gray, 1838)*	LC	Unlisted
6.	Bonnet Macaque	*Macaca radiata (E.Geoffroy, 1812)*	LC	II
7.	Nilgiri Langur	*Semnopithecus johnii (Fischer, 1829)*	VU	I
8.	Oriental Small-clawed (Clawless) Otter	*Aonyx cinerea (Illiger, 1815)*	VU	II
9.	Small Indian Civet	*Viverricula indica (Desmarest, 1804)*	LC	II
10.	Ruddy Mongoose	*Herpestes smithii (Gray, 1837)*	LC	IV
11.	Jungle Cat	*Felis chaus (Schreber, 1777)*	LC	II
12.	Wild Boar	*Sus scrofa (Linnaeus, 1758)*	LC	III
13.	Indian Chevrotain, Mouse Deer	*Moschiola meminna (Erxleben, 1777)*	LC	I
14.	Sambar	*Cervus unicolor (Kerr, 1792)*	VU	III
15.	Gaur	*Bos gaurus (Smith, 1827)*	VU	I
16.	Three-striped Palm Squirrel	*Funambulus palmarum (Linnaeus, 1766)*	LC	Unlisted
17.	Dusky Striped Squirrel	*Funambulus sublineatus (Waterhouse,1838)*	VU	Unlisted

S. No	Common Name	Scientific Name	IUCN Status	WPA Schedule
18.	Indian (Malabar) Giant Squirrel	*Ratufa indica (Erxleben, 1777)*	TH	II
19.	Large (Greater) Bandicoot-rat	*Bandicota indica (Bechstein, 1800)*	LC	V
20.	House Mouse	*Mus musculus (Linnaeus, 1758)*	LC	IV
21.	House (Roof, Black) Rat	*Rattus rattus (Linnaeus, 1758)*	LC	
22.	Indian (Crested) Porcupine	*Hystrix indica (Kerr, 1792)*	LC	IV
23.	Indian Hare, Black-naped Hare	*Lepus nigricollis (F. Cuvier, 1823)*	LC	IV

Notes: NE = Not Evaluated; LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered

Table-3.35: List of mammal species alongwith their conservation status recorded during field studies conducted in post-monsoon season

S. No	Common Name	Scientific Name	IUCN Status	WPA Schedule
1.	Indian Hedgehog	*Hemiechinus micropus (Blyth, 1846)*	LC	IV
2.	House (Grey Musk) Shrew	*Suncus murinus (Linnaeus, 1766)*	LC	Unlisted
3.	Short-nosed Fruit Bat	*Cynopterus sphinx (Vahl, 1797)*	LC	V
4.	Indian Flying Fox	*Pteropus giganteus (Brünnich, 1782)*	LC	V
5.	Indian Pipistrelle	*Pipistrellus coromandra (Gray, 1838)*	LC	Unlisted
6.	Bonnet Macaque	*Macaca radiata (E.Geoffroy, 1812)*	LC	II
7.	Nilgiri Langur	*Semnopithecus johnii (Fischer, 1829)*	VU	I
8.	Oriental Small-clawed (Clawless) Otter	*Aonyx cinerea (Illiger, 1815)*	VU	II
9.	Small Indian Civet	*Viverricula indica (Desmarest, 1804)*	LC	II
10.	Ruddy Mongoose	*Herpestes smithii (Gray,*	LC	IV

S. No	Common Name	Scientific Name	IUCN Status	WPA Schedule
		1837)		
11.	Jungle Cat	*Felis chaus (Schreber, 1777)*	LC	II
12.	Wild Boar	*Sus scrofa (Linnaeus, 1758)*	LC	III
13.	Sambar	*Cervus unicolor (Kerr, 1792)*	VU	III
14.	Indian Muntjac, Barking Deer	*Muntiacus muntjak (Zimmermann, 1780)*	LC	III
15.	Gaur	*Bos gaurus (Smith, 1827)*	VU	I
16.	Three-striped Palm Squirrel	*Funambulus palmarum (Linnaeus, 1766)*	LC	Unlisted
17.	Dusky Striped Squirrel	*Funambulus sublineatus (Waterhouse,1838)*	VU	Unlisted
18.	Indian (Malabar) Giant Squirrel	*Ratufa indica (Erxleben, 1777)*	TH	I
19.	Large (Greater) Bandicoot-rat	*Bandicota indica (Bechstein, 1800)*	LC	V
20.	House Mouse	*Mus musculus (Linnaeus, 1758)*	LC	IV
21.	House (Roof, Black) Rat	*Rattus rattus (Linnaeus, 1758)*	LC	
22.	Indian (Crested) Porcupine	*Hystrix indica (Kerr, 1792)*	LC	IV
23.	Indian Hare, Black-naped Hare	*Lepus nigricollis (F. Cuvier, 1823)*	LC	IV

Notes: NE = Not Evaluated; LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered

Table-3.36: List of mammal species alongwith their conservation status recorded during field studies conducted in pre-monsoon season

S.No.	Common Name	Scientific Name	IUCN Status	WPA Schedule
1.	Indian Hedgehog	*Hemiechinus micropus (Blyth, 1846)*	LC	IV
2.	House (Grey Musk) Shrew	*Suncus murinus (Linnaeus, 1766)*	LC	Unlisted
3.	Short-nosed Fruit Bat	*Cynopterus sphinx (Vahl, 1797)*	LC	V
4.	Indian Flying Fox	*Pteropus giganteus (Brünnich, 1782)*	LC	V

S.No.	Common Name	Scientific Name	IUCN Status	WPA Schedule
5.	Indian Pipistrelle	*Pipistrellus coromandra (Gray, 1838)*	LC	Unlisted
6.	Bonnet Macaque	*Macaca radiata (E.Geoffroy, 1812)*	LC	II
7.	Nilgiri Langur	*Semnopithecus johnii (Fischer, 1829)*	VU	I
8.	Oriental Small-clawed (Clawless) Otter	*Aonyx cinerea (Illiger, 1815)*	VU	II
9.	Small Indian Civet	*Viverricula indica (Desmarest, 1804)*	LC	II
10.	Ruddy Mongoose	*Herpestes smithii (Gray, 1837)*	LC	IV
11.	Jungle Cat	*Felis chaus (Schreber, 1777)*	LC	II
12.	Wild Boar	*Sus scrofa (Linnaeus, 1758)*	LC	III
13.	Sambar	*Cervus unicolor (Kerr, 1792)*	VU	III
14.	Indian Muntjac, Barking Deer	*Muntiacus muntjak (Zimmermann, 1780)*	LC	III
15.	Gaur	*Bos gaurus (Smith, 1827)*	VU	I
16.	Three-striped Palm Squirrel	*Funambulus palmarum (Linnaeus, 1766)*	LC	Unlisted
17.	Dusky Striped Squirrel	*Funambulus sublineatus (Waterhouse,1838)*	VU	Unlisted
18.	Indian (Malabar) Giant Squirrel	*Ratufa indica (Erxleben, 1777)*	TH	I
19.	Large (Greater) Bandicoot-rat	*Bandicota indica (Bechstein, 1800)*	LC	V
20.	House Mouse	*Mus musculus (Linnaeus, 1758)*	LC	IV
21.	House (Roof, Black) Rat	*Rattus rattus (Linnaeus, 1758)*	LC	
22.	Indian (Crested) Porcupine	*Hystrix indica (Kerr, 1792)*	LC	IV
23.	Indian Hare, Black-naped Hare	*Lepus nigricollis (F. Cuvier, 1823)*	LC	IV

Notes: NE = Not Evaluated; LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered

Avifauna

The list of avi-faunal species recorded during monitoring conducted for three seasons is given in Tables-3.37 to 3.39.

Table-3.37: List of Avi-faunal species alongwith their conservation status recorded during field studies conducted in monsoon season

S.No.	Common Name	Scientific Name	WPA	IUCN
1.	Indian Peafowl	*Pavo cristatus*	I	LC
2.	Grey Francolin	*Francolinus pondicerianus*	IV	LC
3.	Rain Quail	*Coturnix coromandelica*	IV	LC
4.	Rock Bush Quail	*Perdicula argoondah*	IV	LC
5.	Grey Junglefowl	*Gallus sonneratti*	IV	LC
6.	Little Egret	*Egretta garzetta*	IV	LC
7.	Cattle Egret	*Bubulcus ibis*	IV	LC
8.	Indian Pond Egret	*Ardeola grayii*	IV	LC
9.	Little Cormorant	*Phalacrocorax niger*	IV	LC
10.	Indian Cormorant	*Phalacrocorax fuscicollis*	IV	LC
11.	Black-Crowned Night Heron	*Nycticorax nycticorax*	IV	LC
12.	Common Kestrel	*Falco tinnunculus*	IV	LC
13.	Black-Shouldered Kite	*Elanus caeruleus*	IV	LC
14.	Black Kite	*Milvus migrans*	IV	LC
15.	Crested Serpant Eagle	*Spilornis cheela*	IV	LC
16.	Black Eagle	*Ictinaetus malayensis*	IV	LC
17.	Crested Goshawk	*Accipiter trivirgatus*	I	LC
18.	Shikra	*Accipiter badius*	I	LC
19.	Oriental Honey Buzzard	*Pernis ptilorhyncus*	IV	LC
20.	Crested Hawk Eagle	*Spizaetus cirrhatus*	IV	LC
21.	White-Breasted Waterhen	*Amaurornis phoenicurus*	IV	LC
22.	Red-Wattled Lapwing	*Vanellus indicus*	IV	LC
23.	Common Pigeon	*Columba livia*	IV	LC
24.	Laughing Dove	*Streptopelia senegalensis*	IV	LC
25.	Spotted Dove	*Streptopelia chinensis*	IV	LC
26.	Eurasian Collared Dove	*Streptopelia decaocto*	IV	LC
27.	Vernal Hanging Parrot	*Loriculus vernalis*	IV	LC
28.	Rose-Ringed Parakeet	*Psittacula krameria*	IV	LC
29.	Plum-Headed Parakeet	*Psittacula cyanocephala*	IV	LC
30.	Malabar Parakeet	*Psittacula columboides*	IV	LC
31.	Pied Cuckoo	*Clamator jacobinus*	IV	LC
32.	Common Hawk Cuckoo	*Hierococcyx varius*	IV	LC
33.	Asian Koel	*Eudynamys scolopacea*	IV	LC
34.	Blue-Faced Malkoha	*Phaenicophaeus viridirostris*	IV	LC
35.	Southern Coucal	*Cetropus parroti*	IV	LC
36.	Eurasian Scops Owl	*Otus scops*	IV	LC

S.No.	Common Name	Scientific Name	WPA	IUCN
37.	Brown Fish Owl	*Ketupa zeylonensis*	IV	LC
38.	Spotted Owl	*Athene brama*	IV	LC
39.	Indian Nightjar	*Caprimulgus asiaticus*	IV	LC
40.	Asian Palm Swift	*Cypsiurus balasiensis*	IV	LC
41.	Common Hoopoe	*Upupa epops*	IV	LC
42.	Indian Roller	*Coracius benghalensis*	IV	LC
43.	Common Kingfisher	*Alcedo atthis*	IV	LC
44.	White-Throated Kingfisher	*Halcyon smynensis*	IV	LC
45.	Pied Kingfisher	*Ceryle rudis*	IV	LC
46.	Blue-Bearded Bee-Eater	*Nyctyornis athertoni*	IV	LC
47.	Green Bee-Eater	*Merops orientalis*	IV	LC
48.	Blue-Tailed Bee-Eater	*Merops philippinus*	IV	LC
49.	Chestnut-Headed Bee-Eater	*Merops leschenaulti*	IV	LC
50.	Great Indian Hornbill	*Buceros bicornis*	I	VU
51.	White-Cheeked Barbet	*Megalaima viridis*	IV	LC
52.	Coppersmith Barbet	*Megalaima haemacephala*	IV	LC
53.	Common Goldenback	*Dinopium javanense*	IV	LC
54.	Asian Fairy Blue Bird	*Irena puella*	IV	LC
55.	Golden-Fronted Leafbird	*Chloropsis aurifrons*	IV	LC
56.	Bay-Backed Shrike	*Lanius vittatus*	IV	LC
57.	Rufous Treepie	*Dendrocitta vagabunda*	IV	LC
58.	House Crow	*Corvus splendens*	V	LC
59.	Eastern Jungle Crow	*Corvus macrorhynchos*	V	LC
60.	Ashy Woodswallow	*Artamus fuscus*	IV	LC
61.	Scarlet Minivet	*Pericrocotus falmmeus*	IV	LC
62.	White-Browed Fantail	*Rhipidura aureola*	IV	LC
63.	Black Drongo	*Dicrurus macrocercus*	IV	LC
64.	Greater Racket-Tailed Drongo	*Dicrurus paradiseus*	IV	LC
65.	Asian Paradise-Flycatcher	*Terpsiphone paradisi*	IV	LC
66.	Common Iora	*Aegithina tiphia*	IV	LC
67.	Malabar Whisling Thrush	*Myophonus horsfieldii*	IV	LC
68.	Eurasian Blackbird	*Turdus merula*	IV	LC
69.	Asian Brown Flycatcher	*Muscicapa dauurica*	IV	LC
70.	Tickell's Blue Flycatcher	*Cyornis tickelliae*	IV	LC
71.	Oriental Magpie Robin	*Copsychus saularis*	IV	LC
72.	Indian Robin	*Saxicoloides fulicata*	IV	LC
73.	Pied Bushchat	*Saxicola caprata*	IV	LC
74.	Chestnut-Tailed Starling	*Sturnus malabaricus*	IV	LC

S.No.	Common Name	Scientific Name	WPA	IUCN
75.	Brahminy Starling	*Sturnus pagodarum*	IV	LC
76.	Common Myna	*Acridotheres tristis*	IV	LC
77.	Jungle Myna	*Acridotheres fuscus*	IV	LC
78.	Hill Myna	*Gracula religiosa*	I	LC
79.	Chestnut-Bellied Nuthatch	*Sitta castanea*	IV	LC
80.	Velvet-Fronted Nuthatch	*Sitta frontalis*	IV	LC
81.	Great Tit	*Parus major*	IV	LC
82.	Pacific Swallow	*Hirundo tahitica*	IV	LC
83.	Red-Whiskered Bulbul	*Pycnonotus jocosus*	IV	LC
84.	Red-Vented Bulbul	*Pycnonotus cafer*	IV	LC
85.	Black Bulbul	*Hypsipetes leucocephalus*	IV	LC
86.	Jungle Prinia	*Prinia sylvatica*	IV	LC
87.	Common Tailorbird	*Orthotomus sutorius*	IV	LC
88.	Greenish Warbler	*Phylloscopus trochiloides*	IV	LC
89.	Blyth's Leaf Warbler	*Phylloscopus reguloides*	IV	LC
90.	Common Babbler	*Turdoides caudatus*	IV	LC
91.	Jungle Babbler	*Turdoides striatus*	IV	LC
92.	Thick-Billed Flowerpecker	*Dicaeum agile*	IV	LC
93.	Purple-Rumped Sunbird	*Nectarinia zeylonica*	IV	LC
94.	Purple Sunbird	*Nectarinia asiatica*	IV	LC
95.	Loten's Sunbird	*Nectarinia lotenia*	IV	LC
96.	House Sparrow	*Passer domesticus*	IV	LC
97.	White-Browed Wagtail	*Motacilla maderaspatensis*	IV	LC
98.	Grey Wagtail	*Motacilla cinerea*	IV	LC
99.	Nilgiri Pipit	*Anthus nilghiriensis*	IV	VU
100.	White-Rumped Munia	*Lonchura striata*	IV	LC
101.	Black-Throated Munia	*Lonchura kelaarti*	IV	LC
102.	Scaly-Breasted Munia	*Lonchura punctulata*	IV	LC

Notes: NE = Not Evaluated; LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered

Table-3.38: List of Avi-faunal species alongwith their conservation status recorded during field studies conducted in post-monsoon season

S.No.	Common Name	Scientific Name	WPA	IUCN
1.	Indian Peafowl	*Pavo cristatus*	I	LC
2.	Grey Francolin	*Francolinus pondicerianus*	IV	LC
3.	Rain Quail	*Coturnix coromandelica*	IV	LC
4.	Rock Bush Quail	*Perdicula argoondah*	IV	LC

S.No.	Common Name	Scientific Name	WPA	IUCN
5.	Grey Junglefowl	*Gallus sonneratti*	IV	LC
6.	Little Egret	*Egretta garzetta*	IV	LC
7.	Cattle Egret	*Bubulcus ibis*	IV	LC
8.	Indian Pond Egret	*Ardeola grayii*	IV	LC
9.	Little Cormorant	*Phalacrocorax niger*	IV	LC
10.	Indian Cormorant	*Phalacrocorax fuscicollis*	IV	LC
11.	Black-Crowned Night Heron	*Nycticorax nycticorax*	IV	LC
12.	Common Kestrel	*Falco tinnunculus*	IV	LC
13.	Black-Shouldered Kite	*Elanus caeruleus*	IV	LC
14.	Black Kite	*Milvus migrans*	IV	LC
15.	Crested Serpant Eagle	*Spilornis cheela*	IV	LC
16.	Black Eagle	*Ictinaetus malayensis*	IV	LC
17.	Crested Goshawk	*Accipiter trivirgatus*	I	LC
18.	Shikra	*Accipiter badius*	I	LC
19.	Oriental Honey Buzzard	*Pernis ptilorhyncus*	IV	LC
20.	Crested Hawk Eagle	*Spizaetus cirrhatus*	IV	LC
21.	White-Breasted Waterhen	*Amaurornis phoenicurus*	IV	LC
22.	Red-Wattled Lapwing	*Vanellus indicus*	IV	LC
23.	Common Pigeon	*Columba livia*	IV	LC
24.	Laughing Dove	*Streptopelia senegalensis*	IV	LC
25.	Spotted Dove	*Streptopelia chinensis*	IV	LC
26.	Eurasian Collared Dove	*Streptopelia decaocto*	IV	LC
27.	Vernal Hanging Parrot	*Loriculus vernalis*	IV	LC
28.	Rose-Ringed Parakeet	*Psittacula krameria*	IV	LC
29.	Plum-Headed Parakeet	*Psittacula cyanocephala*	IV	LC
30.	Malabar Parakeet	*Psittacula columboides*	IV	LC
31.	Pied Cuckoo	*Clamator jacobinus*	IV	LC
32.	Common Hawk Cuckoo	*Hierococcyx varius*	IV	LC
33.	Asian Koel	*Eudynamys scolopacea*	IV	LC
34.	Blue-Faced Malkoha	*Phaenicophaeus viridirostris*	IV	LC
35.	Southern Coucal	*Cetropus parroti*	IV	LC
36.	Eurasian Scops Owl	*Otus scops*	IV	LC
37.	Brown Fish Owl	*Ketupa zeylonensis*	IV	LC
38.	Spotted Owl	*Athene brama*	IV	LC
39.	Indian Nightjar	*Caprimulgus asiaticus*	IV	LC
40.	Asian Palm Swift	*Cypsiurus balasiensis*	IV	LC
41.	Common Hoopoe	*Upupa epops*	IV	LC
42.	Indian Roller	*Coracius benghalensis*	IV	LC

S.No.	Common Name	Scientific Name	WPA	IUCN
43.	Common Kingfisher	*Alcedo atthis*	IV	LC
44.	White-Throated Kingfisher	*Halcyon smynensis*	IV	LC
45.	Pied Kingfisher	*Ceryle rudis*	IV	LC
46.	Blue-Bearded Bee-Eater	*Nyctyornis athertoni*	IV	LC
47.	Green Bee-Eater	*Merops orientalis*	IV	LC
48.	Blue-Tailed Bee-Eater	*Merops philippinus*	IV	LC
49.	Chestnut-Headed Bee-Eater	*Merops leschenaulti*	IV	LC
50.	Great Indian Hornbill	*Buceros bicornis*	I	VU
51.	White-Cheeked Barbet	*Megalaima viridis*	IV	LC
52.	Coppersmith Barbet	*Megalaima haemacephala*	IV	LC
53.	Common Goldenback	*Dinopium javanense*	IV	LC
54.	Asian Fairy Blue Bird	*Irena puella*	IV	LC
55.	Golden-Fronted Leafbird	*Chloropsis aurifrons*	IV	LC
56.	Bay-Backed Shrike	*Lanius vittatus*	IV	LC
57.	Rufous Treepie	*Dendrocitta vagabunda*	IV	LC
58.	House Crow	*Corvus splendens*	V	LC
59.	Eastern Jungle Crow	*Corvus macrorhynchos*	V	LC
60.	Ashy Woodswallow	*Artamus fuscus*	IV	LC
61.	Scarlet Minivet	*Pericrocotus falmmeus*	IV	LC
62.	White-Browed Fantail	*Rhipidura aureola*	IV	LC
63.	Black Drongo	*Dicrurus macrocercus*	IV	LC
64.	Greater Racket-Tailed Drongo	*Dicrurus paradiseus*	IV	LC
65.	Asian Paradise-Flycatcher	*Terpsiphone paradisi*	IV	LC
66.	Common Iora	*Aegithina tiphia*	IV	LC
67.	Malabar Whisling Thrush	*Myophonus horsfieldii*	IV	LC
68.	Eurasian Blackbird	*Turdus merula*	IV	LC
69.	Asian Brown Flycatcher	*Muscicapa dauurica*	IV	LC
70.	Tickell's Blue Flycatcher	*Cyornis tickelliae*	IV	LC
71.	Oriental Magpie Robin	*Copsychus saularis*	IV	LC
72.	Indian Robin	*Saxicoloides fulicata*	IV	LC
73.	Pied Bushchat	*Saxicola caprata*	IV	LC
74.	Chestnut-Tailed Starling	*Sturnus malabaricus*	IV	LC
75.	Brahminy Starling	*Sturnus pagodarum*	IV	LC
76.	Common Myna	*Acridotheres tristis*	IV	LC
77.	Jungle Myna	*Acridotheres fuscus*	IV	LC
78.	Hill Myna	*Gracula religiosa*	I	LC
79.	Chestnut-Bellied Nuthatch	*Sitta castanea*	IV	LC
80.	Velvet-Fronted Nuthatch	*Sitta frontalis*	IV	LC

S.No.	Common Name	Scientific Name	WPA	IUCN
81.	Great Tit	*Parus major*	IV	LC
82.	Pacific Swallow	*Hirundo tahitica*	IV	LC
83.	Red-Whiskered Bulbul	*Pycnonotus jocosus*	IV	LC
84.	Red-Vented Bulbul	*Pycnonotus cafer*	IV	LC
85.	Black Bulbul	*Hypsipetes leucocephalus*	IV	LC
86.	Jungle Prinia	*Prinia sylvatica*	IV	LC
87.	Common Tailorbird	*Orthotomus sutorius*	IV	LC
88.	Greenish Warbler	*Phylloscopus trochiloides*	IV	LC
89.	Blyth's Leaf Warbler	*Phylloscopus reguloides*	IV	LC
90.	Common Babbler	*Turdoides caudatus*	IV	LC
91.	Jungle Babbler	*Turdoides striatus*	IV	LC
92.	Thick-Billed Flowerpecker	*Dicaeum agile*	IV	LC
93.	Purple-Rumped Sunbird	*Nectarinia zeylonica*	IV	LC
94.	Purple Sunbird	*Nectarinia asiatica*	IV	LC
95.	Loten's Sunbird	*Nectarinia lotenia*	IV	LC
96.	House Sparrow	*Passer domesticus*	IV	LC
97.	White-Browed Wagtail	*Motacilla maderaspatensis*	IV	LC
98.	Grey Wagtail	*Motacilla cinerea*	IV	LC
99.	Nilgiri Pipit	*Anthus nilghiriensis*	IV	VU
100.	White-Rumped Munia	*Lonchura striata*	IV	LC
101.	Black-Throated Munia	*Lonchura kelaarti*	IV	LC
102.	Scaly-Breasted Munia	*Lonchura punctulata*	IV	LC

Notes: NE = Not Evaluated; LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered

Table-3.39: List of Avi-faunal species alongwith their conservation status recorded during field studies conducted in pre-monsoon season

S. No.	Common Name	Scientific Name	WPA	IUCN
1.	Indian Peafowl	*Pavo cristatus*	I	LC
2.	Grey Francolin	*Francolinus pondicerianus*	IV	LC
3.	Rain Quail	*Coturnix coromandelica*	IV	LC
4.	Rock Bush Quail	*Perdicula argoondah*	IV	LC
5.	Grey Junglefowl	*Gallus sonneratti*	IV	LC
6.	Little Egret	*Egretta garzetta*	IV	LC
7.	Cattle Egret	*Bubulcus ibis*	IV	LC
8.	Indian Pond Egret	*Ardeola grayii*	IV	LC
9.	Little Cormorant	*Phalacrocorax niger*	IV	LC
10.	Indian Cormorant	*Phalacrocorax fuscicollis*	IV	LC
11.	Black-Crowned Night Heron	*Nycticorax nycticorax*	IV	LC

S. No.	Common Name	Scientific Name	WPA	IUCN
12.	Common Kestrel	*Falco tinnunculus*	IV	LC
13.	Black-Shouldered Kite	*Elanus caeruleus*	IV	LC
14.	Black Kite	*Milvus migrans*	IV	LC
15.	Crested Serpant Eagle	*Spilornis cheela*	IV	LC
16.	Black Eagle	*Ictinaetus malayensis*	IV	LC
17.	Crested Goshawk	*Accipiter trivirgatus*	I	LC
18.	Shikra	*Accipiter badius*	I	LC
19.	Oriental Honey Buzzard	*Pernis ptilorhyncus*	IV	LC
20.	Crested Hawk Eagle	*Spizaetus cirrhatus*	IV	LC
21.	White-Breasted Waterhen	*Amaurornis phoenicurus*	IV	LC
22.	Red-Wattled Lapwing	*Vanellus indicus*	IV	LC
23.	Common Pigeon	*Columba livia*	IV	LC
24.	Laughing Dove	*Streptopelia senegalensis*	IV	LC
25.	Spotted Dove	*Streptopelia chinensis*	IV	LC
26.	Eurasian Collared Dove	*Streptopelia decaocto*	IV	LC
27.	Vernal Hanging Parrot	*Loriculus vernalis*	IV	LC
28.	Rose-Ringed Parakeet	*Psittacula krameria*	IV	LC
29.	Plum-Headed Parakeet	*Psittacula cyanocephala*	IV	LC
30.	Malabar Parakeet	*Psittacula columboides*	IV	LC
31.	Pied Cuckoo	*Clamator jacobinus*	IV	LC
32.	Common Hawk Cuckoo	*Hierococcyx varius*	IV	LC
33.	Asian Koel	*Eudynamys scolopacea*	IV	LC
34.	Blue-Faced Malkoha	*Phaenicophaeus viridirostris*	IV	LC
35.	Southern Coucal	*Cetropus parroti*	IV	LC
36.	Eurasian Scops Owl	*Otus scops*	IV	LC
37.	Brown Fish Owl	*Ketupa zeylonensis*	IV	LC
38.	Spotted Owl	*Athene brama*	IV	LC
39.	Indian Nightjar	*Caprimulgus asiaticus*	IV	LC
40.	Asian Palm Swift	*Cypsiurus balasiensis*	IV	LC
41.	Common Hoopoe	*Upupa epops*	IV	LC
42.	Indian Roller	*Coracius benghalensis*	IV	LC
43.	Common Kingfisher	*Alcedo atthis*	IV	LC
44.	White-Throated Kingfisher	*Halcyon smynensis*	IV	LC
45.	Pied Kingfisher	*Ceryle rudis*	IV	LC
46.	Blue-Bearded Bee-Eater	*Nyctyornis athertoni*	IV	LC
47.	Green Bee-Eater	*Merops orientalis*	IV	LC
48.	Blue-Tailed Bee-Eater	*Merops philippinus*	IV	LC
49.	Chestnut-Headed Bee-Eater	*Merops leschenaulti*	IV	LC
50.	Great Indian Hornbill	*Buceros bicornis*	I	VU
51.	White-Cheeked Barbet	*Megalaima viridis*	IV	LC
52.	Coppersmith Barbet	*Megalaima haemacephala*	IV	LC

S. No.	Common Name	Scientific Name	WPA	IUCN
53.	Common Goldenback	*Dinopium javanense*	IV	LC
54.	Asian Fairy Blue Bird	*Irena puella*	IV	LC
55.	Golden-Fronted Leafbird	*Chloropsis aurifrons*	IV	LC
56.	Bay-Backed Shrike	*Lanius vittatus*	IV	LC
57.	Rufous Treepie	*Dendrocitta vagabunda*	IV	LC
58.	House Crow	*Corvus splendens*	V	LC
59.	Eastern Jungle Crow	*Corvus macrorhynchos*	V	LC
60.	Ashy Woodswallow	*Artamus fuscus*	IV	LC
61.	Scarlet Minivet	*Pericrocotus falmmeus*	IV	LC
62.	White-Browed Fantail	*Rhipidura aureola*	IV	LC
63.	Black Drongo	*Dicrurus macrocercus*	IV	LC
64.	Greater Racket-Tailed Drongo	*Dicrurus paradiseus*	IV	LC
65.	Asian Paradise-Flycatcher	*Terpsiphone paradisi*	IV	LC
66.	Common Iora	*Aegithina tiphia*	IV	LC
67.	Malabar Whisling Thrush	*Myophonus horsfieldii*	IV	LC
68.	Eurasian Blackbird	*Turdus merula*	IV	LC
69.	Asian Brown Flycatcher	*Muscicapa dauurica*	IV	LC
70.	Tickell's Blue Flycatcher	*Cyornis tickelliae*	IV	LC
71.	Oriental Magpie Robin	*Copsychus saularis*	IV	LC
72.	Indian Robin	*Saxicoloides fulicata*	IV	LC
73.	Pied Bushchat	*Saxicola caprata*	IV	LC
74.	Chestnut-Tailed Starling	*Sturnus malabaricus*	IV	LC
75.	Brahminy Starling	*Sturnus pagodarum*	IV	LC
76.	Common Myna	*Acridotheres tristis*	IV	LC
77.	Jungle Myna	*Acridotheres fuscus*	IV	LC
78.	Hill Myna	*Gracula religiosa*	I	LC
79.	Chestnut-Bellied Nuthatch	*Sitta castanea*	IV	LC
80.	Velvet-Fronted Nuthatch	*Sitta frontalis*	IV	LC
81.	Great Tit	*Parus major*	IV	LC
82.	Pacific Swallow	*Hirundo tahitica*	IV	LC
83.	Red-Whiskered Bulbul	*Pycnonotus jocosus*	IV	LC
84.	Red-Vented Bulbul	*Pycnonotus cafer*	IV	LC
85.	Black Bulbul	*Hypsipetes leucocephalus*	IV	LC
86.	Jungle Prinia	*Prinia sylvatica*	IV	LC
87.	Common Tailorbird	*Orthotomus sutorius*	IV	LC
88.	Greenish Warbler	*Phylloscopus trochiloides*	IV	LC
89.	Blyth's Leaf Warbler	*Phylloscopus reguloides*	IV	LC
90.	Common Babbler	*Turdoides caudatus*	IV	LC
91.	Jungle Babbler	*Turdoides striatus*	IV	LC
92.	Thick-Billed Flowerpecker	*Dicaeum agile*	IV	LC
93.	Purple-Rumped Sunbird	*Nectarinia zeylonica*	IV	LC

S. No.	Common Name	Scientific Name	WPA	IUCN
94.	Purple Sunbird	*Nectarinia asiatica*	IV	LC
95.	Loten's Sunbird	*Nectarinia lotenia*	IV	LC
96.	House Sparrow	*Passer domesticus*	IV	LC
97.	White-Browed Wagtail	*Motacilla maderaspatensis*	IV	LC
98.	Grey Wagtail	*Motacilla cinerea*	IV	LC
99.	Nilgiri Pipit	*Anthus nilghiriensis*	IV	VU
100.	White-Rumped Munia	*Lonchura striata*	IV	LC
101.	Black-Throated Munia	*Lonchura kelaarti*	IV	LC
102.	Scaly-Breasted Munia	*Lonchura punctulata*	IV	LC

Notes: NE = Not Evaluated; LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered

Reptiles

The list of reptile species recorded during field studies conducted in monsoon, post-monsoon and pre-monsoon season are given in Tables-3.40 to 3.42

Table-3.40: List of reptile species alongwith their conservation status recorded during field studies conducted in monsoon season

S.No.	***Name***	***Scientific Name***
1.	Bark gecko	*Hemidactylus leschenaultii*
2.	Common keeled skink	*Eutropis carinata*
3.	Indian Chamaeleon	*Chamaeleo zeylanicus*
4.	Common green forest lizard	*Calotes calotes*
5.	Indian garden lizard	*Calotes versicolor*
6.	South Indian flying lizard	*Draco dussumier*
7.	Brahminy worm snake	*Indotyphlops braminus*
8.	Large-scaled shieldtail	*Uropeltis macrolepis*
9.	Rock python	*Phyton molurus*
10.	Russel's Viper	*Daboia russelii*
11.	Malabar pit viper	*Trimeresurus malabaricus*
12.	Common Indian Krait	*Bungarus caeruleus*
13.	Spectacled cobra	*Naja naja*
14.	King cobra	*Ophiophagus hannah*
15.	Green keelback	*Macrophistodon plumbicolor*
16.	Checkered keelback	*Xenochrophis piscator*
17.	Common vine snake	*Ahaetulla nasuta*
18.	Common bronzeback	*Dendrelaphis tristis*
19.	Common wolf snake	*Lycodon aulicus*
20.	Indian Rat snake	*Ptyas mucosa*

S.No.	Name	Scientific Name
21.	Western shieldtail	Teretrurus sanguineus
22.	Elliot's shieldtail	Uropeltis ellioti

Notes: NE = Not Evaluated; LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered

Table-3.41: List of reptile species alongwith their conservation status recorded during field studies conducted in post-monsoon season

S.No.	Name	Scientific name	Status	IUCN status	WPA schedule
1.	Bark gecko	*Hemidactylus leschenaultii*			IV
2.	Common keeled skink	*Eutropis carinata*			IV
3.	Indian Chamaeleon	*Chamaeleo zeylanicus*			IV
4.	Common green forest lizard	*Calotes calotes*			IV
5.	Indian garden lizard	*Calotes versicolor*			IV
6.	South Indian flying lizard	*Draco dussumier*	Endemic	LC	IV
7.	Brahminy worm snake	*Indotyphlops braminus*			IV
8.	Large-scaled shieldtail	*Uropeltis macrolepis*	Endemic		IV
9.	Rock python	*Phyton molurus*			IV
10.	Russel's Viper	*Daboia russelii*			II
11.	Malabar pit viper	*Trimeresurus malabaricus*	Endemic	LC	IV
12.	Common Indian Krait	*Bungarus caeruleus*			IV
13.	Spectacled cobra	*Naja naja*			IV
14.	King cobra	*Ophiophagus Hannah*			II
15.	Green keelback	*Macrophistodon plumbicolor*			II
16.	Checkered keelback	*Xenochrophis piscator*			II
17.	Common vine snake	*Ahaetulla nasuta*			IV
18.	Common bronzeback	*Dendrelaphis tristis*			IV
19.	Common wolf snake	*Lycodon aulicus*			IV
20.	Indian Rat snake	*Ptyas mucosa*			IV
21.	Western shieldtail	*Teretrurus*	Endemic		IV

S.No.	Name	Scientific name	Status	IUCN status	WPA schedule
		sanguineus			
22.	Elliot's shieldtail	*Uropeltis ellioti*			IV

Notes: NE = Not Evaluated; LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered

Table-3.42: List of reptile species alongwith their conservation status recorded during field studies conducted in pre-monsoon season

S.No	Name	Scientific name	Status	IUCN status	WPA schedule
1.	Bark gecko	*Hemidactylus leschenaultii*			IV
2.	Common keeled skink	*Eutropis carinata*			IV
3.	Indian Chamaeleon	*Chamaeleo zeylanicus*			IV
4.	Common green forest lizard	*Calotes calotes*			IV
5.	Indian garden lizard	*Calotes versicolor*			IV
6.	South Indian flying lizard	*Draco dussumier*	Endemic	LC	IV
7.	Brahminy worm snake	*Indotyphlops braminus*			IV
8.	Large-scaled shieldtail	*Uropeltis macrolepis*	Endemic		IV
9.	Rock python	*Phyton molurus*			IV
10.	Russel's Viper	*Daboia russelii*			II
11.	Malabar pit viper	*Trimeresurus malabaricus*	Endemic	LC	IV
12.	Common Indian Krait	*Bungarus caeruleus*			IV
13.	Spectacled cobra	*Naja naja*			IV
14.	King cobra	*Ophiophagus Hannah*			II
15.	Green keelback	*Macrophistodon plumbicolor*			II
16.	Checkered keelback	*Xenochrophis piscator*			II
17.	Common vine snake	*Ahaetulla nasuta*			IV
18.	Common bronzeback	*Dendrelaphis tristis*			IV
19.	Common wolf snake	*Lycodon aulicus*			IV
20.	Indian Rat snake	*Ptyas mucosa*			IV
21.	Western shieldtail	*Teretrurus sanguineus*	Endemic		IV
22.	Elliot's shieldtail	*Uropeltis ellioti*			IV

Notes: NE = Not Evaluated; LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered

Butterflies

The list of butterfly species recorded during field studies conducted in monsoon, post-monsoon and pre-monsoon seasons is given in Tables-3.43 to 3.45.

Table-3.43: List of Butterfly species alongwith their conservation status recorded during field studies conducted in Monsoon Season

S. No.	Common Name	Scientific Name	IUCN Status	Endemism
1	Crimson Rose	*Pachliopta hector Linnaeus, 1758*	---	---
2	Common Rose	*Pachliopta aristolochiae Fabricius, 1775*	---	---
3	Common Jay	*Graphium doson C. & R. Felder, 1864*	---	---
4	Tailed Jay	*Graphium agamemnon Linnaeus, 1758*	---	---
5	Southern Bluebottle	*Graphium teredon C. & R. Felder, 1865*	---	---
6	Lime Butterfly	*Papilio demoleus Linnaeus, 1758*	---	---
7	Common Mormon	*Papilio polytes Linnaeus, 1758*	---	---
8	Blue Mormon	*Papilio polymnestor Cramer, 1775*	---	---
9	Common Banded Peacock	*Papilio crino Fabricius, 1792*	---	---
10	Red Helen	*Papilio helenus Linnaeus, 1758*	---	---
11	Paris Peacock	*Papilio paris tamilana Linn.*	---	Endemic
12	Southern birdwing	*Troides minos*	---	Endemic
13	Common Silverline	*Spindasis vulcanus Fabricius, 1775*	---	---
14	Common Pierrot	*Castalius rosimon Fabricius, 1775*	---	---
15	Banded Blue Pierrot	*Discolampa ethion Westwood, 1851*	---	---
16	Red Pierrot	*Talicada nyseus GuerinMeneville, 1843*	---	---
17	Common Cerulean	*Jamides celeno Cramer, 1775*	---	---
18	Dark Cerulean	*Jamides bochus Stoll, 1782*	---	---
19	Lime Blue	*Chilades lajus Stoll, 1780*	---	---
20	Tiny Grass Blue	*Zizula hylax Fabricius, 1775*	---	---
21	Dark Grass Blue	*Zizeeria karsandra Moore, 1865*	---	---
22	Plains Cupid	*Chilades pandava Horsfield, 1829*	---	---
23	Grass Jewel	*Freyeria trochylus Freyer, 1845*	---	---

S. No.	Common Name	Scientific Name	IUCN Status	Endemism
24	Blue Tiger	*Tirumala limniace Cramer, 1775*	LC	---
25	Dark Blue Tiger	*Tirumala septentrionis Butler, 1874*	LC	---
26	Plain Tiger	*Danaus chrysippus Linnaeus, 1758*	LC	---
27	Striped Tiger	*Danaus genutia Cramer, 1779*	LC	---
28	Glassy Tiger	*Parantica aglea Stoll, 1782*	LC	---
29	Nilgiri tiger	*Parantica nilgiriensis (Moore, 1877)*	NT	Endemic
30	Common Crow	*Euploea core Cramer, 1780*	LC	
31	Danaid Eggfly	*Hypolimnas misippus Linnaeus, 1764*	LC	
32	Great Eggfly	*Hypolimnas bolina Linnaeus, 1758*	---	---
33	Grey Pansy	*Junonia atlites Linnaeus, 1763*	---	---
34	Common Sailer	*Neptis hylas Linnaeus, 1758*	---	---
35	Common Fivering	*Ypthima baldus Fabricius, 1775*	---	---
36	Common Threering	*Ypthima asterope Klug, 1832*	---	---
37	Common Fourring	*Ypthima huebneri Kirby, 1871*	---	---
38	Common Lascar	*Pantoporia hordonia Stoll, 1790*	---	---
39	Indian Red Admiral	*Vanessa indica Herbst, 1794*	---	---
40	Blue Admiral	*Kaniska canace Linnaeus, 1763*	---	---
41	Common Evening Brown	*Melanitis leda Linnaeus, 1758*	LC	---
42	Common Bushbrown	*Mycalesis perseus Fabricius, 1775*	LC	---
43	Glad-eye Bushbrown	*Mycalesis patnia Moore, 185*	---	---
44	Indian fritillary	*Argynnis hyperbius (Linnaeus, 1763)*	---	---
45	Common Map	*Cyrestis thyodamas Boisduval, 1846*	---	---
46	Indian Cabbage White	*Pieris canidia Linnaeus, 1768*	---	---
47	Common Albatross	*Appias albina Boisduval, 1836*	---	---
48	Pioneer	*Anaphaeis aurota Fabricius, 1793*	---	---
49	Common Emigrant	*Catopsilia pomona Fabricius, 1775*	---	---
50	Mottled Emigrant	*Catopsilia pyranthe Linnaeus, 1758*	---	---
51	Common Jezebel	*Delias eucharis Drury, 1773*	---	---

S. No.	Common Name	Scientific Name	IUCN Status	Endemism
52	Common Grass Yellow	*Eurema hecabe Linnaeus, 1758*	---	---
53	Small Grass Yellow	*Eurema brigitta Stoll, 178*	---	---
54	Spotless Grass Yellow	*Eurema laeta (Boisduval, 1836)*	---	---
55	Nilgiri Clouded Yellow	*Colias nilagiriensis,C. & R. Felder, 1859*	---	Endemic
56	Great Orange Tip	*Hebomoia glaucippe Linnaeus, 1758*	LC	---
57	White Orange Tip	*Ixias marianne Cramer, 1779*	---	---
58	Large Salmon Arab	*Colotis fausta Olivier, 1804*	---	---
59	Common Wanderer	*Pareronia hippia Cramer, 1776*	---	---
60	Dark Wanderer	*Pareronia ceylanica C. & R. Felder, 1865*	---	---
61	Common Gull	*Cepora nerissa Fabricius, 1775*	---	---
62	Psyche	*Leptosia nina Fabricius, 1793*	---	---
63	Common Banded Awl	*Hasora chromus Cramer, 1780*	---	---
64	Common Spotted Flat	*Celaenorrhinus leucocera (Kollar, [1844])*	---	---
65	Indian awlking	*Choaspes benjaminii (Guérin-Méneville, 1843)*	---	---

Notes: NE = Not Evaluated; LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered

Table-3.44: List of Butterfly species alongwith their conservation status recorded during field studies conducted in Post-Monsoon Season

S. No.	Common Name	Scientific Name	IUCN Status	Endemism
1.	Crimson Rose	*Pachliopta hector Linnaeus, 1758*		
2.	Common Rose	*Pachliopta aristolochiae Fabricius, 1775*		
3.	Common Jay	*Graphium doson C. & R. Felder, 1864*		
4.	Tailed Jay	*Graphium agamemnon Linnaeus, 1758*		
5.	Southern Bluebottle	*Graphium teredon C. & R. Felder, 1865*		
6.	Lime Butterfly	*Papilio demoleus Linnaeus, 1758*		
7.	Common Mormon	*Papilio polytes Linnaeus, 1758*		
8.	Blue Mormon	*Papilio polymnestor Cramer, 1775*		
9.	Common Banded	*Papilio crino Fabricius, 1792*		

S. No.	Common Name	Scientific Name	IUCN Status	Endemism
	Peacock			
10.	Red Helen	*Papilio helenus Linnaeus, 1758*		
11.	Paris Peacock	*Papilio paris tamilana Linn.*		Endemic
12.	Southern birdwing	*Troides minos*		Endemic
13.	Common Silverline	*Spindasis vulcanus Fabricius, 1775*		
14.	Common Pierrot	*Castalius rosimon Fabricius, 1775*		
15.	Banded Blue Pierrot	*Discolampa ethion Westwood, 1851*		
16.	Red Pierrot	*Talicada nyseus GuerinMeneville, 1843*		
17.	Common Cerulean	*Jamides celeno Cramer, 1775*		
18.	Dark Cerulean	*Jamides bochus Stoll, 1782*		
19.	Lime Blue	*Chilades lajus Stoll, 1780*		
20.	Tiny Grass Blue	*Zizula hylax Fabricius, 1775*		
21.	Dark Grass Blue	*Zizeeria karsandra Moore, 1865*		
22.	Plains Cupid	*Chilades pandava Horsfield, 1829*		
23.	Grass Jewel	*Freyeria trochylus Freyer, 1845*		
24.	Blue Tiger	*Tirumala limniace Cramer, 1775*	LC	
25.	Dark Blue Tiger	*Tirumala septentrionis Butler, 1874*	LC	
26.	Plain Tiger	*Danaus chrysippus Linnaeus, 1758*	LC	
27.	Striped Tiger	*Danaus genutia Cramer, 1779*	LC	
28.	Glassy Tiger	*Parantica aglea Stoll, 1782*	LC	
29.	Nilgiri tiger	*Parantica nilgiriensis (Moore, 1877)*	NT	Endemic
30.	Common Crow	*Euploea core Cramer, 1780*	LC	
31.	Danaid Eggfly	*Hypolimnas misippus Linnaeus, 1764*	LC	
32.	Great Eggfly	*Hypolimnas bolina Linnaeus, 1758*		
33.	Grey Pansy	*Junonia atlites Linnaeus, 1763*		
34.	Common Sailer	*Neptis hylas Linnaeus, 1758*		
35.	Common Fivering	*Ypthima baldus Fabricius, 1775*		
36.	Common Threering	*Ypthima asterope Klug, 1832*		
37.	Common Fourring	*Ypthima huebneri Kirby, 1871*		
38.	Common Lascar	*Pantoporia hordonia Stoll, 1790*		
39.	Indian Red Admiral	*Vanessa indica Herbst, 1794*		
40.	Blue Admiral	*Kaniska canace Linnaeus, 1763*		
41.	Common Evening Brown	*Melanitis leda Linnaeus, 1758*	LC	
42.	Common Bushbrown	*Mycalesis perseus Fabricius,*	LC	

S. No.	Common Name	Scientific Name	IUCN Status	Endemism
		1775		
43.	Glad-eye Bushbrown	*Mycalesis patnia Moore, 185*		
44.	Indian fritillary	*Argynnis hyperbius (Linnaeus, 1763)*		
45.	Common Map	*Cyrestis thyodamas Boisduval, 1846*		
46.	Indian Cabbage White	*Pieris canidia Linnaeus, 1768*		
47.	Common Albatross	*Appias albina Boisduval, 1836*		
48.	Pioneer	*Anaphaeis aurota Fabricius, 1793*		
49.	Common Emigrant	*Catopsilia pomona Fabricius, 1775*		
50.	Mottled Emigrant	*Catopsilia pyranthe Linnaeus, 1758*		
51.	Common Jezebel	*Delias eucharis Drury, 1773*		
52.	Common Grass Yellow	*Eurema hecabe Linnaeus, 1758*		
53.	Small Grass Yellow	*Eurema brigitta Stoll, 178*		
54.	Spotless Grass Yellow	*Eurema laeta (Boisduval, 1836)*		
55.	Nilgiri Clouded Yellow	*Colias nilagiriensis,C. & R. Felder, 1859*		Endemic
56.	Great Orange Tip	*Hebomoia glaucippe Linnaeus, 1758*	LC	
57.	White Orange Tip	*Ixias marianne Cramer, 1779*		
58.	Large Salmon Arab	*Colotis fausta Olivier, 1804*		
59.	Common Wanderer	*Pareronia hippia Cramer, 1776*		
60.	Dark Wanderer	*Pareronia ceylanica C. & R. Felder, 1865*		
61.	Common Gull	*Cepora nerissa Fabricius, 1775*		
62.	Psyche	*Leptosia nina Fabricius, 1793*		
63.	Common Banded Awl	*Hasora chromus Cramer, 1780*		
64.	Common Spotted Flat	*Celaenorrhinus leucocera (Kollar, [1844])*		
65.	Indian awlking	*Choaspes benjaminii (Guérin-Méneville, 1843)*		

Notes: NE = Not Evaluated; LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered

Table-3.45: List of Butterfly species alongwith their conservation status recorded during field studies conducted in Pre-Monsoon Season

S.No.	Common Name	Scientific Name	IUCN Status	Endemism
1.	Crimson Rose	*Pachliopta hector Linnaeus, 1758*		
2.	Common Rose	*Pachliopta aristolochiae Fabricius, 1775*		
3.	Common Jay	*Graphium doson C. & R. Felder, 1864*		
4.	Tailed Jay	*Graphium agamemnon Linnaeus, 1758*		
5.	Southern Bluebottle	*Graphium teredon C. & R. Felder, 1865*		
6.	Lime Butterfly	*Papilio demoleus Linnaeus, 1758*		
7.	Common Mormon	*Papilio polytes Linnaeus, 1758*		
8.	Blue Mormon	*Papilio polymnestor Cramer, 1775*		
9.	Common Banded Peacock	*Papilio crino Fabricius, 1792*		
10.	Red Helen	*Papilio helenus Linnaeus, 1758*		
11.	Paris Peacock	*Papilio paris tamilana Linn.*		Endemic
12.	Southern birdwing	*Troides minos*		Endemic
13.	Common Silverline	*Spindasis vulcanus Fabricius, 1775*		
14.	Common Pierrot	*Castalius rosimon Fabricius, 1775*		
15.	Banded Blue Pierrot	*Discolampa ethion Westwood, 1851*		
16.	Red Pierrot	*Talicada nyseus GuerinMeneville, 1843*		
17.	Common Cerulean	*Jamides celeno Cramer, 1775*		
18.	Dark Cerulean	*Jamides bochus Stoll, 1782*		
19.	Lime Blue	*Chilades lajus Stoll, 1780*		
20.	Tiny Grass Blue	*Zizula hylax Fabricius, 1775*		
21.	Dark Grass Blue	*Zizeeria karsandra Moore, 1865*		
22.	Plains Cupid	*Chilades pandava Horsfield, 1829*		
23.	Grass Jewel	*Freyeria trochylus Freyer, 1845*		
24.	Blue Tiger	*Tirumala limniace Cramer, 1775*	LC	
25.	Dark Blue Tiger	*Tirumala septentrionis Butler, 1874*	LC	
26.	Plain Tiger	*Danaus chrysippus Linnaeus, 1758*	LC	
27.	Striped Tiger	*Danaus genutia Cramer, 1779*	LC	
28.	Glassy Tiger	*Parantica aglea Stoll, 1782*	LC	
29.	Nilgiri tiger	*Parantica nilgiriensis (Moore, 1877)*	NT	Endemic
30.	Common Crow	*Euploea core Cramer, 1780*	LC	
31.	Danaid Eggfly	*Hypolimnas misippus Linnaeus,*	LC	

S.No.	Common Name	Scientific Name	IUCN Status	Endemism
		1764		
32.	Great Eggfly	*Hypolimnas bolina Linnaeus, 1758*		
33.	Grey Pansy	*Junonia atlites Linnaeus, 1763*		
34.	Common Sailer	*Neptis hylas Linnaeus, 1758*		
35.	Common Fivering	*Ypthima baldus Fabricius, 1775*		
36.	Common Threering	*Ypthima asterope Klug, 1832*		
37.	Common Fourring	*Ypthima huebneri Kirby, 1871*		
38.	Common Lascar	*Pantoporia hordonia Stoll, 1790*		
39.	Indian Red Admiral	*Vanessa indica Herbst, 1794*		
40.	Blue Admiral	*Kaniska canace Linnaeus, 1763*		
41.	Common Evening Brown	*Melanitis leda Linnaeus, 1758*	LC	
42.	Common Bushbrown	*Mycalesis perseus Fabricius, 1775*	LC	
43.	Glad-eye Bushbrown	*Mycalesis patnia Moore, 185*		
44.	Indian fritillary	*Argynnis hyperbius (Linnaeus, 1763)*		
45.	Common Map	*Cyrestis thyodamas Boisduval, 1846*		
46.	Indian Cabbage White	*Pieris canidia Linnaeus, 1768*		
47.	Common Albatross	*Appias albina Boisduval, 1836*		
48.	Pioneer	*Anaphaeis aurota Fabricius, 1793*		
49.	Common Emigrant	*Catopsilia pomona Fabricius, 1775*		
50.	Mottled Emigrant	*Catopsilia pyranthe Linnaeus, 1758*		
51.	Common Jezebel	*Delias eucharis Drury, 1773*		
52.	Common Grass Yellow	*Eurema hecabe Linnaeus, 1758*		
53.	Small Grass Yellow	*Eurema brigitta Stoll, 178*		
54.	Spotless Grass Yellow	*Eurema laeta (Boisduval, 1836)*		
55.	Nilgiri Clouded Yellow	*Colias nilagiriensis,C. & R. Felder, 1859*		Endemic
56.	Great Orange Tip	*Hebomoia glaucippe Linnaeus, 1758*	LC	
57.	White Orange Tip	*Ixias marianne Cramer, 1779*		
58.	Large Salmon Arab	*Colotis fausta Olivier, 1804*		
59.	Common Wanderer	*Pareronia hippia Cramer, 1776*		
60.	Dark Wanderer	*Pareronia ceylanica C. & R. Felder, 1865*		
61.	Common Gull	*Cepora nerissa Fabricius, 1775*		
62.	Psyche	*Leptosia nina Fabricius, 1793*		
63.	Common Banded Awl	*Hasora chromus Cramer, 1780*		
64.	Common Spotted Flat	*Celaenorrhinus leucocera (Kollar, [1844])*		

S.No.	Common Name	Scientific Name	IUCN Status	Endemism
65.	Indian awlking	*Choaspes benjaminii (Guérin-Méneville, 1843)*		

Notes: NE = Not Evaluated; LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered

3.4.3 Aquatic Ecology

Six locations were selected along the stretch of the proposed pumping project for aquatic ecological study as given in Table-3.46 and shown in Figure-3.26.

Table-3.46: Sampling Stations for Aquatic Ecological Assessment

S. No	Location	District	Land mark	Latitude	Longitude
1.	Muthorai Palada	Nilgiris	Bridge	11.368869 ^{O}	76.665525 ^{O}
2.	Avalanche Dam	Nilgiris	Dam	11.328313 ^{O}	76.620828 ^{O}
3.	Emerald Dam	Nilgiris	Dam	11.319188^{O}	76.620461^{O}
4.	Yedakadu	Nilgiris	Bridge	11.302478^{O}	76.654086^{O}
5.	Kundha Upper Dam	Nilgiris	Bridge	11.302478^{O}	76.654086^{O}
6.	Kundha Lower Dam	Nilgiris	Bridge	11.282664^{O}	76.655149^{O}

Figure-3.26: Aquatic Ecological Sampling Location Map

Monitoring for three seasons listed below:

- Monsoon season : October – November 2021
- Post-monsoon season : February 2022 – March 2022
- Pre-monsoon Season : May 2022 – June 2022

Primary Productivity

The Gross Primary Productivity, Net Primary Productivity and Community Respiration were calculated using Light and Dark Bottle Methods. The Primary and Net Productivity for monsoon, post-monsoon and pre-monsoon seasons have been presented in Figures-3.27 to 3.29 respectively.

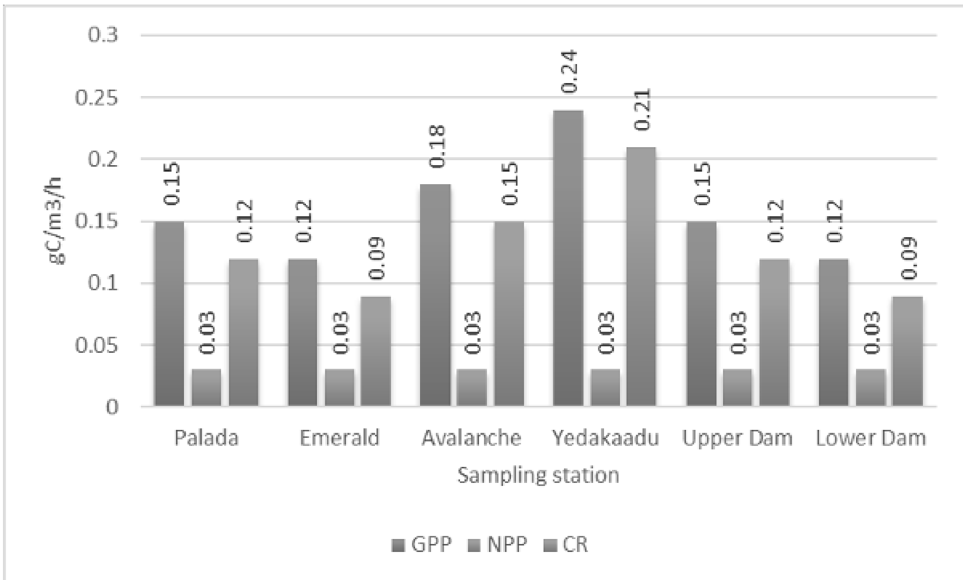


Figure-3.27: Primary and Net Productivity of the waterbodies (Monsoon Season)

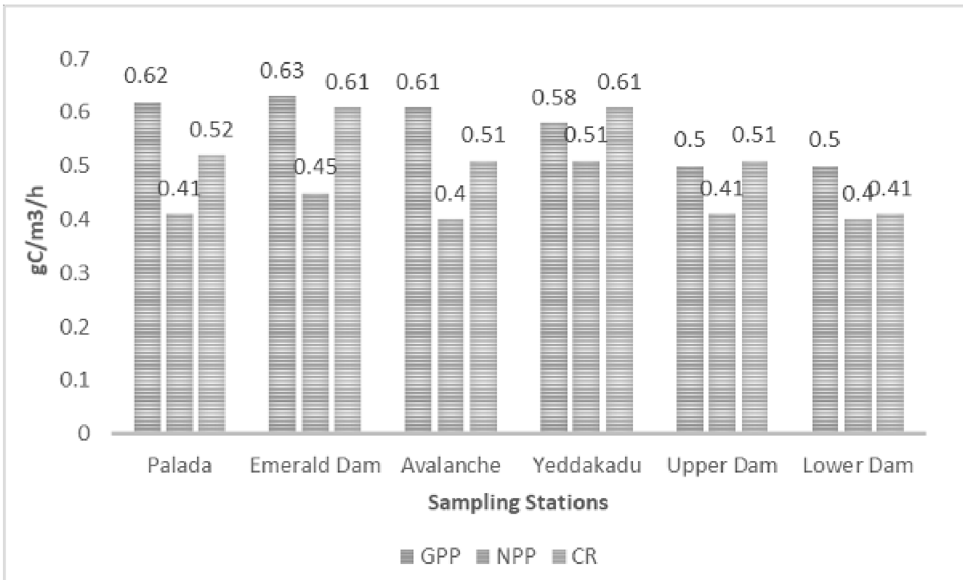


Figure-3.28: Primary and Net Productivity of the Waterbodies (Post-monsoon Season)

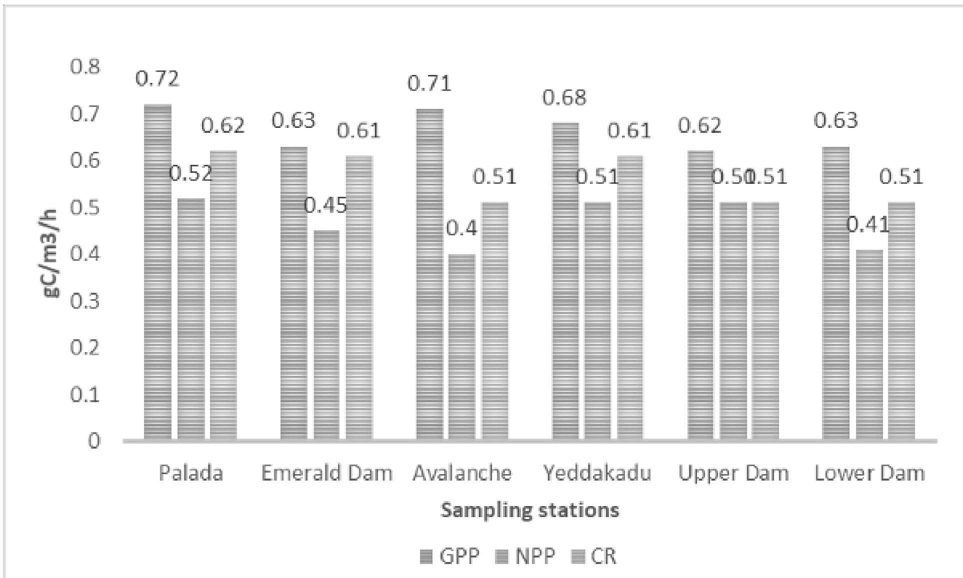


Figure-3.29: Primary and Net Productivity of the Waterbodies (Pre-monsoon Season)

Phosphates (PO_4^-): The maximum phosphate level (500 µg/l) was recorded in Yedakaadu followed by Avalanche (440 µg/l) and minimum (42 µg/l) was recorded in Emerald dam normally in the surface water, phosphate ranges from 0.005 mg/l (5 µg/l) to 0.05 mg/L (50 µg/l). Many freshwater bodies are currently experiencing in increase of phosphorous due to non - point sources of pollution including agricultural runoff. The phosphate levels as little as 0.15 mg/l (150 µg/l) are considered to be sufficient to trigger algal blooms in the surface water.

Of the 6 selected stations, phosphate level was recorded above 192 µg/l in two stations, viz., Yedakaadu and Avalanche in Monsoon. Based on phosphate values, it may be said that these two stations are covered by the algal scum and macrophytes.

Chlorophyll-a (Chl-a): The maximum choloraphyll value was recorded as 960 µg/l in Emerald dam and the minimum value was recorded as 18 µg/l at Emarald dam sampling site. From the three season data it is observed that Chlorophyll-a was higher during Pre-Monsoon season and minimum during Post monsoon season. The Chlorophyll`a' level observed during sampling conducted for post-monsoon,, pre-monsoon and monsoon seasons is given in Figures-3.30 to 3.32 respectively.

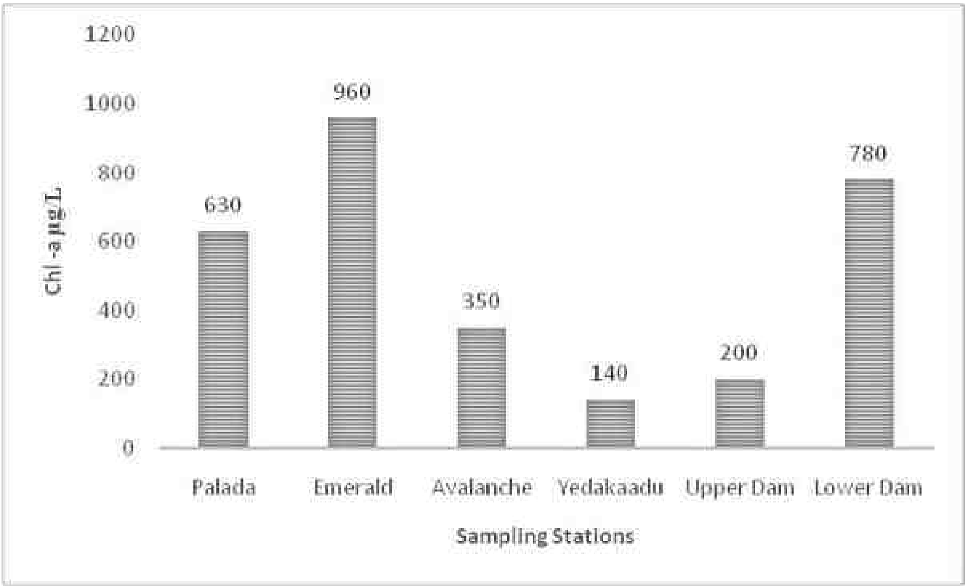


Figure 3.30: Chlorophyll-a of the waterbodies (Monsoon Season)

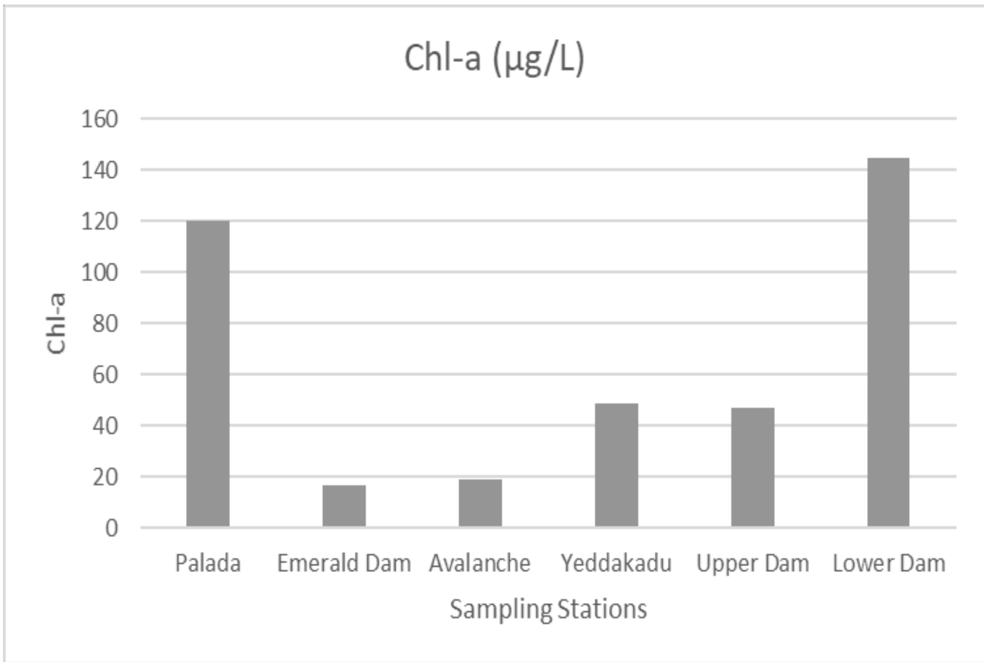


Figure 3.31: Chlorophyll-a of the waterbodies (Post-monsoon Season)

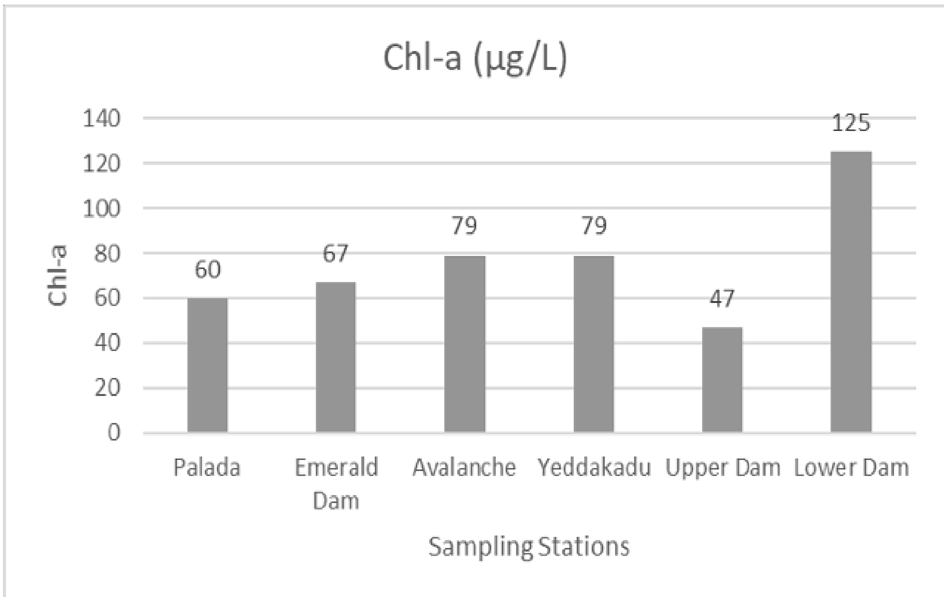


Figure 3.32: Chlorophyll-a of the waterbodies (Pre-monsooon Season)

Phytoplanktons

The phytoplankton species recorded at various sampling locations for 3 seasons monitored as a part of the field studies are given in Tables-3.47 to 3.49. A total of 17, 14 and 15 species were observed in monsoon, post-monsoon and pre-monsoon season respectively.

Zooplanktons

The zooplankton species recorded at various sampling locations in the seasons covered as a part of the field studies are given in Tables-3.50 to 3.52. A total of 11, 6 and 8 species were observed in monsoon, post-monsoon and pre-monsoon season respectively.

Benthos

The details of Benthos are are covered in Table-3.5.3

Fisheries

The list of fish species recorded at various sampling locations is given in Tables-3.54 to 3.56. A total of 11 to 14 fish species were recorded at various sampling locations.

Table-3.47: Phytoplanktons observed in the Waterbodies (Monsooon Season)

S. No	Name of Species	Kingdom	Phylum	Class	Order	Family	Genus	Species
1.	Anabaena	Bacteria	Negibacteria	Cyanobacteria	Nostocales	Nostocacae	*Anabaena*	*spiroides*
2.	Aulocoseira	Chromista	Ochrophyta	Bacillariophyacae	Aulacoseriales	Aulacoseriacae	*Aulocoseira*	*nivalis*
3.	Ceratium	Chromista	Dinoflagellata	Dinophyceae	Gonyaulacales	Ceratiaceae	*Certium*	*furca*
4.	Cosmarium	Plantae	Charophyta	Conjugatophyacae	Desmidales	Desmidacae	*Cosmarium*	*inornatum*
5.	Fragilaria	Chromista	Ochrophyta	Bacillariophyacae	Flagariales	Flagilariaceae	*Fragilaria*	*capucina*
6.	Fragilaria	Chromista	Ochrophyta	Bacillariophyacae	Flagariales	Flagilariaceae	*Fragilaria*	*construens*
7.	Fragilaria	Chromista	Ochrophyta	Bacillariophyacae	Flagariales	Flagilariaceae	*Fragilaria*	*crotonesis*
8.	Fragilaria	Chromista	Ochrophyta	Bacillariophyacae	Flagariales	Flagilariaceae	*Fragilaria*	*frustules*
9.	Melosira	Chromista	Ochrophyta	Bacillariophyceae	Melosirales	Melosiraceae	*Melosira*	*monoliformis*
10.	Microcystis	Bacteria	Cyanobacteria	Cyanophyacae	Chroococcales	Microcystaceae	*Microcystis*	*aerugonisa*
11.	Oscillatoria	Bacteria	Cyanobacteria	Cyanophyacae	Oscilaatorilaes	Oscillatoriacae	*Oscilatoria*	*princeps*
12.	Oscillatoria	Bacteria	Cyanobacteria	Cyanophyacae	Nostocales	Oscillatoriacae	*Oscillatoria*	*limosa*
13.	Raphidiopsis	Bacteria	Cyanobacteria	Cyanophyacae	Nostocales	Rivulariacaea	*Raphidiopsis*	*curvata*
14.	Spirogyra	Plantae	Algae	Zygnametophycae	Zygnametales	Zygnematcae	*Spirogyra*	*porticalis*
15.	Synedra	Chromista	Ochrophyta	Bacillariophyacae	Flagariales	Flagilariaceae	*Synedra*	*ulna*
16.	Synedra	Plantae	Algae	Flagiloriaphyacae	Fragilariales	Fragilariaceae	*Synedra*	*acus*
17.	Zygnema	Plantae	Charophyta	Zygnametophyacae	Zygnemateles	Zygnamatacae	*Zygnema*	*carteri*

Table-3.48: Phytoplankton observed in the Waterbodies (Post-monsoon Season)

S. No	Name of Species	Kingdom	Phylum	Class	Order	Family	Genus	Species
1.	Anabaena	Bacteria	Negibacteria	Cyanobacteria	Nostocales	Nostocacae	*Anabaena*	*spiroides*
2.	Aulocoseira	Chromista	Ochrophyta	Bacillariophyacae	Aulacoseriales	Aulacoseriacae	*Aulocoseira*	*nivalis*
3.	Cosmarium	Plantae	Charophyta	Conjugatophyacae	Desmidales	Desmidacae	*Cosmarium*	*inornatum*
4.	Fragilaria	Chromista	Ochrophyta	Bacillariophyacae	Flagariales	Flagilariaceae	*Fragilaria*	*capucina*
5.	Fragilaria	Chromista	Ochrophyta	Bacillariophyacae	Flagariales	Flagilariaceae	*Fragilaria*	*construens*
6.	Fragilaria	Chromista	Ochrophyta	Bacillariophyacae	Flagariales	Flagilariaceae	*Fragilaria*	*crotonesis*
7.	Fragilaria	Chromista	Ochrophyta	Bacillariophyacae	Flagariales	Flagilariaceae	*Fragilaria*	*frustules*
8.	Oscillatoria	Bacteria	Cyanobacteria	Cyanophyacae	Oscilaatorilaes	Oscillatoriacae	*Oscilatoria*	*princeps*
9.	Oscillatoria	Bacteria	Cyanobacteria	Cyanophyacae	Nostocales	Oscillatoriacae	*Oscillatoria*	*limosa*
10.	Raphidiopsis	Bacteria	Cyanobacteria	Cyanophyacae	Nostocales	Rivulariacaea	*Raphidiopsis*	*curvata*
11.	Spirogyra	Plantae	Algae	Zygnametophycae	Zygnametales	Zygnematcae	*Spirogyra*	*porticalis*
12.	Synedra	Chromista	Ochrophyta	Bacillariophyacae	Flagariales	Flagilariaceae	*Synedra*	*ulna*
13.	Synedra	Plantae	Algae	Flagiloriaphyacae	Fragilariales	Fragilariaceae	*Synedra*	*acus*
14.	Zygnema	Plantae	Charophyta	Zygnametophyacae	Zygnemateles	Zygnamatacae	*Zygnema*	*carteri*

Table-3.49: Phytoplankton observed in the Waterbodies (Pre-monsoon Season)

S. No.	Name of Species	Kingdom	Phylum	Class	Order	Family	Genus	Species
1.	Anabaena	Bacteria	Negibacteria	Cyanobacteria	Nostocales	Nostocacae	*Anabaena*	*Spiroides*
2.	Aulocoseira	Chromista	Ochrophyta	Bacillariophyacae	Aulacoseriales	Aulacoseriacae	*Aulocoseira*	*nivalis*
3.	Ceratium	Chromista	Dinoflagellata	Dinophyceae	Gonyaulacales	Ceratiaceae	*Certium*	*furca*
4.	Fragilaria	Chromista	Ochrophyta	Bacillariophyacae	Flagariales	Flagilariaceae	*Fragilaria*	*capucina*
5.	Fragilaria	Chromista	Ochrophyta	Bacillariophyacae	Flagariales	Flagilariaceae	*Fragilaria*	*construens*
6.	Fragilaria	Chromista	Ochrophyta	Bacillariophyacae	Flagariales	Flagilariaceae	*Fragilaria*	*crotonesis*
7.	Fragilaria	Chromista	Ochrophyta	Bacillariophyacae	Flagariales	Flagilariaceae	*Fragilaria*	*frustules*
8.	Microcystis	Bacteria	Cyanobacteria	Cyanophyacae	Chroococcales	Microcystaceae	*Microcystis*	*aerugonisa*
9.	Oscillatoria	Bacteria	Cyanobacteria	Cyanophyacae	Oscilaatorilaes	Oscillatoriacae	*Oscilatoria*	*princeps*
10.	Oscillatoria	Bacteria	Cyanobacteria	Cyanophyacae	Nostocales	Oscillatoriacae	*Oscillatoria*	*limosa*
11.	Raphidiopsis	Bacteria	Cyanobacteria	Cyanophyacae	Nostocales	Rivulariacaea	*Raphidiopsis*	*curvata*
12.	Spirogyra	Plantae	Algae	Zygnametophycae	Zygnametales	Zygnematcae	*Spirogyra*	*porticalis*
13.	Synedra	Chromista	Ochrophyta	Bacillariophyacae	Flagariales	Flagilariaceae	*Synedra*	*ulna*
14.	Synedra	Plantae	Algae	Flagiloriaphyacae	Fragilariales	Fragilariaceae	*Synedra*	*acus*
15.	Zygnema	Plantae	Charophyta	Zygnametophyacae	Zygnemateles	Zygnamatacae	*Zygnema*	*carteri*

Table-3.50: Zooplankton observed in the Waterbodies (Monsoon Season)

S. No	Name of Species	Kingdom	Phylum	Class	Order	Family	Genus	Species
1.	Anuraea	Animalia	Rotifer	Eurotatoria	Ploima	Brochionidae	Anuraea	longispina
2.	Copepoda	Animalia	Arthropoda	Hexanaulia	Cyclopodia	Acartiidae	Copepod	carcasses
3.	Brachionus	Animalia	Rotifera	Monogononta	Ploima	Brachionidae	Brachionus	plicatilis
4.	Daphnia	Animalia	Arthropoda	Branchiopoda	Cladocera	Dhaphniidae	Dhapnia	pulex
5.	Eucyclops	Animalia	Arthoropoda	Maxillopoda	Cyclopoida	Cyclopidae	Eucyclops	elegans
6.	Hyperia	Animalia	Arthopoda	Malocastroca	Amphipoda	Hyperiidae	Hyperia	macrocephala
7.	Limnocalanus	Animalia	Arthopoda	Maxillopoda	Calanoida	Centropagidae	Limnocalanus	macrurus
8.	Mesicyclops	Animalia	Arthoropoda	Hexanauplia	Cyclopoida	Cyclopidae	Mesicyclops	agilli
9.	Mesosyclops	Animalia	Arthopoda	Hexanauplia	Cyclopida	Cyclopoidae	Mesosyclops	leuckarti
10.	Monostyla	Animalia	Rotifera	Monogononta	Ploima	Lecanidae	Monostyla	copies
11.	Nauplius	Animalia	Arthoropoda	Crustacae	Crangonacae	Crangonidae	Nauplius	larvae

Table-3.51: Zooplanktons observed in the Waterbodies (Post-monsoon Season)

S. No.	Name of Species	Kingdom	Phylum	Class	Order	Family	Species	Genus
1.	Daphnia	Animalia	Arthropoda	Branchiopoda	Cladocera	Dhaphniidae	pulex	Dhapnia
2.	Eucyclops	Animalia	Arthoropoda	Maxillopoda	Cyclopoida	Cyclopidae	elegans	Eucyclops
3.	Hyperia	Animalia	Arthopoda	Malocastroca	Amphipoda	Hyperiidae	macrocephala	Hyperia
4.	Mesicyclops	Animalia	Arthoropoda	Hexanauplia	Cyclopoida	Cyclopidae	agilli	Mesicyclops
5.	Mesosyclops	Animalia	Arthopoda	Hexanauplia	Cyclopida	Cyclopoidae	leuckarti	Mesosyclops
6.	Nauplius	Animalia	Arthoropoda	Crustacae	Crangonacae	Crangonidae	larvae	Nauplius

Table-3.52: Zooplankton observed in the Waterbodies (Pre-monsoon Season)

S. No.	Name of Species	Kingdom	Phylum	Class	Order	Family	Species	Genus
1.	Brachionus	Animalia	Rotifera	Monogononta	Ploima	Brachionidae	Brachionus	plicatilis
2.	Copepoda	Animalia	Arthropoda	Hexanaulia	Cyclopodia	Acartiidae	Copepod	carcasses
3.	Daphnia	Animalia	Arthropoda	Branchiopoda	Cladocera	Dhaphniidae	pulex	Dhapnia
4.	Eucyclops	Animalia	Arthoropoda	Maxillopoda	Cyclopoida	Cyclopidae	elegans	Eucyclops
5.	Hyperia	Animalia	Arthopoda	Malocastroca	Amphipoda	Hyperiidae	macrocephala	Hyperia
6.	Mesicyclops	Animalia	Arthoropoda	Hexanauplia	Cyclopoida	Cyclopidae	agilli	Mesicyclops
7.	Mesosyclops	Animalia	Arthopoda	Hexanauplia	Cyclopida	Cyclopoidae	leuckarti	Mesosyclops
8.	Nauplius	Animalia	Arthoropoda	Crustacae	Crangonacae	Crangonidae	larvae	Nauplius

Table-3.53: Benthos Observed in the Waterbodies (Monsoon season)

S. No	Name of Species	Kingdom	Phylum	Class	Order	Family	Genus	Species
1.	Chironomous larvae	Animalia	Arthopoda	Insecta	Diptera	Chironomidae	Chironomous	Plumosus
2.	Earthworm	Animalia	Anellida	Clitellata	Opisthopora	Lumbricidae	Lumbricus	Terrestris
3.	Sand fly larvae	Animalia	Arthopoda	Insecta	Diptera	Pshycodidae	Phelbotomous	Alexandri
4.	Tubifex	Animalia	Anallida	Clitellata	Haplotaxida	Naididae	Tubifex	tubifex

Table-3.54: Fishes observed in the Waterbodies (Monsoon Season)

S. No	Common Name	Scientific Name	IUCN Status
1.	Bullseye snakehead fish	*Channa marulius*	LC
2.	Catla	*Catla catla*	LC
3.	Carassius carassius	*Carassius carassius*	LC
4.	Cuttle fish	*Sepiida zittel*	-
5.	Cyprinus carpio	*Cyprinus carpio*	VU
6.	Electric eel	*Electrophorus electricus*	LC
7.	Fringe barbel	*Bastard sturgeon*	CR
8.	Indian Anchovy	*Stolephorus indicus*	LC
9.	Indian prawn	*Fenneropenaeus Indicus*	-
10.	Lergehead hairtail	*trichiurus lepturus*	LC
11.	Mosambique Tilapia	*Oreochromis mossambicus*	VU
12.	Nile tilapia	*Oreochromis niloticus*	LC
13.	Rohu fish	*Labeo rohita*	LC
14.	Wellscat fish	*Silurus Glanis*	LC

Notes: LC= Least Concern; VU= Vulnerable; CR= Critically Endangered - = Not listed; IUCN= International Union for Conservation of Nature

Table-3.55: Fishes observed in the Waterbodies (Post-monsoon Season)

S. No	Common Name	Scientific Name	IUCN Status
1.	Bullseye snakehead fish	*Channa marulius*	LC
2.	Catla	*Catla catla*	LC
3.	Cuttle fish	*Sepiida zittel*	-
4.	Electric eel	*Electrophorus electricus*	LC
5.	Fringe barbel	*Bastard sturgeon*	CR
6.	Indian Anchovy	*Stolephorus indicus*	LC
7.	Indian prawn	*Fenneropenaeus indicus*	-
8.	Lergehead hairtail	*trichiurus lepturus*	LC
9.	Nile tilapia	*Oreochromis niloticus*	LC
10.	Rohu fish	*Labeo rohita*	LC
11.	Wellscat fish	*Silurus Glanis*	LC

Notes: LC= Least Concern; CR= Critically Endangered - = Not listed; IUCN= International Union for Conservation of Nature

Table-3.56 Fishes observed in the Waterbodies (Pre-Monsoon Season)

S. No	Common Name	Scientific Name	IUCN Status
1.	Bullseye snakehead fish	*Channa marulius*	LC
2.	Catla	*Catla catla*	LC
3.	Carassius carassius	*Carassius carassius*	LC
4.	Cuttle fish	*Sepiida zittel*	-
5.	Cyprinus carpio	*Cyprinus carpio*	VU
6.	Electric eel	*Electrophorus electricus*	LC
7.	Fringe barbel	*Bastard sturgeon*	CR
8.	Indian Anchovy	*Stolephorus indicus*	LC
9.	Indian prawn	*Fenneropenaeus Indicus*	-
10.	Lergehead hairtail	*trichiurus lepturus*	LC
11.	Mosambique Tilapia	*Oreochromis Mossambicus*	-
12.	Nile tilapia	*Oreochromis niloticus*	LC
13.	Rohu fish	*Labeo rohita*	LC
14.	Wellscat fish	*Silurus Glanis*	LC

Notes: LC= Least Concern; VU= Vulnerable; CR= Critically Endangered - = Not listed; IUCN= International Union for Conservation of Nature

3.5 Socio-Economic Aspects

3.5.1 Demographic profile

The study area comprises of 2 community development blocks in Niligiris district. The location of study area villages is depicted in Figure 3.33. The total population in the study area villages is of the order of 19382 persons as per Census 2011. The distribution of population and demographic profile in the study area villages is outlined in Table-3.57.

Table-3.57: Demographic profile in Study Area Villages

S.No	Village Name	Total Household	Total Population	Total Male	Total Female	Population <6 years	Average Family Size	Sex Ratio
1.	Balacola	4097	13622	6515	7107	871	3	1091
2.	Doddapetta	2419	8214	4097	4117	652	3	1005
3.	Ithalar	2814	9876	4760	5116	712	3	1075
4.	Kundah	1124	3412	1655	1757	205	3	1062
5.	Mulligoor	1363	4647	2301	2346	433	3	1019

S.No	Village Name	Total Household	Total Population	Total Male	Total Female	Population <6 years	Average Family Size	Sex Ratio
6.	Nanjanadu	3621	13007	6354	6653	1025	3	1047
7.	Melur	3944	13244	6442	6802	1101	3	1056
Total		**19382**	**66022**	**32124**	**33898**	**4999**	**3**	**1055**

Source: Census of India, 2011

The male and female population in study area villages comprises about 50.01% and 49.98% respectively of the total population. The population comprising of children below the age of 6 years accounts for about 10.9% of the total population in the study area villages. The sex ratio (no. of females per 1000 males) and average family size in the study area villages is 1055 and 3 persons per family respectively.

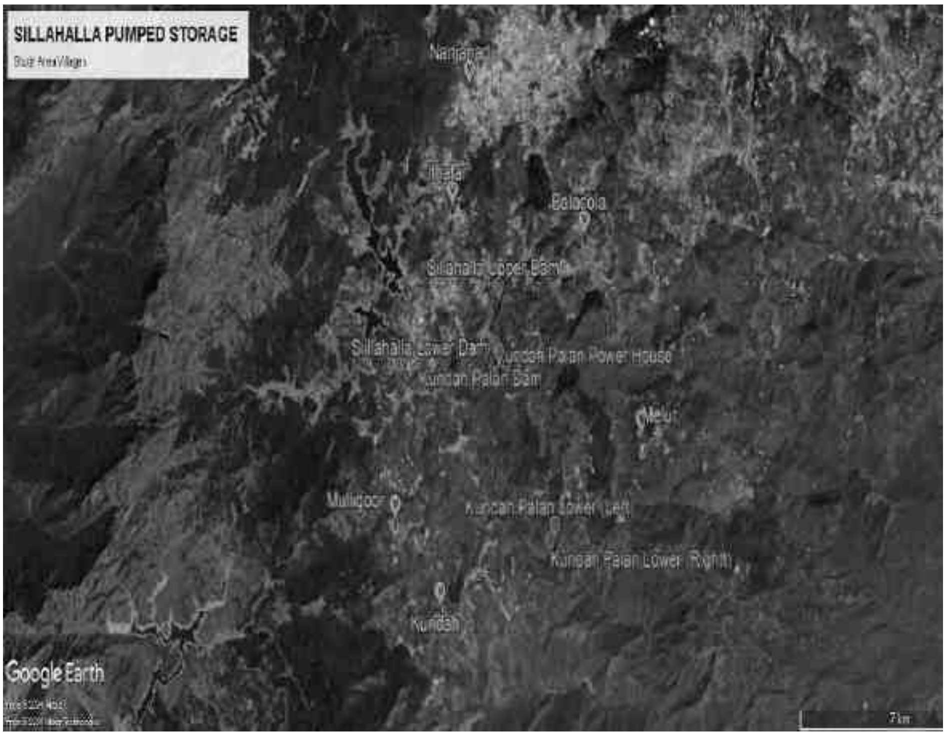


Figure 3.33: Location of Study Area Villages

3.5.2 Caste Profile

The distribution of population in study area villages on the basis of caste is summarized in Table-3.58 and Figure-3.34. The Schedule Castes and Schedule Tribes population of Study Area Villages accounts for 39% and 2.29% of the total population respectively.

Table-3.58: Caste profile in Study Area Villages

S.No	Village Name	Total Population	Schedule Caste	Schedule Tribe	General Caste
1.	Balacola	13622	4253	55	9314
2.	Doddapetta	8214	3587	178	4449
3.	Ithalar	9876	2968	68	6840
4.	Kundah	3412	1742	156	1514
5.	Mulligoor	4647	2511	88	2048
6.	Nanjanadu	13007	4144	460	8403
7.	Melur	13244	6529	507	6208
Total		**66022**	**25734**	**1512**	**38776**

Source: Census of India, 2011

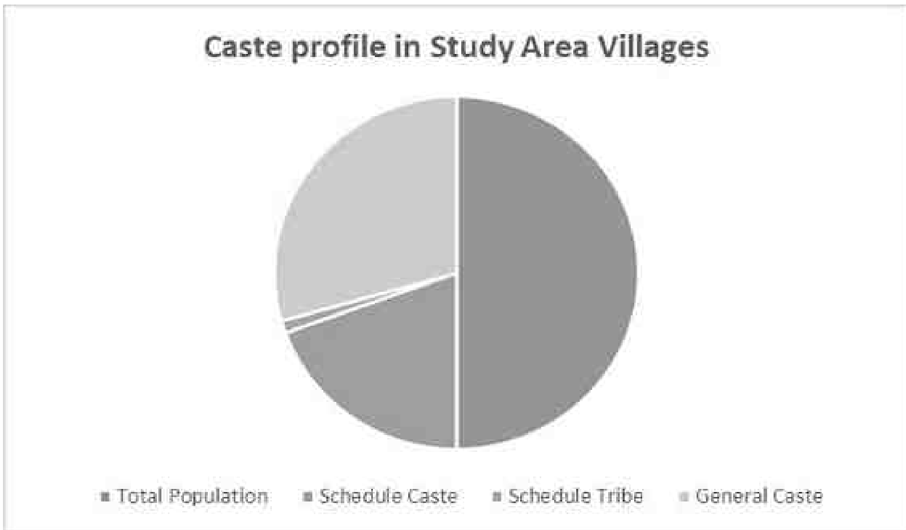


Figure – 3.34: Caste profile in the study area villages

3.5.3 Literacy Levels

The details of literate and illiterate population amongst the total population of study area villages is given in Table-3.59. It is observed that about 75.23% of the total population in the study area villages is literate, while about 24.76% are illiterate (Refer Figure–3.35). The literacy rate among male and female population is 82.74% and 68.11% respectively.

Table-3.59: Distribution of literate and illiterate population in study area villages

S.No	Village Name	Total Population	Population Literate	Male Literate	Female Literate	Population Illiterate	Male Illiterate	Female Illiterate
1.	Balacola	13622	10923	5633	5290	2699	882	1817
2.	Doddapetta	8214	6074	3305	2769	2140	792	1348
3.	Ithalar	9876	7485	3998	3487	2391	762	1629
4.	Kundah	3412	2405	1319	1086	1007	336	671
5.	Mulligoor	4647	3411	1850	1561	1236	451	785
6.	Nanjanadu	13007	9409	5088	4321	3598	1266	2332
7.	Melur	13244	9966	5389	4577	3278	1053	2225
Total		**66022**	**49673**	**26582**	**23091**	**16349**	**5542**	**10807**

Source: Census of India, 2011

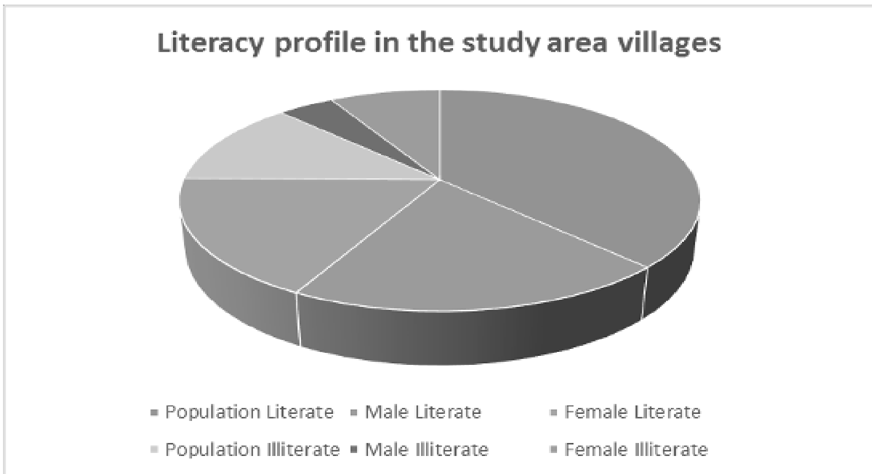


Figure – 3.35: Literacy profile in Study Area Villages

3.5.4 Occupational profile

The details on occupational profile in the study area villages are given in Table-3.60. It is observed that 57.37% of the total population is engaged in some form of economically productive activity or vocational activity, and have been designated as Total Working population. On the other hand, Non-workers or persons who are dependent on the population, which is engaged in economically productive work accounts for about 42.63% of the total population.

Table-3.60: Occupational profile in the study area villages

S.No	Village Name	Total Population	Total Working Population	Total Male Workers	Total Female Workers	Main-Workers	Marginal - Workers	Non-Workers
1.	Balacola	13622	7863	3989	3874	7421	442	5759
2.	Doddapetta	8214	4577	2623	1954	4305	272	3637
3.	Ithalar	9876	6426	3276	3150	5758	668	3450
4.	Kundah	3412	1955	1038	917	1902	53	1457
5.	Mulligoor	4647	2559	1391	1168	2524	35	2088
6.	Nanjanadu	13007	7272	3985	3287	6545	727	5735
7.	Melur	13244	7228	3836	3392	6739	489	6016
Total		**66022**	**37880**	**20138**	**17742**	**35194**	**2686**	**28142**

Source: Census of India, 2011

Figure -3.36 represents the occupational profile of the study area on the basis of gender.

It can be concluded form it is observed that:

- Working population accounts for about 57.37% of the total polulation
- Non-Working population accounts for about 42.63% of the total polulation
- Male workers account for about 53.16% of the working total polulation
- Female workers account for about 46.84% of the working total polulation

Among the population that is working about 92.91% has been designated as Main workers while the remaining 7.09 % has been designated as Marginal workers. Figure–3.37 presents the occupational pofile of the Study Area.

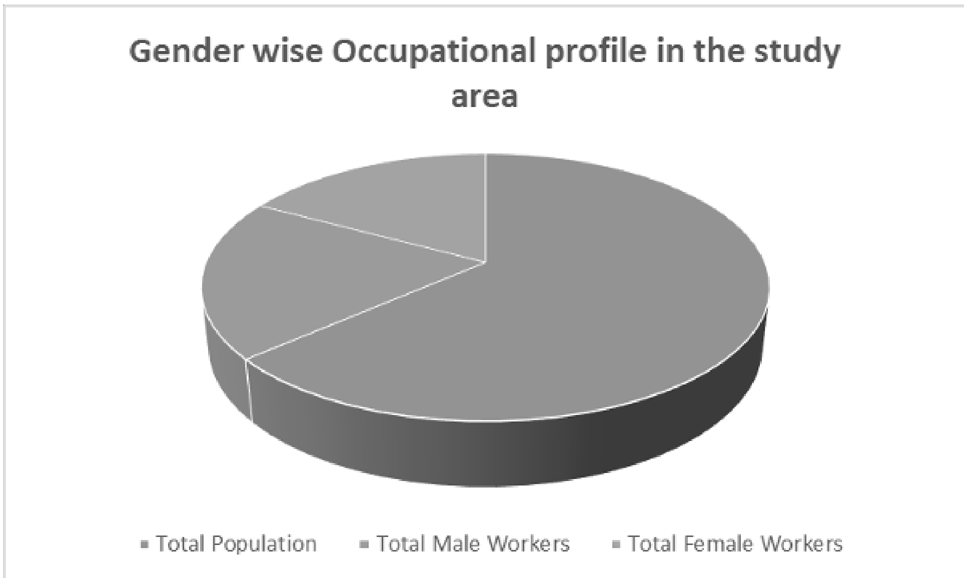


Figure – 3.36: Genderwise Occupational profile in Study Area Villages

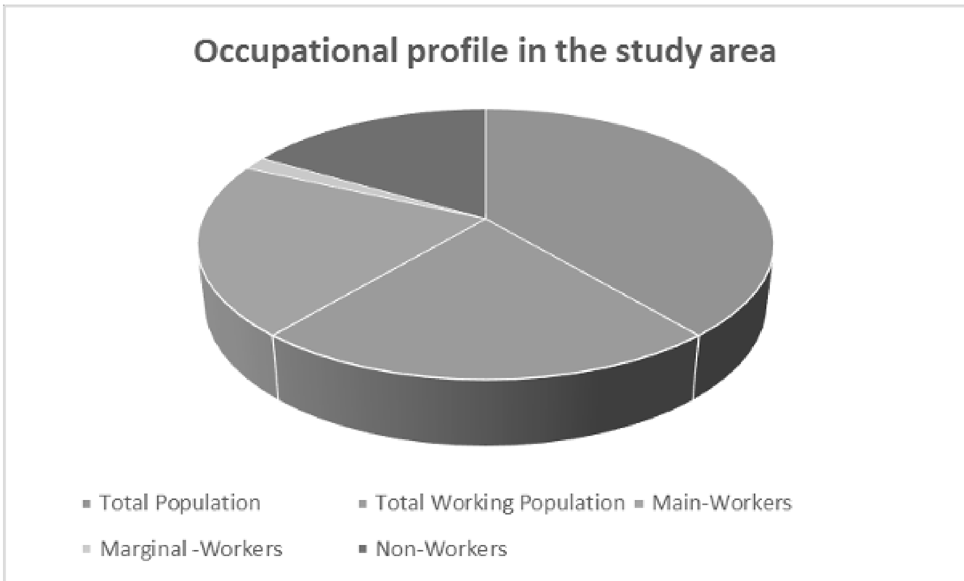


Figure – 3.37: Occupational profile in Study Area Villages

3.5.5 Availability of Different Amenities

The distribution of community development block according to the availability of different amenities like education, medical, drinking water, telephone, transport, communications, approach by pucca road and power supply within the villages are presented in Table 3.61 to 3.66 and depicted in Figures 3.38 and 3.39 respectively.

3.5.5.1 Educational Institutions

The availability of educational institutions in the project villages vary significantly based on factors like geography, government policies, population.

- **Pre-Primary, Primary and Middle Schools**: All the project affected villages have pre-primary, primary and atleast one middle school. These schools aim to provide basic education to children.
- **Secondary Schools**: Most of the project villages have access to secondary schools.
- **Senior Secondary Schools:** Access to senior secondary schools is limited in the project affected villages, as some villages may have nearby secondary schools, while others might require students to travel to neighboring villages.

- **Higher Education**: Villages typically have no options for higher education institutions. Many students may need to relocate to urban areas for colleges and universities.

Table 3.61: Villages having Educational Institutions

S No.	Name of Village	Total Population	Total number of Households	Villages having Educational institutions						
				Pre-primary school	Primary school	Middle school	Secondary school	Senior secondary school (SS)	Degree college of arts sceince & commerce	Medical college
1	Balacola	13622	4097	13	12	10	7	4	-	-
2	Doddapetta (Udhagamandalam)	8214	2419	2	3	2	3	-	-	-
3	Ithalar	9876	2814	7	10	5	4	1	-	-
4	Kundah	3412	1124	2	3	2	-	-	-	-
5	Mulligoor	4647	1363	8	4	1	-	-	-	-
6	Nanjanadu	13007	3621	4	9	5	1	1	-	-
7	Melur	13244	3944	8	8	3	2	1	-	-
	Total	**66022**	**19382**	**44**	**49**	**28**	**17**	**7**	**-**	**-**

Source: Census of India, 2011

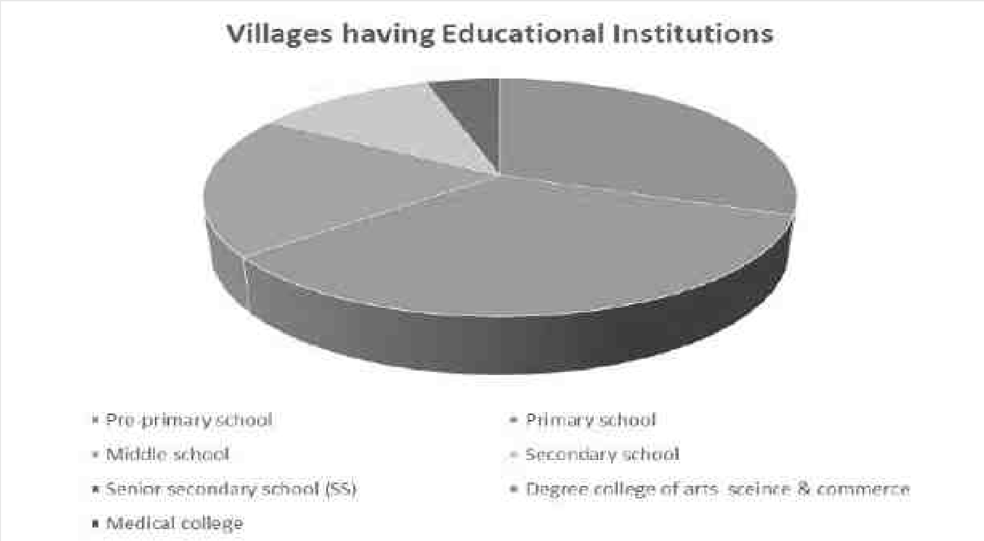


Figure 3.38: Villages having Educational Institutions

3.5.5.2 Medical Institutions

The availability of medical institutions in villages are reported as below:

- **Primary Health Care Centers (PHCs)**: Some villages of the project affected villages have PHCs, which provide essential health services, including maternal and child health care, immunizations, and basic treatments.
- **Community Health Centres/ Maternity and child welfare centre/ Hospitals**: Most of the project affected villages don't have the facility of community health centre/ Maternity and child welfare centre/ Hospitals.

Table 3.62: Villages having Medical Institutions

S No.	Name of Village	Total Population	Total number of Households	Villages having Medical institutions						
				Community health centre	Primary health centre	Maternity and child welfare centre	T.B. clinic	Hospital-allopathic	Dispensary	Family welfare centre
1	Balacola	13622	4097	1	1	1	1	-	1	1
2	Doddapetta	8214	2419	-	-	-	-	-	-	-

S No.	Name of Village	Total Population	Total number of Households	Villages having Medical institutions						
				Community health centre	Primary health centre	Maternity and child welfare centre	T.B. clinic	Hospital-allopathic	Dispensary	Family welfare centre
	(Udhagamandalam)									
3	Ithalar	9876	2814	-	1	1	1	-	1	1
4	Kundah	3412	1124	-	-	-	-	-	-	-
5	Mulligoor	4647	1363	-	-	-	-	-	-	-
6	Nanjanadu	13007	3621	-	1	1	1	-	1	1
7	Melur	13244	3944							
	Total	**66022**	**19382**							

Source: Census of India, 2011

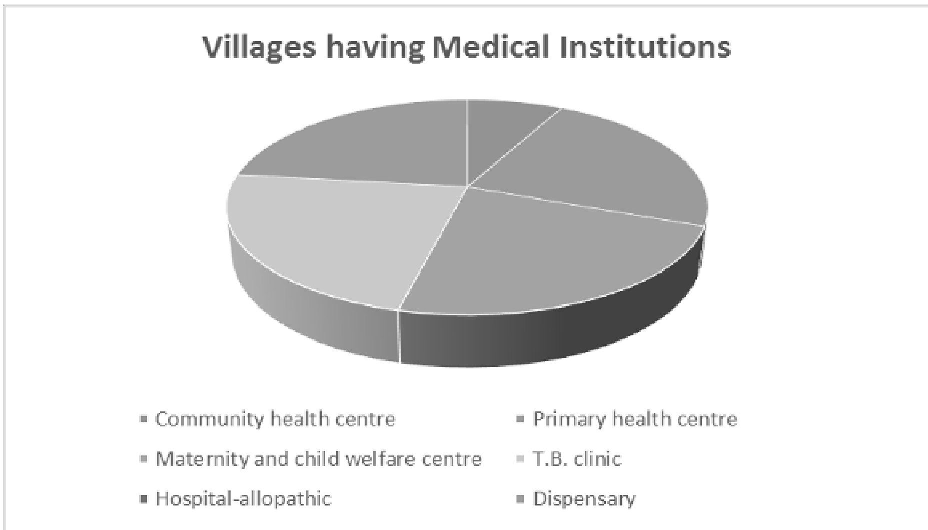


Figure 3.33: Villages having Medical Institutions

Figure 3.39: Villages having Medical Institutions

3.5.5.3 Drinking Water Facilities

Potable drinking water facilities are available in allthe project affected villages. Tap water in all the villages with option of well, spring tubewell and handpump are also available in some of the villages.The details of Villages having Drinking Water Facilities are given in Table-3.63.

Table 3.63: Villages having Drinking Water Facilities

S No.	Name of Village	Total Population	number of Household	Villages having Drinking Water Facilities							
				Tap water	Well water	Hand pump	Tubewell/ borewell	Spring	River/ canal	Tank/ pond/ lake	Others
1	Balacola	13622	4097	Y	Y	N	Y	Y	Y	N	Y
2	Doddapetta (Udhagamandalam)	8214	2419	Y	Y	N	Y	Y	Y	Y	N
3	Ithalar	9876	2814	Y	Y	N	N	Y	Y	Y	N
4	Kundah	3412	1124	Y	N	N	N	Y	N	N	N
5	Mulligoor	4647	1363	Y	Y	N	Y	Y	Y	N	N
6	Nanjanadu	13007	3621	Y	Y	Y	Y	Y	Y	Y	N
7	Melur	13244	3944	Y	Y	N	Y	Y	Y	N	Y
	Total	**66022**	**19382**								

**Y = Yes; N = No* *Source: Census of India, 2011*

3.5.5.4 Post & Telegraph Facilities

All the project affected villages have the facility of Sub post office, Phone (land lines), Public call office and Mobile phone coverage. However, some villages also have the facility of Post Office, Internet Café and Common Facility Centres. The details of Villages having Post & Telegraph Facilities are given in Table-3.64.

Table 3.64: Villages having Post & Telegraph Facilities

S No.	Name of Village	Total Population	Total number of Households	Villages having Post & Telegraph						
				Post office	Sub post office	Post & telegraph office	Phone (land lines)	Public call office	Mobile phone coverage	Internet cafe/ Common service centre
1	Balacola	13622	4097	-	Yes	-	Yes	Yes	Yes	-
2	Doddapetta (Udhagamandalam)	8214	2419	-	Yes	-	Yes	Yes	Yes	-
3	Ithalar	9876	2814	Yes	Yes	Yes	Yes	Yes	Yes	Ye

S No.	Name of Village	Total Population	Total number of Households	Villages having Post & Telegraph						
				Post office	Sub post office	Post & telegraph office	Phone (land lines)	Public call office	Mobile phone coverage	Internet cafes/ Common service centre
										s
4	Kundah	3412	1124	-	Yes	-	Yes	Yes	Yes	-
5	Mulligoor	4647	1363	Yes	Yes	Yes	Yes	Yes	Yes	Ye s
6	Nanjanadu	13007	3621	-	Yes	-	Yes	Yes	Yes	-
7	Melur	13244	3944	-	Yes	-	Yes	Yes	Yes	-
	Total	**66022**	**19382**							

Source: Census of India, 2011

3.5.5.5 Transport Facilities

Transport facilities such as pucca road and bus services are available in all the project affected villages. Limited options of vans/ taxi services are also available in some villages. None of the villages in the project are are connected with railway facilities. The details Villages having Transport Facilities are given in Table3.65.

Table 3.65: Villages having Transport Facilities

S No.	Name of Village	Total Population	er of Ho	Villages having Transport Facilities				
				Village roads- pucca road	Bus service (public/private)	Railway station	Auto/ modified autos	Taxi & vans
1	Balacola	13622	4097	Yes	Yes	No	No	Yes
2	Doddapetta (Udhagamandalam)	8214	2419	Yes	Yes	No	No	No
3	Ithalar	9876	2814	Yes	Yes	No	No	Yes
4	Kundah	3412	1124	Yes	Yes	No	No	No
5	Mulligoor	4647	1363	Yes	Yes	No	No	Yes
6	Nanjanadu	13007	3621	Yes	Yes	No	No	No
7	Melur	13244	3944	Yes	Yes	No	No	No
	Total	**66022**	**19382**					

Source: Census of India, 2011

3.5.5.6 Bank Facilities & Credit Societies

Most of the villages have the facility of cooperative/ commercial banks in the project area. Agricultural credit societies are also functional in the area but ATM services are majorly missing. The details of Villages having Bank Facilities & Credit Societies are given in Table-3.66.

Table 3.66: Villages having Bank Facilities & Credit Societies

S No.	Name of Village	Total Population	Total number of Households	Villages Bank Facilities & Credit Societies		
				Commercial & co-operative	ATM	Agricultural credit societies
1	Balacola	13622	4097	No	No	Yes
2	Doddapetta (Udhagamandalam)	8214	2419	Yes	Yes	No
3	Ithalar	9876	2814	Yes	No	Yes
4	Kundah	3412	1124	Yes	No	Yes
5	Mulligoor	4647	1363	Yes	No	Yes
6	Nanjanadu	13007	3621	Yes	No	Yes

S No.	Name of Village	Total Population	Total number of Households	Villages Bank Facilities & Credit Societies		
				Commercial & co-operative	ATM	Agricultural credit societies
7	Melur	13244	3944	Yes	No	Yes
	Total	**66022**	**19382**			

Source: Census of India, 2011

3.5.5.7 Miscellaneous Facilities

Public distribution system (PDS) shop is available in all the project affected villages. Birth & death registration office is also functional in the villages. Project affected villages also have the assembly polling station and all the villages are also electrified. The details are given in Table-3.67.

Table 3.67: Miscellaneous Facilities in Villages

S No.	Name of Village	Total Population	Total number of Households	Miscellaneous				
				Public distribution system (PDS) shop	Weekly haat	Asembly polling station	Birth & death registration office	Power Supply
1	Balacola	13622	4097	Yes	No	Yes	Yes	Yes
2	Doddapetta (Udhagamandalam)	8214	2419	Yes	No	Yes	Yes	Yes
3	Ithalar	9876	2814	Yes	No	Yes	Yes	Yes
4	Kundah	3412	1124	Yes	No	Yes	Yes	Yes
5	Mulligoor	4647	1363	Yes	No	Yes	Yes	Yes
6	Nanjanadu	13007	3621	Yes	No	Yes	Yes	Yes
7	Melur	13244	3944	Yes	No	Yes	Yes	Yes
	Total	**66022**	**19382**					

Source: Census of India, 2011

3.6 Agriculture

The major crops grown in the development block are potato, turnip, carrot, beet root, cabbage under vegetable crop cultivation, in fruit crop cultivation banana, guava, mango and strawberry, garlic and chillies under spice crop, rose, carnation, gerbera under flower crop and tea and coffee in plantation crops are cultivated. These crops account for the major share in the crop production in the development block Udhagamandalam.

The Area, production and productivity of vegetable crops, fruit crops, Spices and Condiments, flowers, plantation crops and oilseeds in project area block is given in Table-3.68 to 3.73 respectively.

Table-3.68: Area, production and productivity of vegetable crops

S No.	Crop	Area (ha)	Production (tonnes)	Productivity (tonne/ha)
1.	Potato	1409.8	30310.70	21.5
2.	Cabbage	333.14	21071.11	63.3
3.	Carrot	2209.88	70716.16	32.0
4.	Beans	582.39	4804.72	8.3
5.	Beetroot	398.20	9556.80	24.0
6.	Radish	163.85	3794.77	23.2
7.	Cauliflower	66.00	1650.00	25.0
8.	Turnip	417.10	9593.30	23.0
9.	Peas	29.60	276.76	9.4
10.	Others	46.0	662.0	14.4

Source: District Agriculture Plan ’2017

Table-3.69: Area, prduction and productivity of fruit crops

S No.	Crop	Area (ha)	Production (tonnes)	Productivity (tonne/ha)
1.	Banana	1.30	32.50	25.0
2.	Guava	0.40	2.20	5.5
3.	Mango	0.80	3.20	4.0
4.	Strawberry	0.48	4.32	9.0

Source: District Agriculture Plan ’2017

Table-3.70: Area, production and productivity of Spices and Condiments

S No.	Crop	Area (ha)	Production (tonnes)	Productivity (tonne/ha)
1.	Garlic	119.00	833.00	7.0
2.	Chillies	21.00	13.65	0.7

Source: District Agriculture Plan ’2017

Table-3.71: Area, production and productivity of Flowers

S No.	Crop	Area (ha)	Production (*Lakhs in stems*)	Productivity (stems in lakh/ha)
1.	Rose	11.00	165.00	15.0
2.	Carnation	23.00	287.50	12.5
3.	Gerbera	8.81	202.63	23.0

Source: District Agriculture Plan ’2017

Table-3.72: Area, production and productivity of Plantation Crops

S No.	Crop	Area (ha)	Production (tonnes)	Productivity (tonne/ha)
1.	Tea	14477.20	138981.12	9.6
2.	Coffee	613.30	398.65	0.7

Source: District Agriculture Plan ’2017

Table-3.73: Area, production and productivity of Oil seeds

S No.	Crop	Area (ha)	Production (tonnes)	Productivity (tonne/ha)
1.	Mustard	0.10	0.03	0.3
2.	Coconut	15.40	107.80	7.0

Source: District Agriculture Plan ’2017

There are no major sources of irrigation in the district. Major sources of water supply for irrigation in this district include 510 open wells.

CHAPTER-4

ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

4.1 General

Based on the project details and the baseline environmental status, potential impacts as a result of the construction and operation of the proposed Sillahalla Pumped Storage Project have been identified. This Chapter addresses the basic concepts and methodological approach for conducting a scientifically based analysis of the potential impacts likely to accrue as a result of the proposed project. The Environmental Impact Assessment (EIA) for quite a few disciplines is subjective in nature and cannot be quantified. Wherever possible, the impacts have been quantified and otherwise, qualitative assessment has been undertaken. This Chapter deals with the anticipated positive as well as negative impacts due to construction and operation of the proposed project. The construction and operation phase comprises of various activities each of which is likely to have an impact on environment. Thus, it is important to understand and analyze each activity so as to assess its impact on environment.

The potential environmental impacts on various environmental parameters due to various project activities have been identified and Scoping Matrix for CEIA study for the proposed Sillahalla Pumped Storage Project is outlined in Table- 4.1.

Table-4.1: Matrix for various project activities and associated potential Environmental Impacts on various Environmental Parameters

S. No.	Project Activities	Soil & Land	Geology	Hydrology	Water quality	Air quality	Noise	Flora/ Fauna	Employment	Socio-Culture
A.	**Construction Phase Activities**									
1.	Site preparation including tree cutting	√				√	√	√	√	
2.	Earthwork and excavation including blasting and drilling	√	√		√	√	√	√	√	
3.	Construction of Upper dam across river	√	√	√		√	√	√	√	

S. No.	Project Activities	Soil & Land	Geology	Hydrology	Water quality	Air quality	Noise	Flora/ Fauna	Employment	Socio-Culture
	Sillahalla and construction of Lower dam across river Kundah									
4.	Construction of under-ground structure	√	√			√	√		√	
5.	Construction of power house	√	√			√	√		√	
6.	Construction of new roads and widening of existing roads	√				√	√	√	√	
7.	Disposal of muck and construction wastes	√	√		√			√		
8.	Transportation of construction materials					√	√	√	√	
9.	Operation and maintenance of construction equipment				√	√	√		√	
10.	Disposal of sewage and solid waste from labour camps	√			√					
11.	Temporary Acquisition of private land	√								√
12.	Acquisition of forest land	√						√		√
13.	Migration of labour population	√			√	√	√	√	√	√
B	**Operation Phase Activities**									
1.	Equipment maintenance				√	√	√		√	
2.	Disposal of sewage and solid waste from project colony	√			√					
3.	Mushrooming of allied activities	√			√	√	√		√	√

The Impacts which have been covered in the present Chapter are categorized as below:

- Impacts on Land Environment
- Impacts on Hydrologic Regime
- Impacts on Sedimentation
- Impacts on Water Quality
- Impacts on Air Environment
- Impacts on Noise Environment
- Impacts on Biological Environment
- Impacts on Socio-Economic Environment

4.2 Impacts on land Environment

4.2.1 Construction Phase

The impacts on land environment due to construction of the project have been evaluated and it was found that terrain around project site is going to have permanent and temporary changes in the landscape.

The major impacts anticipated on land environment during construction are as follows:

- Land Acquisition
- Operation of construction equipment
- Soil erosion
- Muck disposal
- Quarrying operations
- Changes in land use

4.2.1.1 Impacts due to acquisition of land

The total land required for the project is approximately 310.157 ha. The details of component wise land requirement is given in Table-4.2. About 239.2444 ha of private land and 8.912 ha of forest land is proposed to be acquired for the Sillahalla Pumped Storage Project. Balance land (62.001 ha) to be acquired for the project is government land.

Table-4.2: Land requirement for the proposed Sillahalla PSHEP Stage-I

S. No.	Project Component	Forest land	Govt. land	Private land	Total Land
1	Upper Reservoir		40.457	93.501	133.958
2	Lower Reservoir		12.359	16.032	28.391
3	HRT	0.391	0.708	1.877	2.976
4	TRT		0.162	1.818	1.98
5	Power House	1.8		0.2	2
6	MAT, CAT, ADIT	1.52	0.396	2.7814	4.6974
7	Surge Shaft			0.45	0.45
8	Upper Dam Axis		0.436	2.289	2.725
9	Lower Dam Axis		0.1	2.236	2.336
10	HRT Intake			2	2
11	TRT Outlet			2	2
12	Diversion Tunnel/Coffer Dam		0.068	0.655	0.723
13	Potheadyard/CCVT			0.8	0.8
14	Project Colony		2.295	17.526	19.821
15	Labour Colony			7.155	7.155
16	Baching Plant		0.159	2.276	2.435
17	Contractor Facilities			6.5	6.5
18	Fabrication Yard/Store	4.242		3.655	7.897
19	Dumping Zone		1.947	54.863	56.81
20	Pressure Shaft	0.778		0.222	1
21	Roads	0.181	2.914	20.408	23.503
	Total	**8.912**	**62.001**	**239.2444**	**310.157**

About 287.202 ha of land is required for over ground works and 22.9554 ha of land is required for underground works.

The proposed project involves construction of Upper and Lower Reservoirs, and would lead to formation of a reservoir of area 162 ha. The land cover of the area likely to be submerged in pre-project scenario is river, vegetal cover, agriculture land, etc. Similarly land cover of the area proposed to be used for muck disposal and quarry sites will be changed and detailed measures have been recommended to be undertaken to stabilize such sites are suggested in the EMP for their reclamation.

4.2.1.2 Quarrying operations

The estimated quantities of major item of works that are likely to be involved for construction of various project components are listed in Table-4.3.

Table-4.3: Estimated Quantities of Major Item of Works

S. No.	Name of Component	Common Excavation (m^3)	Rock Excavation (m^3)	Fill Materials (m^3)	Concrete (m^3)	Reinforcement (MT)	Steel Liner (MT)
1		11,96,400	1,13,833	-	8,40,797	1,921	-
2		2,96,845	3,80,157	-	8,60,815	1,967	-
3	U/S Diversion Tunnel	1,500	29,588	-	6,007	70	-
4	D/S Diversion Tunnel	1,500	31,749	-	6,205	70	-
5	U/S & D/S Coffer Dams (For Upper Dam)	4,613	-	22,509	6,551	393	-
6	U/S & D/S Coffer Dams (For Lower Dam)	2,768	-	13,506	3,931	236	-
7	Intake	1,03,917	11,804	-	31,912	2,282	-
8	HRT Gate Shaft	20	14,906	-	2,647	122	-
9	Headrace Tunnel	-	2,29,051	-	48,490	2,784	-
10	HRT Surge Shaft	-	24,125	-	5,521	459	-
11	Pressure Shaft	-	26,496	-	11,701	-	7,484
12	Power House	-	2,09,010	-	36,909	399	-
13	Transformer Hall	-	104,139	-	11,672	163	-
14	TRT Surge Chamber	-	1,42,774	-	9,229	185	-

S. No.	Name of Component	Common Excavation (m^3)	Rock Excavation (m^3)	Fill Materials (m^3)	Concrete (m^3)	Reinforcement (MT)	Steel Liner (MT)
15	Tail Race Tunnel	-	1,81,504	-	41,310	2,124	-
16	TRT Gate Shaft	20	16,567	-	2,862	122	-
	TRT Outfall	4,175	91,593	-	33,021	2,298	-

The key construction materials like stone pitching, Coarse Aggregate & fine aggregate will be transported from quarries in Coimbatore district. The muck generated from Headrace Tunnel (HRT), Tailrace Tunnel (TRT) and Underground Caverns shall also be used for fill material, coarse aggregates and fine aggregates.

In addition to above, 7484 MT of steel liner will also be required. The key construction materials, e.g., stone pitching, coarse aggregates and fine aggregates will be transported from quarries in Coimbatore district and shall also be derived using muck from Headrace Tunnel (HRT), Tailrace Tunnel (TRT) and Underground Caverns quantity of approx. 16 lakh m^3 range compared to actual required quantity of 25.00 lakh m^3 including fill material, coarse aggregates & fine aggregates.

Since, no new quarrying sites are to be used for extraction of construction materials. Hence, no impacts are anticipated due to quarrying activities.

B. Landscaping and Restoration of Construction Areas

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 as a part of the project, especially upper reservoir can be developed as a tourist attraction. Thus, 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 of ornamental plants and flower garden.

There would be sufficient open space in power house complex and colony area which could be used for plantation, which would enhance aesthetic view and add to beauty scenic of the area. The beautification in the colony area is proposed to 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.

The construction of the project is expected to lead to certain changes in the area, as the construction of the proposed project requires excavations. Also approach roads have been proposed to access these construction areas. Thus, no major alteration of the area is expected.

The measures recommended for landscaping and restoration of construction sites are outlined in the following paragraphs.

Garden Complex

A garden with local ornamentation plants and trees will be created near dam site in areas left after the construction activities. All plants will be properly labeled with scientific and/or common names.

Creation of viewpoints

Viewpoints can be created at suitable places along the periphery of the reservoir.

A total amount of Rs.100.0 lakh can be earmarked for implementation of various works related to landscaping and restoration of construction sites.

4.2.1.3 Impacts due to muck disposal

The project envisages construction of dams (upper & Lower), headrace tunnel, Upper surge shafts, pressure shafts, TRT surge chamber, underground power house, tailrace Tunnel, Transformer hall, inlet outlet, etc., will generates enormous quantities of muck. It is estimated that about 5.05 MCM muck will be generated from various components of the project, as detailed in Table-4.4.

Table-4.4: Muck generated from various project components

S. No.	Components	Muck Quantity(MCM)
1.	Upper Dam	1.3
2.	Lower Dam	0.7
3.	U/S Diversion Tunnel	0.03
4.	D/S Diversion Tunnel	0.03
5.	U/S Coffer Dam	0.005
6.	D/S Coffer Dam	0.003
7.	Intake	0.1
8.	HRT Gate Shaft	0.01
9.	HRT	0.23
10.	HRT Surge Shaft	0.02
11.	Pressure Shaft	0.03
12.	Power House	0.21
13.	Transformer Hall	0.10
14.	TRT Surge Chamber	0.14
15.	TRT	0.18
16.	TRT Gate Shaft	0.02
17.	TRT Outfall	0.1
18.	MAT	0.07
19.	CAT	0.04
20.	Adits	0.08
	Total	3.398, say 3.4 MCM
	Swelling Factor	**1.65**
	Total Muck generated	**5.05 MCM**

For disposal of above estimated muck, dumping areas /muck disposal areas have been identified in the vicinity of project area. The capacity of each muck disposal yard has been calculated based on the average cross-sections generated using available 20m contour interval topographical map. The total estimated capacity of identified muck dumping yards is about 5.05 MCM. A total of 14 muck dumping sites have been identified, with a total area of 59 ha.

The sites identified for muck disposal are away from HFL of rivers. The drainage side bank of the area will be properly protected and stabilized with Gabions/ Retaining Walls of suitable designed sections.

The details of muck disposal sites are given in Table-4.5.

Table-4.5: Dumping Area /Muck Disposal Sites

S. No.	Descriptions	Area (ha)
1.	Dumping Area /Muck Disposal Area – 1	15.0
2.	Dumping Area /Muck Disposal Area – 2	7.0
3.	Dumping Area /Muck Disposal Area – 3	3.5
4.	Dumping Area /Muck Disposal Area – 4	3.5
5.	Dumping Area /Muck Disposal Area – 5	5.0
6.	Dumping Area /Muck Disposal Area – 6	1.25
7.	Dumping Area /Muck Disposal Area – 7	1.0
8.	Dumping Area /Muck Disposal Area – 8	1.5
9.	Dumping Area /Muck Disposal Area – 9	1.0
10.	Dumping Area /Muck Disposal Area – 10	4.25
11.	Dumping Area /Muck Disposal Area – 11	9.0
12.	Dumping Area /Muck Disposal Area – 12	1.0
13.	Dumping Area /Muck Disposal Area – 13	2.0
14.	Dumping Area /Muck Disposal Area – 14	4.0
	Total	**59.0**

Muck, if not securely transported and dumped at pre-designated sites, can lead to following adverse environmental impacts:

- Muck, if not disposed properly, can be washed away into the main river which can cause negative impacts on the aquatic ecosystem of the river.
- Muck disposal can lead to impacts on various aspects of environment. Normally, the land is cleared before muck disposal. During clearing operations, trees are cut, and undergrowth perishes as a result of muck disposal.
- In many of the sites, muck is stacked without adequate stabilisation measures. In such a scenario, the muck moves along with runoff and creates landslide like situations. Many a times, boulders/large stone pieces enter the river/water body, affecting the benthic fauna, fisheries and other components of aquatic biota.
- Normally muck disposal is done at low lying areas, which get filled up due to stacking of muck. This can sometimes affect the natural drainage pattern of the area leading to accumulation of water or partial flooding of some area which can provide ideal breeding habitat for mosquitoes.

Mitigation Measures

A. Muck disposal Plan

It is proposed to dispose muck, after creating terraces. Suitable retaining walls shall be constructed to develop terraces so as to support the muck on vertical slope and for optimum space utilization. Loose muck would be compacted layer wise. The muck disposal area will be developed in a series of terraces of boulder crate wall and masonry wall to protect the area/muck from flood water during monsoons. In-between the terraces, catch water drain will be provided.

The terraces of the muck disposal area will be ultimately covered with fertile soil and suitable plants will be planted adopting suitable bio-technological measures.

The basic aim and objectives of the muck management plan are to:

- Protect these areas from soil erosion
- Develop these areas by afforestation
- Develop them into parks, gardens etc.
- Utilize the maximum quantity of muck for development of infrastructure of the project
- Develop these areas in harmony with the landscape of the project area.

Various activities proposed as a part of the management plan are given as below:

- Land acquisition for muck dumping sites
- Civil works (construction of retaining walls, boulder crate walls etc.)
- Dumping of muck
- Levelling of the area, terracing and implementation of various engineering control measures e.g., boulder, crate wall, masonry wall, catch water drain.
- Spreading of soil
- Application of fertilizers to facilitate vegetation growth over disposal sites.

For stabilization of muck dumping areas following measures of engineering and biological measures have been proposed

Engineering Measures

- Wire crate wall
- Boulder crate wall
- R.C.C wall
- Catch water Drain

Biological Measures

- Plantation of suitable tree species and soil binding species
- Plantation of ornamental plants
- Barbed wire fencing

Muck generally lacks nutrients and therefore, are difficult to re-vegetate. However, if no attempts to vegetate the slopes are made, 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 hilly terrain, 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. It is proposed to use their technique in the proposed project as well. As a part of this technique, 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 Mycorrizae (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. About 1000-1200 trees/ha shall be planted.

Some of the muck dumping sites shall be used for temporary infrastructure works during construction phase. On completion of construction activities, the same shall be used for Greenbelt Development. A provision of Rs.1020.0 lakh has been earmarked for stabilization and restoration of muck disposal site. The details are given in Table-4.6.

Table-4.6: Cost estimate for stabilization of muck disposal sites

S. No.	Works	Cost (Rs.lakh)
A.	**Engineering Measures**	
1.	Boulder Crate Wall	300.0
2.	Masonry Wall	120.0
3.	Catch Water Drain	350.0
4.	Levelling including spreading of soil	30.0
	Sub-Total (A)	**800.0**
B.	**Biological Measures**	
1.	Plant sapling procurement and Plantation	90.0
2.	Fencing	60.0
3.	Biological fertilizer procurement	20.0
4.	Watch and ward	50.0
	Sub Total (B)	**220.0**
	Total (A+B)	**1020.0**

4.2.1.4 Impacts due to Construction of Roads

A total of 25 km of new roads are to be constructed. The details are given in Table-4.7.

Table-4.7: Length of new roads to be constructed

S. No.	Proposed Road	Length (km)
1.	Road to Upper Dam	1.5 km
2.	Road to Surge Shaft Adit Portal	0.5 km
3.	Road to MAT & CCVT Portal	1.5 km
4.	Road to Lower Dam Right Bank	4.0 km
5.	Road to Lower Dam Left Bank	2.5 km
6.	Other Proposed Project Roads	15 km
	Total	**25 km**

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.

B. Management Measures

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

Construction

- Area for clearing 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 operations shall be so scheduled and performed that grading operations and permanent erosion control measures can follow immediately thereafter
- 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.
- The method of balanced cut and fill formation shall be adopted to avoid large difference in cut and fill quantities.

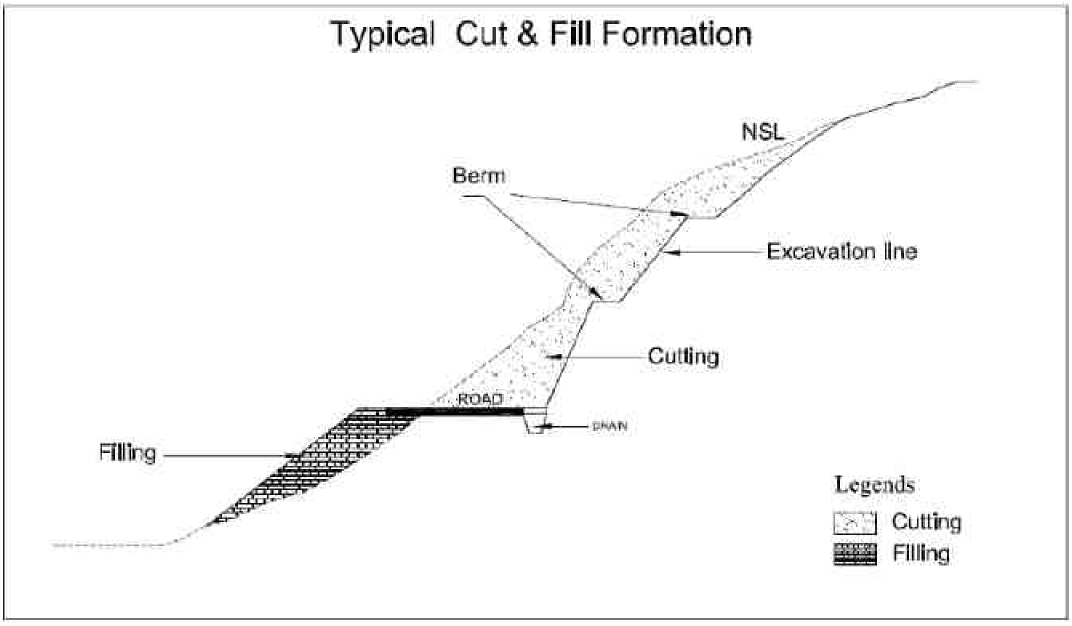


Figure-4.1: Method of balanced cut and fill formation

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. (Refer Figure-4.2).

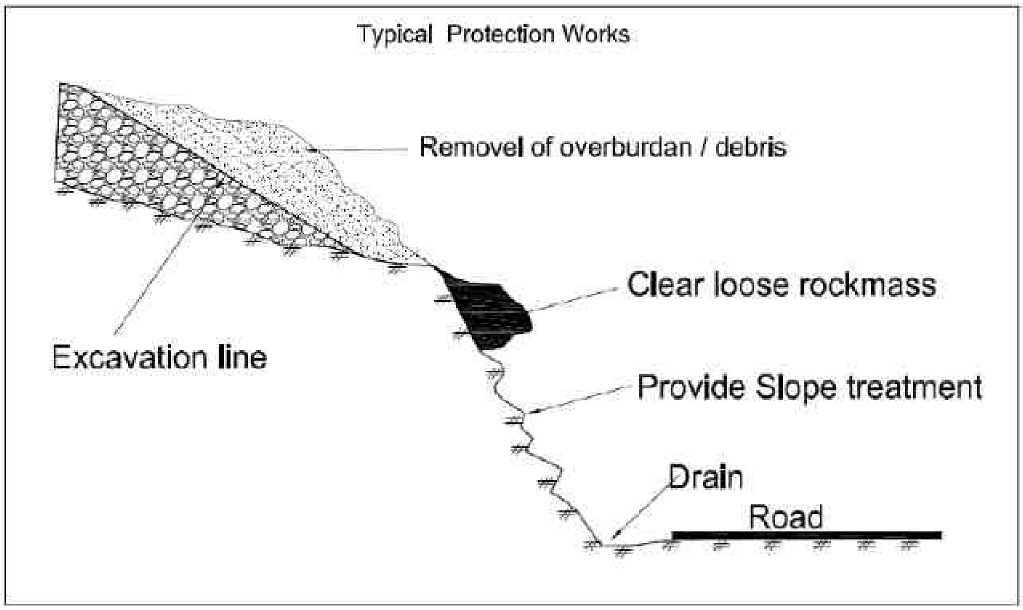


Figure-4.2: Protection of slopes

- 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

- 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.

An amount of Rs. 800 lakh has been earmarked for implementation of various measures for Environmental Management in road construction. The details are given in Table-4.8.

Table-4.8: Details of expenditure for implementation of measures for management of Impacts due to construction of roads

S. No.	Item	Cost (Rs. lakh)
1.	Clearing	100.0
2.	Provision of breast walls, construction of catch water and interceptor drains	300.0
3.	Provision of drainage system along roads	300.0
4.	Roadside plantation, Jute matting etc.	100.0
	Total	**800.0**

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.

4.2.1.5 Changes in Land Use

Project activities such as construction of Upper and Lower Reservoirs, powerhouse, water conveyance system, and other associated structures, project office and working facility sites, muck disposal, haul road and service road construction, workshops, etc. during construction phase will change the existing land use and land cover in the project area.

The construction of Upper and Lower reservoirs with a total area of about 162 ha would lead to acquisition of private, forest and government land, which is a significant change in land use. Likewise, river stretch within submergence area, with moving water condition will be converted into quiescent conditions.

New roads of about 25 km length are proposed to be constructed to connect the various project components. Adequate measures need to be implemented as a part of EMP to ameliorate this adverse impact to the extent possible.

The storage of scrap materials, used containers, cement bags, domestic and construction wastes, etc. in scrap yards will degrade the land quality. After the completion of the project, temporarily acquired land will be returned to the owners.

The construction sites would be adversely affected on account of large scale construction activities. The construction sites will have to clear of waste construction material, solid waste from various sources, leading to adverse impacts.

4.2.1.6 Impacts due to Blasting on springs

There are no known springs in the project area, hence, impacts due to blasting on springs or water bodies is not anticipated due to construction and operation of the proposed Sillahalla Pumped Storage Project.

4.2.1.6 Solid waste generation from labour camps

The labour colonies will be located at dam site, powerhouse and at adit sites. During construction phase, about 1600 labour and technical staff is likely to congregate. The increase in population is expected to be order of 6400 including family members of the individuals. The solid waste likely to be generated from labour camps shall be of the order of 1.34 tons/day. The chemical characteristics of solid waste generated are given in Table-4.9. The composition of various waste materials is in the municipal refuse is detailed in Table-4.10.

Table-4.9: Chemical characteristics of municipal waste

Component	Percentage by weight (%)
Moisture	19.52
Organic matter	25.14
Nitrogen (as Total Nitrogen)	0.66
Phosphorous (as P_2O_S)	0.56
Potassium (as K_2O)	0.69

Table-4.10: Composition of waste material in municipal refuse

Ingredient	Percentage by weight (%)
Paper	4.71
Rubber, Leather and synthetics	0.71
Glass	0.46
Metals	0.49

Ingredient	Percentage by weight (%)
Total compostable matter	38.95
Inert matter	44.73
Others/ plastic	9.95
Total	**100**

Mitigation Measures

A. Solid Waste Management Plan

The labour colonies will generate substantial amount of municipal wastes. In view of the condition that might exist in the labour camps, most likely the solid wastes will contain majority of vegetable matter followed by paper cans and glasses. About 6400 persons are likely to congregate during the construction phases resulting in generation of about 1.34 tonnes of solid waste/day. Adequate facilities for collection, conveyance and disposal of municipal waste generated from labour camps should be developed. For solid waste collection, masonry storage vats, each of 2 m^3 capacity at convenient dumping points in the labour camp will be constructed. Each vat will have a storage capacity of 150 kg (dry weight) of garbage, which will be emptied at regular intervals and will be transported to the landfill site. One covered truck to collect the solid waste from the common collection point and transfer it to the disposal site needs to be put to service.

Various aspects of solid waste management include:

- Reuse/Recycling
- Refuse storage
- Collection and Transportation
- Disposal

Reuse/Recycling

The opportunity to recycle the waste generated at the project site will be explored. In this context authorized vendors will be identified to send used batteries, used oil, and used oil filters for recycling.

Bio-degradable waste will be disposed by composting and the manure generated will be given to local community for cultivating vegetables and flowers.

Refuse storage

The labour colony shall have provisions to separately store the degradable and non-degradable solid waste.

Two different coloured bins shall be supplied to each labour family, who will segregate the waste generated by their family. Green and Biodegradable waste is to be deposited in one container and non-biodegradable waste in another container. In case of canteens, kitchens also, two different coloured dust-bins suitable to deposit the Biodegradable and non-biodegradable waste generated in their unit shall be provided. A sustained awareness programme will be conducted to educate workers about the segregation of degradable and bio-degradable wastes.

Collection of Household Waste

Every day the trolleys will collect the waste at the door of each unit of labour camp and colonies. The trolleys will be provided with two compartments for depositing segregated waste separately. Each worker will be allotted at a fixed area. The collection will be on regular pre-informed timings and the arrival will be informed through blowing a whistle/horn. The solid waste so collected shall be disposed at a common storage point. Two trucks will be commissioned to collect the solid waste and dispose the same at sites designated for disposal of solid waste.

Segregation of waste

Awareness programmes shall be organized, to train labour and staff for waste segregation. Residents of labour camps shall be apprised of the benefits of waste segregation. Regular meeting shall be conducted with representative of residents of colonies where good upkeep shall be recognized and rewarded.

Disposal

Degradable component

The degradable portion of the solid waste would be disposed off by composting. The degradable portion is taken as about 38.9%. Thus, (0.389*0.67) about 0.26 t/day of degradable portion of solid waste will be generated. In composting the process takes around 60 days to mature. Keeping, a margin of 30 days total capacity of pits have been provided as (0.26x90 = 23.4 m^3). Thus the total capacity of pits required would be 30 cum.

A pit of 2m x 1.5m x 1.3m deep (0.3 m freeboard) size can take 3.0 cu m of compostable waste. Thus the no. of pits required shall be about 10. The total area will be almost three times the pit area as some area in between pits will be required for transportation and stacking of waste. Hence, total area required will be 126 m^2. The pits will be covered with GI sheets. Additional 63 m^2 shall be kept for storage for compost plus screening and other activities.

The pits to be constructed will have around 25 cm of bottom lining consisting of about 5 cm thick stone grit over which 15 cm thick coarse sand followed by 15 cm thick earth lining will be done. The refuse along with animal dung will have to be laid in layers of 5 to 10 cm thickness. The pit will be then watered on alternate days. Thereafter waste is laid in 5 to 10 cm thick layers twice in a week till the whole pit is filled up. Every week, waste will need to be turned up and water will have to be sprinkled every day to keep adequate moisture. The process will take around 60 days where after the composted waste from the pit is taken out and after drying it is screened with screens having 2 mm dia holes. The screened compost would be filled in plastic bags and used as good manure especially for cultivation of vegetables and flowers.

Non-Degradable component

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

A suitable landfill site can be identified and designed to contain the municipal waste from all the Project Township, labour colonies, etc. A total provision of Rs.108.92 lakh has been earmarked for this purpose. The details are given in Table-4.11.

Table-4.11: Details of expenditure required for solid waste management

S. No.	Item	Cost (Rs.lakh)
1.	One covered truck for conveyance of solid waste up to landfill site.	30.0
2	Manpower cost for 6 persons @ Rs.10000/month for 5 years including 10% escalation/year.	43.92
3	Waste collection hand carts 30 @ Rs.50,000/unit	15.0
4	Preparation of landfill site	20.0
	Total	**108.92**

A provision of 15% of the total area, for accommodating infrastructure facilities will be included while working out requirement of space. The liner system will comprise of the following layers below the waste:

- 0.30 m thick drainage layer comprising of coarse sand or gravel (stone dust with no fines)
- 0.2 m thick protective layer of sandy silt
- 1.50 mm thick HDPE geo-membrane
- 1.0 m thick clay layer/amended soil layer, amended soil layer comprising of local soil + bentonite is to be provided).

,

The sites for disposal of solid waste shall be finalized in consultation with district administration.

4.3 Water Quality

4.3.1 Construction phase

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

- Sewage from labour camps/colonies.
- Effluent from crushers.
- Effluents from other sources

4.3.1.1 Sewage from labour camps

The project construction is likely to last for a period of 61 months. The peak labour strength likely to be employed during project construction phase is about 1500 workers and 100 technical staff. The employment opportunities in the area are limited. Thus, during the project construction phase, some of the locals may get employment. It has been observed during construction phase of many of the projects; the major works are contracted out, who bring their own skilled labour. However, it is only in the unskilled category, that locals get employment.

The construction phase shall also lead to mushrooming of various allied activities to meet the demands of the immigrant labour population in the project area.

Based on experience of similar projects and above referred assumptions, the increase in the population as a result of migration of labour population during construction phase is expected to be of the order of 6400.

The domestic water requirement has been estimated as 70 lpcd. Thus, total water requirements work out to 0.45 mld. It is assumed that about 80% of the water supplied will be generated as sewage. Thus, total quantum of sewage generated is expected to be of the order of 0.36 mld.

It is recommended to commission units for treatment of sewage generated from labour camps.

Mitigation Measures

One community latrine shall be provided per 20 persons. The sewage from the community latrines shall be treated in Sewage Treatment Plant (STP). The effluent from mobile sewage treatment plant shall be disposed off through absorption trenches. As mentioned earlier, the drinking water facilities and waste disposal sites will be located away from each other.

At peak construction phase, there will be an increase in population by 6400. To ensure that the sewage from the labour camps do not pollute the river water it has been estimated that about 320 community toilets and sewage treatment plants need to be constructed. The total cost required will be Rs.188.0 lakh (Refer Table-4.12).

Table-4.12: Cost estimate for sanitary facilities for labour camps

Unit	Rate (Rs./unit)	Number	Total cost (Rs. lakh)
Community toilets	40,000	320	128.0
Sewage Treatment Plant			60.0
Total			**188.0**

4.3.1.2 Effluent from crushers

During construction phase, at least one crusher will be commissioned at the quarry site by the contractor involved in construction activities. It is proposed only crushed material would be brought at construction site. The total capacities of the two crushers are likely to be of the order of 120-150 tph. Water is required to wash the boulders and to lower the temperature of the crushing edge. About 0.1 m^3 of water is required per tonne of material crushed. The effluent from the crusher would contain high-suspended solids. About 12-15 m^3/hr of wastewater is expected to be generated from each crusher. The effluent, if disposed without treatment can lead to marginal increase in the turbidity levels in the receiving water bodies. The natural slope in the area is such that, the effluent from the crushers will ultimately find its way in river Kundah or Sillahalla. This amounts to a discharge of 0.0033 to 0.0042 cumec. The effluent from crusher will have suspended solids level of 3000-4000 mg/l.

Mitigation Measures

It is proposed to treat the effluent from crushers in a settling tank. The treated effluent shall be disposed only the treatment to minimize the adverse impacts. An amount of Rs. 50 lakh has been earmarked for this purpose.

4.3.1.3 Effluent from Batching Plants

During construction phase, batching plants will be commissioned for production of concrete. Effluent containing high suspended solids shall be generated during operation and cleaning of batching plants.

Mitigation Measures

It is proposed to treat the effluent before disposal to ameliorate even the marginal impacts likely to accrue on this account. An amount of Rs. 50.0 lakh has been earmarked for construction of settling tanks to treat effluent generated from Batching Plants.

4.3.1.4 Effluent from Fabrication Units and Workshops

The fabrication units and workshops which shall be functional during construction phase will generate effluents with high suspended solids and oil and grease.

Mitigation Measure

It is proposed to treat the effluent from fabrication units and workshops in a oil and grease separator unit prior to disposal. An amount of Rs.50.0 lakh has been earmarked for construction of settling tanks to treat effluent generated from Fabrication Units and Workshops.

4.3.2 Operation phase

4.3.2.1 Effluent from project colony

During project operation phase, due to absence of any large-scale construction activity, the cause and source of water pollution will be much different. Since, only a small number of O&M staff will reside in the area in a well-designed colony with sewage treatment plant and other infrastructure facilities, the problems of water pollution due to disposal of sewage are not anticipated.

In the operation phase, about 100 families (total population of 500) will be residing in the project colony. About 0.23 to 0.27 MLD of sewage will be generated. The total BOD loading will be order of 68 to 81 kg/day.

Mitigation Measures

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 BOD load after treatment will reduce to 10 to 12 kg/day. It shall be ensured that sewage from the project colony be treated in a sewage treatment plant so as to meet the disposal standards for effluent. Thus, with commissioning of facilities for sewage treatment, no impact on receiving water body is anticipated. Thus, no impacts are anticipated as a result of disposal of effluents from the project 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 been included in the cost for implementing EMP.

4.3.2.2 Impacts on Reservoir Water Quality

Submergence area comprises of forests on both banks and river bed. The flooding of previously forests will increase the availability of nutrients due to decomposition of vegetative matter. Enrichment of water with organic and inorganic nutrients will be the main water quality problem immediately on commencement of the operation. However, this phenomenon is likely to last for a short duration of few years from the filling up of the reservoir. The proposed project is envisaged as a pumped storage hydroelectric project. The Upper and Lower reservoirs will be daily filled up and emptied from MDDL to FRL and FRL to MDDL for power generation. Thus, there will be significant diurnal variations in water level of Upper and Lower reservoirs. This diurnal in levels will lead to natural reaeration and reservoir stratification is not anticipated.

4.4 Impacts due to Sedimentation

There will be significant modification in hydrologic regime of river due to diversion of water for hydropower generation and storage of water in the reservoir. The discharge in the intervening stretch downstream of dam site up to tail race disposal site would be reduced from the pre-project level to the spills/releases from the reservoir. In addition, there will be contribution from the intervening catchment as well.

The construction of the reservoir would reduce the velocity of flowing water converting a lotic system to lentic system. The reduction in velocity would lead to sedimentation at the dam site. Increased levels of soil erosion are not anticipated at the dam site due to the project.

As a part of DPR, a sediment rate of 1.79 mm/sq.km/year has been adopted based on the average sediment rate of Kundah Palam Forebay and Emerald- Avalanche reservoir. Both the reservoirs are in the vicinity of the proposed Upper and Lower reservoirs.

According to BIS guidelines 12182-1987 for “Determination of effects of sedimentation in planning and performance of Reservoir” for Hydroelectric Power Project supplying power to the grid, the full service time shall not be less than 25 years and the feasible service time shall not be less than 70 years. Feasible service time is the period for which the reservoir is expected to provide a part of planned benefit in respect of storage in the reservoir being impaired by sedimentation. It is estimated as the time after which the new zero elevation of the reservoir would equal the sill level of the outlet. According to BIS guidelines 12182-1987, assessment of seriousness of sedimentation problem may be made by comparing the expected average annual volume of sediment deposition with the gross storage capacity of the reservoir. If the ratio is more than 0.5% per year the problem is usually said to be serious and special care is required in estimating the sediment yield from the catchment. If it is less than 0.1% per year, the problem of siltation may be insignificant and changes in reservoir capacity can be neglected for studies of reservoir performance.

In case of Upper reservoir it is 0.4 percent per year, the problem of siltation is significant and studies has been carried out to determine the changes in reservoir capacity and performance of the reservoir. However the NZL (New Zero Level) has been computed for feasible service time of 70 years. The sediment into the Upper dam is assumed to be trapped 96%. The new zero elevation in upper reservoir after feasible service time (70 years) is 1915 which is much below the MDDL of 1940 m. Similarly, for Lower reservoir it is 0.91 percent per year, the problem of siltation is serious. The new zero elevation in lower reservoir after feasible service time 70 years is 1538 m which is above the MDDL of 1520m. However, NZL for (50 years) is 1520 m which is below the MDDL.

Mitigation Measures

The proposed project is a storage scheme. At regular intervals, flushing will be done to clear out the sediments. Catchment Area Treatment Plan (refer Chapter-10) is prepared to address the issue of sedimentation in the dam.

4.5 Impacts on Downstream Users

The flows and yield of river Sillahalla for 90% dependable year flow (1986-87) is given in Table-4.13.

Table-4.13: 90% Dependable Year Flows (1986-1987) for River Sillahalla

Month	Runoff (MCM)	Discharge (cumec)
June	1.05	0.41
July	1.66	0.62
August	2.90	1.08
September	2.00	0.77
October	1.70	0.63
November	1.91	0.74
December	0.67	0.25
January	0.50	0.19
February	0.31	0.13
March	0.19	0.07
April	0.14	0.05
May	0.27	0.10
Annual	**13.29**	

The Gross Storage capacity of the Upper Reservoir is around 27.836 MCM. The dead storage capacity of Lower Reservoir is 2.044 MCM. The gross water storage will be 29.88 MCM.

It is proposed to fill the Upper and Lower reservoirs by storing 70% of yield in Monsoon months from June to November. No water will be used for storage of reservoir in non-monsoon months. The details are given in Table-4.14.

Table-4.14: Quantum of water stored is 90% Dependable year for filling up of Upper Reservoir

Months	Runoff (MCM)	Percentage of water stored (%)	Quantum of water stored (MCM)
June	1.05	70	0.735
July	1.66	70	1.16
August	2.90	70	2.03
September	2.00	70	1.40
October	1.70	70	1.19
November	1.91	70	1.33
December	0.67	-	-
January	0.50	-	-
February	0.31	-	-
March	0.19	-	-
April	0.14	-	-
May	0.27	-	-
Annual	**13.29**		**7.845**

The yield of river Sillahalla for 90% dependable year (1986-87) as approved by CWC 132.29 MCM. The gross storage capacity of Upper Reservoir on river Sillahalla at FRL is 27.836 MCM. The dead storage of Upper Reservoir at MDDL is 8.048 MCM. The live storage is 19.788 MCM.

The total water to be stored in the Upper Reservoir (Gross Storage capacity) is 27.836 MCM. Thus, time required to fill the Upper Reservoir upto FRL shall be (27.836/7.845) 3.54 years or 3 years and 7 months. After filling of Upper reservoir, the entire discharge shall be released into the river Sillahalla. The details are given in Table-4.14.

The gross storage capacity of Lower Reservoir on river Kundah at FRL is 17.218 MCM. The dead storage of Lower Reservoir at MDDL is 2.044 MCM. The live storage is 15.174 MCM.

The Lower Reservoir needs to be filled upto Dead storage, which would require 2.044 MCM of water. The yield of river Kundah for 90% Dependable Year (1986-87) is 13.87 MCM. Thus, time required to fill Lower Reservoir upto MDDL shall be less than 1 year. After filling of Lower Reservoir, the entire discharge.

Since main storage is at Upper dam Sillahalla site, the water as available therein would be utilized for one time filling only and subsequently during operation of pumping operation, the stored water would be recycled thereby ensuring no consumptive use.

Flows of river Sillahalla would be required to fill the Upper reservoir in 3 years and 7 months, considering Environmental Flows, after which there will be no consumptive use of water of river Sillahallla. Thus, no major impact on downstream water users is expected due to the proposed Sillahalla Pumped Storage Project.

Mitigation Measures

The total water to be stored in the Upper Reservoir (Gross Storage capacity) is 27.836 MCM. Thus, time required to fill the Upper Reservoir upto FRL shall be (27.836/7.845) 3.54 years or 3 years and 7 months. After filling of Upper reservoir, the entire discharge shall be released into the river Sillahalla. The details are given in Table-4.14.

The Lower Reservoir needs to be filled upto Dead storage, which would require 2.044 MCM of water. The yield of river Kundah for 90% Dependable Year (1986-87) is 13.87 MCM. Thus, time required to fill Lower Reservoir upto MDDL shall be less than 1 year. After filling of Lower Reservoir, the entire discharge.

Since main storage is at Upper dam Sillahalla site, the water as available therein would be utilized for one time filling only and subsequently during operation of pumping operation, the stored water would be recycled thereby ensuring no consumptive use.

4.6 Projects in Cascade Development

There are no projects in cascade development on river Sillahalla. On river Kundah, one Power House, namely, Kundah Power House – I upstream of Lower Dam site is existing. The distance between the two projects is 1.4 km.

4.7 Impacts on Air Environment

4.7.1 Construction Phase

4.7.1.1 Pollution due to fuel combustion of various equipment

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

4.7.1.2 Emissions from crushers

The operation of the crusher during the construction phase is likely to generate fugitive emissions, which can move even up to 1 km in predominant wind direction. During construction phase, one crusher each is likely to be commissioned near proposed dams and proposed power house sites. During crushing operations, fugitive emissions comprising mainly the suspended particulate will be generated. Since, there are no major settlements close to the dam and power house, no major adverse impacts on this account are anticipated.

During the layout design, care should be taken to ensure that the labour camps, colonies, etc. are located on the leeward side and outside the impact zone (say about 2 km on the wind direction) of the crushers.

4.7.1.3 Fugitive Emissions from various sources

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

4.7.1.4 Blasting Operations

Blasting will result in vibration, which shall propagate through the rocks to various degrees and may cause loosening of rocks/boulders. The overall impact due to blasting operations will be restricted well below the surface and no major impacts are envisaged at the ground level.

During tunneling operations, dust will be generated during blasting. ID blowers will be provided with dust handling system to capture and generated dust. The dust will settle on vegetation, in the predominant down wind direction. Appropriate control measures have been recommended to minimize the adverse impacts on this account.

4.7.1.5 Pollution due to increased vehicular movement

During construction phase, there will be increased vehicular movement for transportation of various construction materials to the project site. Similarly, these will be increased traffic movement on account of disposal of muck or construction waste at the dumping site. The maximum increase in vehicle is expected to 50 vehicles per hour. Large quantity of dust is likely to be entrained due to the movement of trucks and other heavy vehicles. Similarly, marginal increase in Hydrocarbons, SO_2 and NOx levels are anticipated for a short duration. Modelling studies for hydrocarbon emissions were conducted and the results are given in Table-4.15.

Table-4.15: Increase in hydrocarbon concentration due to vehicular movement

Distance (m)	Increase in HC concentration (μg/m^3)
10	5.00
20	2.50
30	1.67
40	1.25
50	1.00
60	0.83
70	0.71
80	0.63
90	0.56
100	0.50

The increase in vehicular density is not expected to significant. In addition, these ground level emissions do not travel for long distances. Thus, no major adverse impacts are anticipated on this account.

4.7.1.6 Dust emission from muck disposal

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

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:

- 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-4.16, and are recommended to be followed.

Table-4.16: 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 need to be followed by the contractor operating the DG sets.

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.
- 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. Three personnel will be earmarked for this purpose.
- 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. Five sweepers will be earmarked for this purpose

An amount of Rs. 256.3 lakh is earmarked for air pollution control. The details are given in Table-4.17.

Table-4.17: Cost estimate for implementation of air pollution control measures

S. No.	Activity	Cost (Rs. lakh)
1.	Repair of roads during construction phase	150.0
2.	3 Traffic managers @ Rs. 25,000 per month for 5 years including 10% escalation per year	77.0
3.	5 sweepers @ Rs. 8,000 per month for 5 years including 10% escalation per year	29.3
	Total	**256.3**

4.7.2 Operation Phase

In a water resources project, air pollution occurs mainly during project construction phase. During operation phase, no major impacts on air environment are anticipated.

4.8 Impacts on Noise Environment

4.8.1 Construction phase

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.

4.8.1.1 Impacts due to operation of construction equipment

The noise level due to operation of various construction equipment is given in Table-4.18.

Table-4.18: Noise level due to operation of various construction equipment

Equipment	Noise level dB (A)
Earth moving	
Compactors	70-72
Loaders and Excavator	72-82
Dumper	72-92
Tractors	76-92
Scrappers, graders	82-92
Pavers	86-88
Truck	84-94
Material handling	
Concrete mixers	75-85
Movable cranes	82-84
Stationary	
Pumps	68-70
Generators	72-82
Compressors	75-85
Others	
Vibrators	69-81
Saws	74-81

Under the worst-case scenario, considered for prediction of noise levels during construction phase, it has been assumed that all these equipment generate noise from a common point. The increase in noise levels due to operation of various construction equipment is given in Table-4.19.

Table-4.19: Noise level due to operation of various construction equipment

Distance (m)	Ambient noise levels dB (A)	Increased noise level due to construction activities dB (A)	Increase in ambient noise level due to construction activities dB (A)
100	44	74	30
200	44	69	25
500	44	65	21
1000	44	61	17
1500	44	58	14
2000	44	54	10

It would be worthwhile to mention here that in absence of the data on actual location of various construction equipment, all the equipment have been assumed to operate at a common point. This assumption leads to over-estimation of the increase in noise levels. Also, it is a known fact that there is a reduction in noise level as the sound wave passes through a barrier. The transmission loss values for common construction materials are given in Table-4.20.

Table-4.20: Transmission loss for common construction materials

Material	Thickness of construction material (inches)	Decrease in noise level dB (A)
Light concrete	4	38
	6	39
Dense concrete	4	40
Concrete block	4	32
	6	36
Brick	4	33
Granite	4	40

Thus, the walls of various houses will attenuate at least 30 dB (A) of noise. In addition there are attenuation due to the following factors.

- Air absorption
- Rain
- Atmospheric in homogeneities.
- Vegetal cover

Thus, no increase in noise levels is anticipated as a result of various activities, during the project construction phase. The noise generated due to blasting is not likely to have any effect on habitations. However, blasting can have adverse impact on wildlife, especially along the alignment of the tunnel portion. It would be worthwhile to mention that no major wildlife is observed in and around the project site. Hence, no significant impact is expected on this account.

4.8.1.2 Impacts due to increased vehicular movement

During construction phase, there will be significant increase in vehicular movement for transportation of construction material. At present, there is negligible vehicular movement near the Dam site. During construction phase, the increase in vehicular movement is expected to increase upto a maximum of 10 to 12 trucks/hour.

As a part of EIA study, impact on noise level due to increased vehicular movement was studied using Federal Highway Administration model. The results of modelling are outlined in Table-4.21.

Table-4.21: Increase in noise levels due to increased vehicular movement

Distance (m)	Ambient noise level dB (A)	Noise levels due to increased vehicular movement dB (A)	Increase in ambient noise level due to increased vehicular movement dB (A)
10	44	72	28
20	44	67	23
50	44	61	17
100	44	57	13
200	44	53	9
500	44	48	4
1000	44	46	2

As mentioned earlier, there will be significant attenuation due to various factors, e.g. absorption by construction material, air absorption, atmospheric in homogeneties, and vegetal cover. Thus, no significant impact on this account is anticipated.

Appropriate measures have been suggested as a part of Environmental Management Plan (EMP) report to minimize impacts.

4.8.1.3 Impacts on labour

The effect of high noise levels on the operating personnel, has to be considered as this may be particularly harmful. It is known that continuous exposures to high noise levels above 90 dB (A) affects the hearing acuity of the workers/operators and hence, should be avoided. To prevent these effects, it has been recommended by Occupational Safety and Health Administration (OSHA) that the exposure period of affected persons be limited as per the maximum exposure period specified in Table-4.22.

Table-4.22: 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	½
115	¼
120	No exposure permitted at or above this level

4.8.1.4 Noise generated due to drilling

The noise levels monitored at a 10 m distance from the source and operator's cabin is given in Table-4.23.

Table-4.23: Noise generated due to drilling

Equipment	Noise level at source dB (A)
Standing idle (inside cabin)	70-72
Standing idle (10 m radius)	72-74
On load (inside cabin)	78-80
On load (10 m radius)	82-84

The noise levels during various construction activities have been compared to various standards prescribed by Occupational Safety and Health Administration (OSHA), which are being implemented in our country through rules framed under Factories Act. It can be observed (Refer Table-4.22) that for an 8 hour duration, equivalent noise level exposure should be less than 90 dB (A).

The Director General of Mines Safety in its circular no. DG(Tech)/18 of 1975, has prescribed the noise level in mining operations for workers in 8 hour shift period with unprotected ear as 90 dB (A) or less. Similar norms can be considered for construction phase of the proposed project as well. The workers who are expected to be exposed to noise levels greater than 90 dB (A), should not work in these areas beyond 6 to 8 hours. In addition, they also need to be provided with ear plugs. Thus, increased noise levels due to drilling are not expected to adversely affect the workers operating the drill or involved in other mining activities closely.

4.8.1.5 Noise generated due to blasting

Noise generated by blasting is instantaneous, site specific and depends on type, quantity of explosives, dimension of drill hole, degree of compaction of explosives in the hole and rock. Noise levels generated due to blasting have been monitored at various sites and the results have been summarized in Table-4.24.

Table-4.24: Noise generation due to blasting

No. of holes	Total charge (kg)	Maximum charge/delay (kg)	Distance (m)	Noise level dB (A)
15	1500	100	250	76-85
17	1700	100	250	76-86
18	1800	100	250	74-85
19	1900	100	400	70-75
20	2000	100	100	76-80

It can be observed from Table-4.24, that noise level due to blasting operations are expected to be of the order of 75-86 dB (A). Since, the nearest settlement are about 0.8 to 1.0 km away, the incremental noise due to blasting is expected to be 50-60 dB (A). As the blasting is likely to last for 4 to 5 seconds depending on the charge, noise levels over this time would be instantaneous and short in duration. Considering attenuation due to various sources, even the instantaneous increase in noise level is not expected to 60 dB (A). Hence, noise level due to blasting is not expected to cause any significant adverse impact.

Mitigation Measures

A. Noise Control Measures

- Contractors will be required to maintain properly functioning equipment and comply with occupational safety and health standards.
- 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.
- Use of temporary sound fences or barriers to be evaluated.
- Notification will be given to residents within 300 feet (about 90 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.
- Provision with ear muffs or plugs for the workers, so as to attenuate the noise level near the crusher by at least 15 dB (A).
- Working hours of the labourers working on dredgers will be decided considering the guidelines of Occupational Safety and Health Administration (OSHA)
- To prevent other psychological and physiological impacts as mentioned in literature, the exposure period of affected persons be limited as recommended by OSHA limits in the Table-4.22.

B. Noise Control Measures for DG sets

➢ 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.
- 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 dB (A) at 1m sound levels specified by CPCB, Ministry of Environment & Forests. This condition should be made mandatory aspect of the DG set specification.
- 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.
- DG set should also be provided with proper exhaust muffler with insertion loss of minimum 25 dB (A).
- 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.

4.8.2 Operation Phase

In a water resources project, noise pollution occurs mainly during project construction phase. During project operation phase, no major impacts are envisaged.

4.9 Impacts on Biological Environment

4.9.1 Construction phase

4.9.1.1 Impacts on Terrestrial Flora

The direct impact of construction activity of any water resource project is generally limited in the vicinity of the construction sites only. As mentioned earlier, a large population (6400) including technical staff, workers and other group of people are likely to congregate in the area during the project construction phase. It can be assumed that the technical staff will be of higher economic status and will live in a more urbanized habitat, and will not use wood as fuel, if adequate alternate sources of fuel are provided. However, workers and other population groups residing in the area may use fuel wood, if no alternate fuel is provided. Hence to minimize impacts, community kitchens have been recommended. These community kitchens shall use LPG or diesel as fuel.

The other major impact on the flora in and around the project area would be due to increased level of human interferences. The workers may also cut trees to meet their requirements for construction of houses and other needs. Thus, if proper measures are not undertaken, adverse impacts on terrestrial flora is anticipated.

Mitigation Measures

A. Provision of Free Fuel

The project proponents, i.e. TNGECL in association with district administration shall make necessary arrangements for supply of kerosene/LPG. The fuel would be supplied at subsidized rates to the local/contract labour for which provision should be kept in the cost estimate. The cost required for LPG and Kerosene distribution shall be Rs.106.29 lakh and Rs.313.46 lakh respectively. The total cost required for provision of fuel works out to Rs.419.75 lakh. The details are given in Tables-4.25 to 4.27.

Table-4.25: Cost estimate for LPG distribution

Year	No. of Employees	Annual requirement @1cylinder per family per month (No. of cylinders)	Total Cost @Rs.1000 /cylinder (Rs. lakh)	Cost after escalation @ 10%/ year(Rs. lakh)
I	180	960	14.4	14.40
II	100	1200	18.0	19.80
III	100	1200	18.0	21.78
IV	100	1200	18.0	23.96
V	100	1200	18.0	26.35
	Total			**106.29**

Table-4.26: Cost estimate for Kerosene distribution

Year	No. of labours	Quantity @15 litre per family per month (litre/yr)	Total Cost @ Rs. 60/-litre (Rs. lakh)	Cost after escalation @ 10%/ year (Rs. lakh)
I	1200	54,000	54.0	54.0
II	1500	90,000	90.0	99.0
III	1500	90,000	90.0	108.9
IV	1500	90,000	90.0	119.79
V	1500	90,000	90.0	131.77
	Total			**313.46**

Table-4.27: Cost estimate for Fuel distribution in Labour Camps

S. No.	Item	Cost (Rs. lakh)
1.	LPG Distribution	106.29
2.	Kerosene Distribution	313.46
	Total	**419.75**

4.9.1.2 Acquisition of forest land

No Rare, Endangered, Threatened species is reported in the land to be acquired for the project.

Mitigation Measures

A. Compensatory Afforestation

The Indian Forest Conservation Act (1980) stipulates:

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

The total land to be acquired for the project shall be estimated. Compensatory afforestation is proposed in lieu of acquisition of this land. It is proposed to afforest the degraded forest patches and as per Forest Conservation Act (1980).

The total forest land to be acquired for the project is 8.712 ha. It is proposed to cover double the area of degraded forest land under compensatory afforestation. An amount of Rs. 46.34 lakh (@ Rs. 1.0 lakh/ha) has been earmarked for afforestation. In addition, cost of trees and NPV too will have to be paid to the Forest Department. The same shall be estimated by the Forest Department, as a part of Forest Clearance.

B. Biodiversity Conservation Plan

As a part of Biodiversity Conservation Plan, the following measures are proposed:

- Afforestation
- Soil stabilization measures & improving water regime,
- Sustenance of Livelihoods
- Establishment of botanical gardens for conservation and propagation of RET species.
- Anti-poaching measures

The activities proposed as a part of Biodiversity Conservation Plan are described in the following paragraphs:

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.50.0 lakh has been earmarked for this purpose.

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 micro planning 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. 50.0 lakh is proposed for victims of the legal heirs.

Publicity and Awareness

The following activities are proposed:

- Training shall 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. 50.0 lakh is earmarked for this purpose.

Establishment of Botanical Gardens

For conservation and propagation of local species, development of Botanical and Herbal garden shall be done at suitable place in consultation with State Forest Department. These gardens would function as repositories and would catalyze the biodiversity conservation, scientific research, education and environmental awareness in the area.

It is proposed to develop nursery at appropriate location preferably in the Gram Panchayat. Self-help groups formed by women shall be involved for the promotion of herbal medicines developed in the herbal garden.

An amount of Rs. 100.00 lakh has been earmarked for the botanical gardens including development of nurseries, collection of seeds and plant species in consultation with the state forest department.

A total provision of Rs. 250.0 lakh has been earmarked for biodiversity conservation. The details are given in Table-4.28.

Table-4.28: Estimated cost for implementation of Biodiversity Conservation and Management Plan

Particulars	Cost (Rs. lakh)
Afforestation in degraded forest	50.0
Eco-Development Works - Compensation	50.0
Eco-Development Works - Publicity & Awareness	50.0
Establishment of Botanical Gardens	100.0
Total	**250.0**

4.10 Impacts on Terrestrial Fauna

4.10.1 Construction Phase

4.10.1.1 Impacts due to labour population and construction activities

Based on the field survey and interaction with locals, it was confirmed that, no major wildlife is reported in the area, proposed to be acquired for the project. Most of the submergence lies within the gorge portion. Thus, creation of a reservoir due to the proposed project is not expected to cause any significant adverse impact on wildlife movement. The submergence area is not reported to serve as habitat for wildlife nor do they lie on any known migratory route. Thus, no impacts are anticipated on this account.

During construction phase, large number of machinery and construction workers shall be mobilized, which may create disturbance to wildlife population in the vicinity of project area. The operation of various equipment will generate significant noise, especially during blasting which will have adverse impact on fauna of the area. The noise may scare the fauna and force them to migrate to other areas. Likewise, siting of construction plants, workshops, stores, labour camps etc. could also lead to adverse impact on fauna of the area.

During construction phase, accessibility to area will lead to influx of workers and the people associated with the allied activities from outside will also increase, which can lead to illegal hunting and poaching. The increase in human interference could have an impact on terrestrial ecosystem.

The project area is not known to be on wildlife route. Hence, no major impact on habitat fragmentation or disruption to wildlife routes is anticipated on account of construction of Sillahalla pumped storage project.

4.10.1.2 Impacts due to Blasting

The other major impact could be the blasting to be carried out during construction phase. This impact needs to be mitigated by adopting controlled blasting and strict surveillance regime and the same is proposed to be used in the project. This will reduce noise level and vibrations due to blasting to a great extent. Likewise, sitting of construction equipment, godowns, stores, labour camps, etc. may generally disturb the fauna in the area. No large-scale fauna is observed in the project area. Thus, impacts on this account are not expected to be significant. However, few stray animals sometimes venture in and around the project site. Thus, to minimize any harm due to poaching activities from immigrant labour population, strict anti-poaching surveillance measures need to be implemented, especially during project construction phase.

Mitigation Measures

A. Wildlife Protection Plan

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. The terrain is hilly, therefore, the wildlife protection force adequately equipped with watch towers, wildlife personnel and other necessary equipment be deployed to prevent poaching in the area. The measures proposed for wildlife protection are outlined in the following paragraphs:

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. For this an amount of Rs. 50.0 lakh has been earmarked.

Infrastructure Development: This includes anti-poaching 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. The basic amenities for the field staff shall be provided to enable them to do effective patrolling in the areas. For watch tower and accommodation an amount of Rs. 100.0 lakh has been earmarked.

Purchase of Survey equipment and Vehicles: In order to improve network and vigilance it is required to procure communication equipment like walkie talkie, IT infrastructure to document and develop a database, altimeters, G.P.S., 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. 100.0 lakh has been earmarked.

Construction of Check posts: To improve vigilance for illegal logging/loping, anti-poaching, better protection, enforcement for control grazing practices, control-grazing-cum-anti poaching check posts are proposed to be constructed. An amount of Rs. 40.0 lakh has been earmarked for this purpose.

Total 8 no. of Guards shall be hired at monthly remuneration of Rs. 20000 for 5 years; hence total expenditure shall be incurred (assuming 10 % escalation per year) Rs. 117.12 lakh.

The cost for implementation of Wildlife Protection Plan is Rs. 407.12 lakh and details are given in Table-4.29.

Table-4.29: Measures for implementation of Wildlife Protection Plan

S. No.	Particulars	Amount(Rs. lakh)
1	Anti-Poaching Kits	50.0
2	Infrastructure	100.0
3	Survey equipment & vehicle	100.0
4	Check posts	40.0
5	Salary for wildlife protection force	117.12
	Total	**407.12**

B. Monitoring of Biodiversity Conservation & Management Plan

Monitoring is an important part of the Biodiversity Management Plan. All the activities of Biodiversity Management Plan 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, Tamil Nadu. The committee shall review and oversee the conservation work to be undertaken.

4.10.1.3 Impacts on Avi-Fauna

The damming of the river will create quiescent/tranquil conditions. The reservoir banks will have wet environment throughout the year which can lead to proliferation of vegetation e.g. grass, etc. along the reservoir banks. Such conditions are generally ideal for various kinds of birds, especially, water birds. This is expected to increase the avi-faunal population of the area.

Mitigation Measures

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.

Feature of a Nest Box:

The characteristic features of nest box are listed below and shown in Figure-4.3.

- Untreated wood (Jamun, mango, pine, cedar or fir)
- Thick walls (at least ¾ 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.

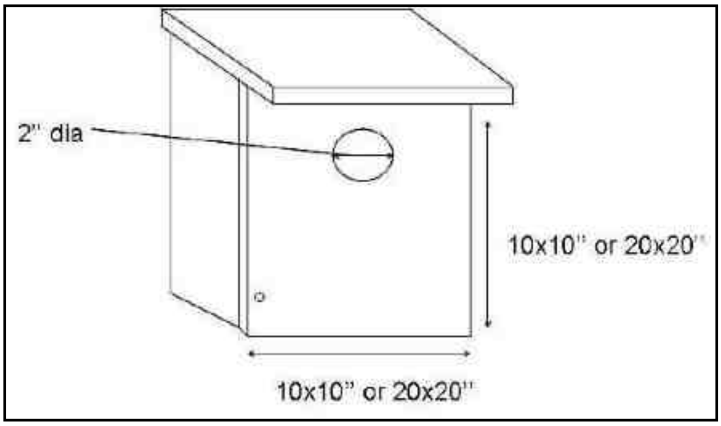


Figure-4.3: Nest Box

It is proposed that one qualified person be hired for a period of five years. An amount of Rs.88.3 lakh can be earmarked for habitat improvement of avi-fauna in the study area. The details are given in Table-4.30.

Table-4.30: Cost of habitat improvement for avi-fauna in the study area

S. No.	Particulars	Amount (Rs. lakh)
A	**Non-recurring Cost**	
1	Cost of nests of different sizes (10"x10" to 20"x20"; average cost Rs. 5000 per wooden box) and installation in the area along with the green belt (1000)	50.0
2	Repair and maintenance of the nests	10.0
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	18.3
2	Contingencies (including avifaunal biodiversity awareness programme for the local inhabitants)	10.0
	Total Cost (A+B)	**88.3**

4.10.1.4 Impacts on Eco-Sensitive Areas

Mukurthi National Park was established in the year 2001 in the Nilgiris Districts and covers an area of 7,846 ha. It is located in Tamil Nadu, India, is part of the Nilgiri Biosphere Reserve. The area was declared as a Wildlife Sanctuary in 1980, and later a National Park in 1990, mainly for the protection of the endangered Nilgiri Tahr (*Hemitragus hylocrius).* It is part of the Nilgiri Biosphere Reserve, which was the first to be declared among the 18 biosphere reserves present in India. It forms a key area for the conservation of grassland habitat in the Nilgiris Hills. The terrain is generally undulating, mostly grassland, and has patches of Montane Evergreen Forest (shola), confined to the folds and depressions of the Western Ghats. There are several streams, many of which drain in to the Bhavani River. There are numerous peaks inside the National Park, the highest being Kolaribetta (2,630m), together with Mukurthi Peak (2,556m) and Nilgiri Peak (2,477m). The major trees species area *Acacia mearnsii*, *Eucalyptus globulus* and *Pinus patula*.

The vegetation of this site can be classified as Southern Montane Wet Temperate Forest (shola) as classified by Champion and Seth (1968), Grassland and Plantation. Pristine patches of shola can be seen all throughout Mukurthi National Park, generally at the heads of streams in the folds of converging slopes. These forests support an amazing variety of flora and fauna. This IBA site is among the richest regions of plant biodiversity, with many endemic orchids and other plant groups. Grasslands in Mukurthi are common and form a mosaic with shola. They are a mixture of *Chrysopogon, Ischaemum, Dicanthium, Andropogon, Eragrostis* and *Panicum* species.

The proposal for declaration of ESZ around Mukurthi National Park was taken up for consideration by the State Government representative. It was informed that Mukurthi National Park is located in Kundah taluk of Nilgiris District in Tamil Nadu. It was further stated that the eastern side of the Mukurthi National Park adjoins extensive Reserve Forests in Nilgiris Division.

The Notification for Mukurthi National Park, in Nilgiris Division, Tamil Nadu is under draft stage as per Minutes of 43rd Meeting of the Expert Committee on Eco-Sensitive Zone (ESZ) vide dated 20.11.2020 (enclosed as Annexure-II). However, Nilgiris

Division Forest Working Plan (2015-2025), has been approved on September 10, 2015, and valid until March 31, 2025.

The Upper Dam site and Lower Dam Site are located about 11.4 and 4.78 km respectively from the boundary Mukurthi National Park (refer Figure-4.4.)

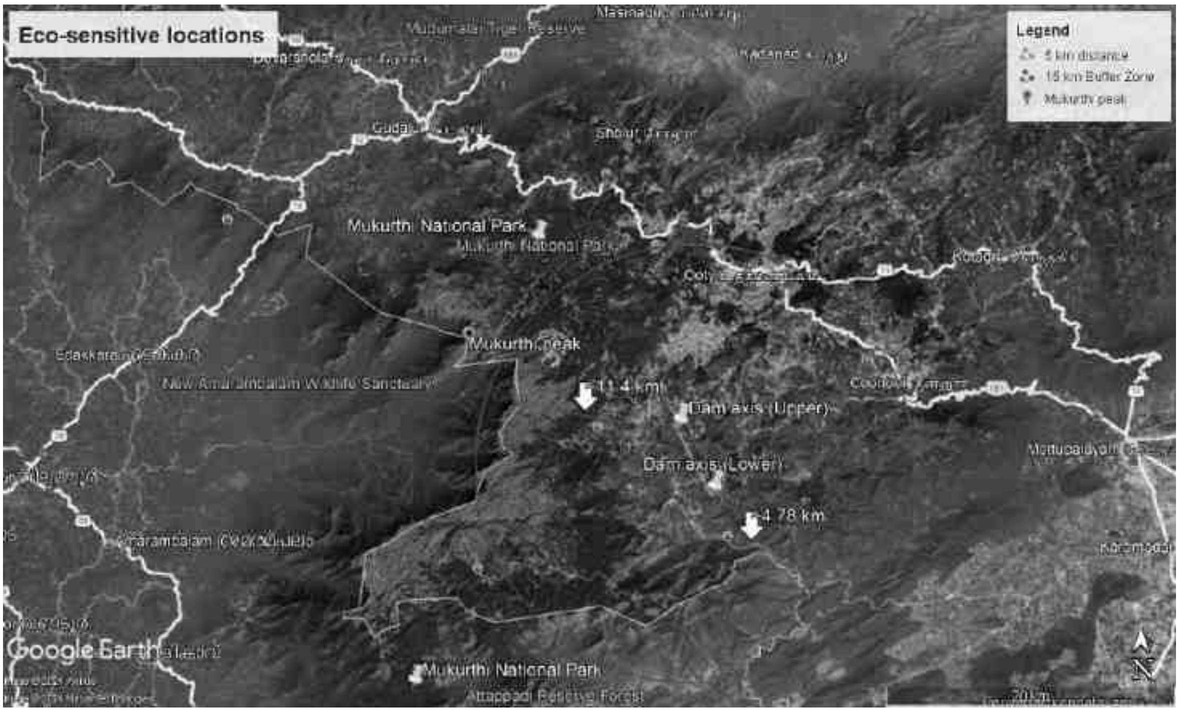


Figure-4.4: Location of Upper and Lower Reservoirs w.r.t Mukurthi National Park

No area of Mukurthi National Park is being acquired for the proposed Sillahalla Pumped storage Project. However, increased human interferences due to labour congregation could lead to adverse impacts on this Eco-Sensitive Area.

Mitigation Measures

During the construction phase, various adverse impacts on the forests and wildlife are anticipated in the surrounding areas of the proposed project in terms of increased noise levels, land vibrations during controlled blasting, air pollution, etc. To avoid and minimize the negative impacts from these activities project authorities are advised to prepare strict guidelines as follows:

- Strict restrictions shall be imposed on the workers at project sites to ensure that they do not harvest any species/produce from the forests and cause any danger or harm to the animals and birds in the wild.

- The fuel wood to the labourers shall be provided by the project proponents so that there is no pressure for cutting of trees to meet fuelwood requirements.
- Interference of human population would be kept to a minimum in the adjacent forest areas and it would be ensured that the contractors do not set up labour colonies/camps in the vicinity of forests and wilderness areas.
- Only well maintained/new equipment that produces lesser noise would be installed at the work sites.
- Equipment that need to be placed permanently at one place like generators, etc. would be housed in enclosed structures to cut off the noise.
- Heavy equipment like rotating or impacting machines will be mounted on anti-vibration mountings.
- Wherever combustion engines are required they will be fitted with silencers.
- Traffic (trucks, etc.) used by the project works will be managed to produce a smooth flow instead of a noise producing stop and start flow. Necessary training/orientation will be provided to the traffic operators/drivers.
- Sounding of loud horns, etc. in the forested areas shall be banned. Project authorities will use water sprinklers on the road to avoid dust from construction activities.
- While clearing the land of vegetation for any project work, the project authorities will ensure that the work area has sufficient layer of tree cover around it. It will act as an effective noise absorber and dust barrier. The tree layer will act as buffer zone and these are known to cut off noise by about 5-20 dB (A) at a site depending upon the density of vegetation. These measures will be planned in advance and well before starting operation at any site.

4.10.2 Operation phase

4.10.2.1 Increased accessibility

During the project operation phase, the accessibility to the area will improve due to construction of roads, which in turn may increase human interferences leading to marginal adverse impacts on the terrestrial ecosystem.

4.11 Impacts on Aquatic Flora

4.11.1 Construction phase

During construction phase wastewater from domestic source will be discharged mostly from various camps of workers actively engaged in the project area. Around 0.45 mld of water is required for the workers during the peak construction phase out of which 80% (i.e. about 0.36 mld) will be discharged back to the river as wastes, more or less as a point sources from various congregation sites where workers will reside. It is proposed to treat the same prior to disposal. In addition, effluents from Batching Plant, Crushers, workshops, shall also be treated so as to minimize the adverse impacts on river water quality and aquatic flora.

4.11.2 Operation phase

4.11.2.1 Impacts due to Reservoir Formation

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

4.12 Impacts on Aquatic Fauna

4.12.1 Construction phase

4.12.1.1 Impacts due to Construction Activities

The construction of the proposed Sillahalla Pumped Storage Project would lead to increased pollution levels due to congregation of labour population during construction phase. The waste water or effluent from various sources shall be treated prior to disposal. Appropriate mitigation measures shall be implemented for the same.

4.12.2 Operation phase

Impacts on fish fauna due to damming and reservoir formation

There are two types of impacts on the aquatic flora and fauna of rivers Kundah and Sillahalla, due to damming and reservoir creation listed as below:

- Submergence of the present fish habitat and the obstruction of migration upstream and downstream movement of the fishes due to the construction of the dam. This will have an impact on riverine fisheries.
- Damming will create deeper and wider water body which could provide suitable habitat for fisheries. Since, it is a pumped storage project, with daily fluctuations in reservoir water level from MDDL to FRL, will not allow reservoir fisheries to develop.

Impacts on Aquatic Ecosystems and Biodiversity

Construction activities, including the diversion of the river through a tunnel, cause major disturbances and have adverse impacts on the aquatic ecosystem. In many cases, vulnerable species, with either limited distribution or low tolerance, become extinct even before the dam is completed. However, in most projects, the study of aquatic biodiversity has been limited to the study of fish, and then only the commercially important species. The results of the Tehri Dam, India (Tehri, 19911) and Uri (UHPP, 1989) indicate that there are significant adverse impacts on the aquatic ecosystems and biodiversity at and around the construction site. The blocking of a river and the formation of a lake significantly alters the ecological conditions of the river: there are changes in pressure, temperature, oxygen levels and even in the chemical and physical characteristics of the water. Besides, by interrupting the flow of water, ecological continuity is broken, especially for those species of fish whose passage up river to their breeding grounds is blocked by the dam.

Migration Pattern of Fisheries

The list of fish species reported to be observed in various seasons is given in Tables3.47 to 3.49 of Chapter-3 of this Report. Only few species are migratory in nature. The migration pattern is described in following paragraphs.

Catla catla

During monsoon season, Catla catla migrates to the upper reaches of rivers to spawn. The spawning season is between May to September.

Cyprinus carpio

Carp migrate seasonally, returning to the same lakes to spawn and overwinter. Adults migrate to suitable backwaters and flooded meadows to spawn. In winter migration months, Carp move to deeper waters to overwinter.

Lebeo rohita

Labeo rohita, commonly known as the Rohu, holds a special place in the freshwater ecosystems of the Indian subcontinent. This remarkable species showcases a unique ability to swim against powerful currents during upstream migration, a phenomenon that has intrigued scientists and environmentalists alike.

Mitigation Measures

I. Provision of minimum flow

The construction of the proposed project will lead to reduction in flow, especially during dry months, in the intervening stretch between the diversion site and the tail race disposal point. Such a situation will adversely affect the benthic communities and fish.

The dry segment of river between diversion site and tail race at certain places may retain some water in shallow pools subjecting the fish to prey by birds and other animals. Such a condition will also enable the poachers to catch fish indiscriminately. It is therefore, very essential for the project authorities to maintain the minimum flow for the survival and propagation of invertebrates and fish. In order to avoid possible loss of aquatic life, a minimum flow will always be released.

The proposed project is a pumped storage scheme. The water will be diverted for storage of Upper and Lower Reservoir for a period of 46 months. During filling phase, 30% of flow in 90% Dependable Year shall be released in monsoon season. In non-monsoon months, 100% flow will be maintained in the intervening stretch. Thus, the reduction in flow is not likely to have any adverse impact on the downstream users.

II. Sustenance of fisheries

The stocking program shall comprise of the following:

- Acclimatization stocking (a new fish species is introduced in a water course)
- Supplementary stocking (a species already living in a water body)
- Transfer stocking (transportation of mature fish from one water body to another)
- Repetitive stocking (species which do not propagate in natural conditions).

To carry out the stocking programme on annual basis, suitable aquaculture facilities have to be created in rivers Sillahalla and Kundah to meet the requirements of fingerlings.

It is proposed to implement supplementary stocking programmes for the project area. In addition to reservoir area, it is proposed to stock rivers Sillahalla and Kundah for a length of 10 km each on the upstream and the downstream side of the Upper/Lower Reservoir site. The rate of stocking is proposed as 100 fingerlings of about 30 mm size per km. For reservoir area, the rate of stocking could be 200 fingerlings of about 30 mm size per ha. The stocking can be done annually by the Fisheries Department, State government of Tamil Nadu.

Facilities to produce seed of trout need to be developed at suitable sites. The cost required for developing of hatcheries shall be Rs. 40 lakh. The dimension of the hatching nurseries and rearing unit and their approximate cost is given in Table-4.31. The recurring expenditure for hatchery will be 13.8 lakh/year. The total recurring expenditure for 6 years including 10% escalation will be Rs. 106.48 lakh. The detail of recurring expenditure are given in Table-4.32.

Table-4.31: Cost required for development of hatcheries

Farm Component	Area (m)	Number	Rate of flow (lpm)	Cost (Rs. lakh)
Hatchery building	15x 6 x 5	1	-	6.0
Hatching trough each with 4 trays each	2.0x0.5x 0.4	30	3.0-5.0	3.0
Nursery ponds (Cement lined)	3.0 x 0.75 x 0.5	15	25-50	4.5
Rearing tanks (cement lined)	10.0x 1.5 x 1.0	15	75-100	7.5
Stock raceways (cement lined)	30.0 x 6.0x 1.5	2	150-200	3.0
Storage – cum – Silting tank	4.0 x 4.0	2	-	2.0
Office store & laboratory room	8.0 x 6.0	5	-	10.0
Watchmen hut	4. 4.0	1	-	2.0
Other items like Dragnet, wide mouth earthen pots miniature happa bucket bamboo patches etc.	Lumpsum			2.0
Total				**40.0**

Table-4.32: Recurring expenditure for hatchery

S. No.	Particular	Number	Rate	Amount (Rs. Lakh)
1.	Salaries			
i)	Farm Manager	1	25000/month	3.0
ii)	Farm Assistants	1	15000/ month	1.8
iii)	Farm Attendants	1	10000/ month	1.2
iv)	Chowkidars	1	10000/ month	1.2
2.	Fish food	Lumpsum		0.10
3.	Brooders	200 kg	150	3.0
4.	Ponds manuring			0
i)	Cow dung	20 tons	200/tons	0.0
ii)	Urea	100 kg	10/kg	0.0
iii)	Potash, phosphate	100 kg	100/kg	1.0

S. No.	Particular	Number	Rate	Amount (Rs. Lakh)
5.	Lime	300 kg	10/kg	0.3
6.	Training and Research	Lumpsum		0.50
7.	Chemical	Lumpsum		0.10
8.	Maintenance	Lumpsum		0.50
9.	Travel	Lumpsum		0.60
10	Miscellaneous	Lumpsum		0.50
	Sub-total for one year			13.8
	Total recurring expenditure for six years including 10% escalation (B)			**106.48**

Thus total cost for fish seed farm will be (Rs. 40.0 + 106.48 lakh) Rs. 146.48 lakh. The above facility can be developed and implemented by Fisheries Department, State Government of Tamil Nadu at an appropriate site. Seeds can be transported from this hatchery. The supply of seeds can also be augmented by collecting them from natural sources. Production, transportation and stocking of fish material is highly technical subject for which project proponent may not have the required expertise. Thus, implementation of this proposal may be done by the Fisheries Department. The funding can be done by Project Proponents.

4.13 Impacts on Public Health

4.13.1 Construction Phase

About 1600 labour and technical staff with a total increase in population by 6,400 will stay in the project area during construction phase. The labour would live in dormitories provided by the Contractor where proper sanitary facilities are to be provided as per contract agreement. However, some of the labour coming from outside the project area could be carrier of certain diseases therefore proper screening of labour population will be done by the contractor.

Inadequate facilities in labour camps

Labour camps without adequate facilities for potable water supply and sewage treatment could lead to outbreak of epidemics of water-borne diseases. Adequate measures for supply of potable water and sewage treatment have been recommended.

Water pollution and water borne diseases

Lack of potable water supply could lead to increased incidence of water borne diseases particularly in camp sites and in adjoining areas. There could incidence of spread of water-borne diseases in labour camps/colonies. Communities located in direct impact zone as well as indirect impact zone could also be severely affected from such epidemics.

Air pollution

Dusts, particulate matters and smoke generated during the time of construction in project construction sites could increases chances of respiratory diseases and dust allergies. Project staffs and labor workers could be affected from the air pollution during the construction of high dam and other relevant engineering structures during the time of construction period. Dust particles ranging from 1-10 microns could spread air borne infections. Diseases related to dusts and smoke such as asthma, bronchitis, eye irritation, throat and nose irritations etc. could prevail into the communities situated at the direct impact zones during the time of construction.

Noise Pollution

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

Occupational Injuries

The construction activities such as blasting, quarrying, heavy vehicular movements are associated with high risk of accidents and injuries for workers as well as surrounding communities. Workers may endure injuries form machinery and equipment, chemical, explosive materials, burns Electrocution, falls, falling objects, dust and vibration during construction activities. Workers exposed to noise levels higher than 90 dB (A) can have hearing acuity problems.

Health Risks due to congregation of Labour Population

The health risks specific to water resources projects emanate from congregation of labour at various construction sites. During construction phase, new groups come and go constantly keeping the human population in a flux. These groups are usually housed in temporary dwellings without proper sanitary conditions and water supply. In the final stages, colonies for project maintenance, townships are built.

During construction phase or for permanent settlement, if adequate precautions are not taken, the vector-borne disease epidemiology may show sudden or long lasting change. Many of the immigrant population could be reservoir of infection for various communicable diseases. Once they settle in labour camps/colonies, there could be increased incidence of various diseases. This aspect needs to be looked into with caution, and efforts must be made to ensure that a thorough check up of the labour population congregating in the area is conducted. Those affected by any ailments need to be properly quarantined depending on the ailment with which they are suffering.

Mitigation Measures

- Measures to be taken for provision of adequate drinking and sanitation facilities for the labour population and their families.
- Borrow areas for excavation material would be under river bed, hence it would prevent formation of mosquitoes breeding ground.
- Adequate measures for supply of potable water and sewage treatment have been recommended as part of mitigation measures.
- A proper surveillance, immunization schedule and medical facilities would be provided for the labour population migrating into the project area.

Development of medical facilities

Proposed Health Facilities at Construction sites

A first aid post is to be provided at 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.

The first-aid post can be housed in temporarily erected structure and should be managed by one Health Assistant and assisted by one dresser/first aid attendant. Doctors from the dispensary can attend First Aid post regularly every day at a fixed time. Communication link between the dispensary and then first-aid post shall be established, so as to enable doctors from dispensary to reach the work site in case of an emergency. The first-aid post shall have facilities such as fire-fighting equipment, telephone connection, one vehicle or ambulance van for effective functioning.

Health Extension Activities

The health extension activities will have to be carried out in the villages situated within the study area. It is important to inculcate hygienic habits of environmental sanitation specially with respect to water pollution by domestic wastes. There would be a possibility of transmission of communicable diseases due to migration of labour population from other areas at the construction site.

The doctors from the dispensary will make regular visits to these villages and organize health promotional activities with the active participation of the local village leaders, 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.
- Close interaction to be maintained with health department functionaries of the state government.

The costs estimated as follows are approximate and indicate the order of expenditure likely to accrue.

A. Expenditure on salaries

Post	Number	Monthly Emoluments (Rs)	Annual Expenditure (Rs. lakh)
Recurring (Dispensary)			
Doctors	2	100,000	24.00
Nurse	4	25,000	12.0
Male Multi-purpose	2	20,000	4.80
Health Workers			
Attendants	2	15,000	3.6
Drivers	2	15,000	3.6
Sub-Total (A)			**48.0**
First Aid Posts			
Health Assistants	2	15,000	3.6
Dressers	2	15,000	3.6
Sub-Total (B)			**7.2**
Grand Total			**55.2**

B. Expenditure on Material and Supplies

Description	Expenditure (Rs. lakh)
Dispensary	
Non-recurring	
2 Vehicles (Closed Jeep)	30.0
Furniture, etc.	5.00
Miscellaneous item	5.00
Total	**40.0**
Recurring	
Drugs and Medicine (per year)	6.00
Contingencies (per year)	5.00
2 First-Aid Posts at construction sites (per year)	2.40
Total	**13.4**

C. Infrastructure

Non-recurring

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 dispensary building 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.50.0 lakh. The land can be purchased by the project proponents from the State Government. An amount of Rs.20.0 lakh can be earmarked for this purpose.

First-Aid Posts: These are of temporary nature and will be constructed with MS/GI sheets, bamboo, etc. It will cost @ Rs.2.0 lakh/First- Aid Post. The total cost for constructing two First -Aid Posts will be of the order of Rs.4.0 lakh.

The total cost for developing the infrastructure will be (Rs.50.0 lakh + Rs.20.0 lakh + Rs.4.0 lakh) Rs.74.0 lakh.

The total expenditure for implementation of various public health measures shall be about Rs.514.16 lakh. The details are given in Table-4.33.

Table-4.33: Details of expenditure in Public Health Delivery System

Description	**Expenditure (Rs. lakh)**
A. Recurring Expenditure	
Expenditure on salaries (per year)	55.2
Expenditure on materials & supplies (per year)	13.4
Sub-total (per year)	65.6
Total expenditure for 5 years (considering 10% escalation per year) **(A)**	**400.16**
B. Non-Recurring Expenditure	
Infrastructure (Construction of Dispensary & 2 First aid posts)	74.0
Expenditure on materials & supplies	40.0
Total (B)	**114.0**
Total A+B	**514.16**

4.13.2 Operation Phase

The construction of a reservoir replaces the riverine ecosystem by a lacustrine ecosystem. The vectors of various diseases breed in shallow areas not very far from the reservoir margins. The magnitude of breeding sites for mosquitoes and other vectors in the impounded water and to the length of the shoreline. Thus, there could be increased incidence malaria and other vector-borne disease during project construction phase.

4.14 Impacts on Social Environment

4.14.1 Construction Phase

4.14.1.1 Impacts due to Private Land Acquisition

Land acquisition and population displacement/involuntary resettlement. The important adverse impact during construction phase will be that, pertaining to land acquisition. About 315 ha of land is to be acquired for the proposed Sillahalla Pumped Storage project. The acquisition of private land would lead to PAFs losing land in varying proportions. A suitable Rehabilitation Plan has been formulated for compensation of families in lieu of acquisition of land, which is outlined in Chapter-7 of this Report.

4.14.1.2 Local employment opportunities

The construction phase will last for about 61 months. The total number of persons inhabiting the area including the service population will be about 6400. Together with the work force many business establishment will take place which will attract people from other places. Influx of labour population might lead to number of social, cultural, economic and security related problems.

The construction phase of any project is rather an unsettled stage characterized by uncertainties and often disorders. The basic problem relates to management of large population, which migrates to the project area or near major construction sites, in search of jobs. The construction of the proposed project would invariably create a number of direct employment opportunities. However, indirect employment opportunities would also be generated which would provide great impetus to the economy of the local area. Various types of businesses, such as shops, food-stalls, tea stalls, restaurants, workshops, etc. would invariably come-up, which would be run by the more entrepreneurial local residents. Besides, a variety of suppliers, traders, transporters, service providers, etc., are also likely to concentrate here and likely to benefit immensely, as demand for almost all types of goods and services will increase significantly. The business community as a whole would be benefited. The locals would also avail these opportunities arising from the project and increase their income levels.

The construction phase of the proposed project will provide an impetus to the industrialization and urbanization in the area. Many of the agricultural lands or barren lands in the vicinity of the project area are likely to be put to non-agricultural uses. The project would require lot of ancillary developments like shops, restaurant, workshops, etc. which will have a significant impact on the existing land use of the area. Job opportunities will drastically improve in this area. At present most of the population sustains on agriculture and allied activities. There are no major industries or other avenues of occupation in the area. The project will open a large number of jobs to the local population during project construction phase.

4.14.1.3 Business opportunities

Apart from direct employment, opportunities for indirect employment will also be generated which would provide great impetus to the economy of the local area. Various types of business like shops, food-stall, tea stalls, etc. besides a variety of suppliers, traders, transporters will concentrate here and benefit immensely as demand will increase significantly for almost all types of goods and services. The business community as a whole will be benefited. The locals will avail these opportunities arising from the project and increase their income levels. With the increase in the income levels, there will be an improvement in the infrastructure facilities in the area.

4.14.1.4 Impacts due to blasting on people and structures

The construction of the project would require blasting for various operations due to tunneling, cutting of roads, quarrying, etc. This could affect the nearby structures. Normally blasting is done in with proper safety measures and major impacts are not anticipated. However, if such impacts do take place, suitable compensation shall be paid for mitigation of adverse impacts in this account.

4.14.1.5 Construction workforce related influence on social services (Educational, Health, Communication, Water Supply, Consumer Goods, and Sanitation etc.)

During construction phase a large labour force, including skilled, semi-skilled and un-skilled labour force, is expected to immigrate into the project area. Some of the locals would also be employed to work in the project. The labour force would stay near to the project construction sites. Education will improve in the area. The advantages of education to secure jobs will quickly percolate through all sections of the population and will induce people to get their children educated. A sizeable amount of surplus generated through labour will be spent on education.

The labour force that would work in the construction phase would settle around the project site. They would temporarily reside there. This may lead to pollution, due to generation of domestic wastewater, human waste, municipal solid waste etc. Besides, other deleterious impacts are likely to emerge due to inter-mixing of the local communities with the labour force. Differences in social, cultural and economic conditions among the locals and labour force could also lead to friction between the migrant labour population and the local population.

4.14.1.6 Improved access facilities in the project area

Development of the proposed Sillahalla Pumped Storage project will have multifold beneficial impacts. The immediate beneficial impacts from the project will be improved road access which will bring food security situation and overall economic and social stability. The improved accessible road will also provide cheap, safe and fast transport of goods and services from rural areas to urban centers and vice versa.

4.14.1.7 Impacts on public health due to migrant population

About 1600 labourers, technical staff and service providers will congregate in the project area during peak construction phase. The total increase in population is expected to be of the order of 6400. Most of the labour would come from various parts of the country. The labour population would live in dormitories provided by the Contractor. Proper sanitation facilities are generally provided. Hence, a proper surveillance and immunization schedule needs to be developed for the labour population migrating into the project area.

4.14.2 Operation Phase

4.14.2.1 Community health improvement

The development of infrastructure facilities in the project area will lead to easy access for the locals to the district hospital as well as project health care units. The better electrification will further enhance the facilities available at the centers.

During project construction phase, proponent will develop health care with adequate number of health workers and logistic supports primarily to provide health support services to the workers and project staff. The health facility will also be made available to local people and visitors as well.

4.14.2.2 Local employment opportunities

The operation of the project will provide some employment opportunity for the local people. The number of employees will decrease in comparison to the requirement during construction but some workers will continue during the operation phase for running the power plant. Besides direct employment opportunity, there shall be enhancement in industrial activities in the area due to availability of electricity. The construction and operation will lead to urbanization, which will also create employment opportunity indirectly.

4.14.2.3 Local employment opportunities

The operation of the project will provide an impetus to the industrialization and urbanization in the area. Many of the agricultural lands or barren lands in the vicinity of the project area are likely to be put to non-agricultural uses. The project would require lot of ancillary developments like shops, restaurant, workshops, etc. which will have a significant impact on the existing land use of the area. Job opportunities will improve in this area. At present most of the population sustains on agriculture and allied activities. There are no major industries or other avenues of occupation in the area. The project will open a large number of jobs to the local population during project operation phase.

4.14.2.4 Impoverishment Risk Assessment (IRA)

One of the most important and negative impact due to the commissioning of the project would be that a number of families could be displaced from their lands, and economic activity. As per the assessment, a total of 22 landholders/ land titleholders would be losing land in varying proportions. In project feasibility and preparation studies, the IRA performs two basic functions. Foremost, it serves as a diagnostic and predictive tool, to anticipate risks in resettlement and to assess their nature and their expected intensity. Secondly, IRA is also used as a problem resolution and planning function, to guide the incorporation of measures matching each main risk, either for prevention or mitigation. The IRA identifies impoverishment not only in terms of income, but also in terms of employment opportunities, health care, nutrition, food security, common assets, education, shelter or social capital. The ira framework has been synthesized from the knowledge of past experiences, which saves considerable time and effort in feasibility work by not demanding general risk analysis to start afresh in each project, but rather by *ex-ante* offering a well-tested starting point. The matrix of eight basic risks in light of historical experience, predictable in most resettlement situations: landlessness, joblessness, homelessness, marginalization, increased morbidity and mortality, food insecurity, loss of access to common property, and social (community) disarticulation. Each of these risks is briefly discussed below in Table-4.34.

Table-4.34: Impoverishment Risk Assessment

S. No.	Risks involved	Description of risks involved	Details
1.	Landlessness	Expropriation of land removes the main foundation on which people build productive systems, commercial activities, and livelihoods. Often land is lost forever, sometimes it is partially replaced, and seldom, it is fully replaced or fully compensated. This is the principal form of de-capitalization and pauperization of displaced	As per our assessment, there are about 818 PAFs who are likely to lose their lands in varying proportions due to the process of land acquisition. The villagers depend on their lands for their livelihood. In addition, there are a number of families that are dependent on these lands for their livelihood, who work as agricultural labour work force. Acquisition of lands

S. No.	Risks involved	Description of risks involved	Details
		people, as they lose both natural and man-made capital.	would invariably affect their means of livelihood and sustenance.
2.	Joblessness	Loss of wage employment occurs on account of acquisition of agriculture land, resulting in unemployment or underemployment among resettlers.	PAFs are dependent on Agricultural land and its acquisition would adversely affect the employment scenario in the area.
3.	Marginalization	Marginalization occurs when families lose economic power and slide on a downward mobility path middle-income farm - households do not become landless, they become small land holders, small shopkeepers' and craftsmen downsize and slip below poverty thresholds. Relative marginalization often begins long before actual displacement; for instance when lands are condemned for future flooding they are implicitly devalued as new public and private infrastructure investment are prohibited and the expansion of social service is undercut.	This aspect needs to be carefully and sensitively assessed, as the main source of sustenance, i.e. land would be acquired and thus the main source of income and livelihood is gone; the possibility of many of the PAFs would become marginalized. As mentioned there are 8`18 land titleholders that would lose land due to the process of land acquisition. It is felt that only a few families/ individuals that would be able to bear the brunt of land acquisition. For the remaining the possibility of sliding on a downward mobility path would be inevitable unless alternative sources of livelihood are not provided.

4.14.2.5 Gender Discrimination Risks

Most of the male labour population is expected to be engaged in the construction works, thereby creating shortage of male labor for agricultural and household activities. This will create additional pressure to women of agricultural and household workload of collecting fodder, firewood, grazing livestock, etc. On the other hand, the contractors/sub-contractors may be willing to employ women for low wages. Women and children particularly from poor and disadvantaged groups may be attracted to any small job offer even for low wages. Thus, wage hours need to be applied for both male and female labour population.

4.15 Budget for Implementation of Mitigation Measures

The cost for implementation of mitigation measures is Rs. 4495.81 lakh. The details are given in Table-4.35

Table-4.35: Cost for Implementing Mitigation Measures

S. No.	Item	Cost (Rs. lakh)
1.	Landscaping and Restoration of Construction Areas	100.00
2.	Stabilization of Muck Disposal Sites	1020.00
3.	Environmental Management in Road Construction	800.00
4.	Solid waste Management	108.92
5.	Sanitary facilities in labour camps	188.00
6.	Treatment of Effluents from Crushers	50.0
7.	Treatment of effluents from batching plants	50.0
8.	Treatment of effluent from fabrication units and workshops	50.0
9.	Air Pollution Control Measures	256.30
10.	Provision of Free Fuel	419.75
11.	Compensatory Afforestation	46.34
12.	Biodiversity Conservation Plan	250.00
13.	Wildlife protection Plan	407.12
14.	Habitat Improvement for Avi-Fauna	88.30
15.	Development of Hatcheries	146.48
16.	Public Health Delivery System	514.60
	Total	**4495.81**

CHAPTER-5
ALTERNATIVES STUDIES

5.1 Introduction

The Feasibility study report was prepared and obtained ToR as 1st stage clearance for EIA/EMP studies from MoEF&CC in September, 2020. In present studies, three possible alternate layouts were identified and studied in detail in view of techno-economic viability of the project on the basis of earlier reports, topography, regional geology and site visit with reconnaissance survey.

To develop the layout of Sillahalla Pumped Storage Hydro-electric Project the following were considered:

- Harness the maximum potential between Sillahalla stream and Kundah river reach just downstream of Kundah Palam dam.
- Pondage requirement for 5 to 6 hrs of generation.
- Fulfil the free stretch criteria between TWL of Kundah Palam Forebay dam and FRL of proposed Lower reservoir.

For alternate planning, studies considered the following criteria:

- Studies were carried out for different height of upper dam.
- Three different alignment of water conductor system was studied in detail.
- Suitability of various waterway alignments was also evaluated for each of the main alternatives.
- Dam axes of both upper & lower dam are kept same for all the alternates.

5.2 Upper Dam

5.2.1 Selection of Site & Type of Dam

Two dam axes alternates for Upper dam i.e. L1 & L2 (located at 25m apart) were identified. Geological survey of India (GSI) carried out the geological mapping (1:1000 scale) of dam site area along with geotechnical investigation on both the dam axis, detailed sub-surface exploration through 11 nos. drill holes were carried out. The alternatives for Upper Dam axis are depicted in Figure-5.1.

Based on logging and assessment of cores, GSI observed deeper foundation grade rock in the right bank as compared to the left bank as well as presence of landslides on either banks close to dam axis alignment. Therefore, GSI recommended the project authorities to carry out detailed Geophysical investigation comprising Seismic refraction survey along the proposed dam axis alternatives. Accordingly, Seismic refraction survey (SRS) along the proposed dam axes (L1 & L2) was carried out by NIRM in April 2017. The summary concluded that right bank has thicker overburden than the left bank. Based on the findings of sub-surface explorations & seismic refraction survey, GSI opined that both the dam axes have similar geological conditions, but L2 axis shows a less overburden thickness as compared to L1axis and has uniform spread of weathered rock. Hence, L2 was preferred over L1.

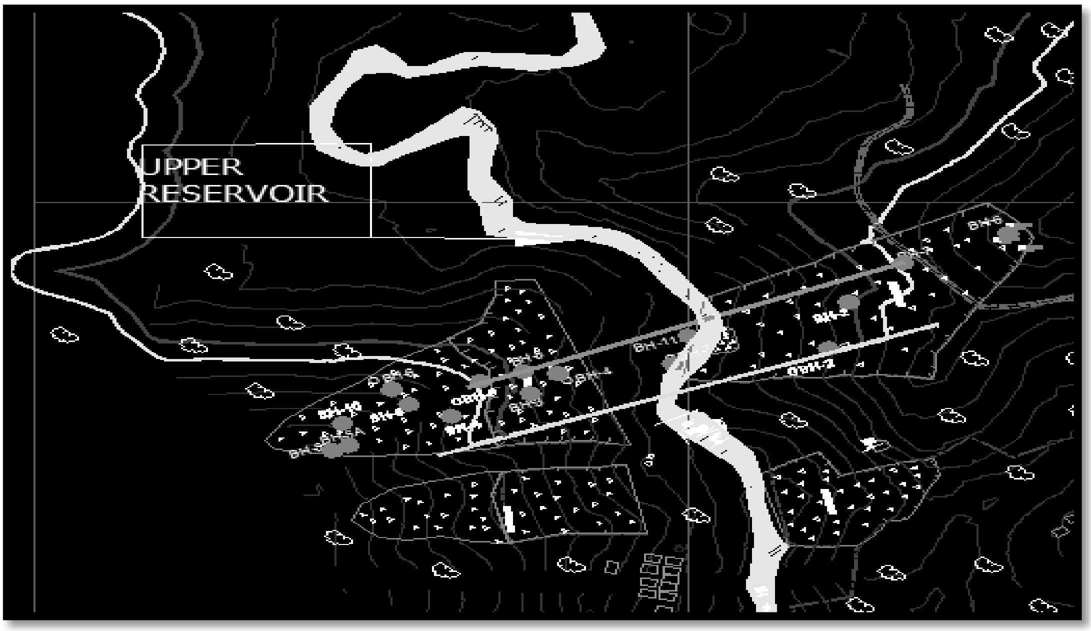


Figure-5.1: Alternatives for Upper Dam axis

After analyzing all the previous studies/ investigations and preliminary site survey at FSR stage, WAPCOS considered L2 as the Upper dam axis and taken for the further studies at DPR stage with additional investigations.

5.2.2 Type of Dam

For selection of type of Lower Dam, followings are considered:

As per the topographical condition, initial choice was Rock-fill with Central Clay Core type as it was best suited from cost consideration. However, during the reconnaissance site visit following likely constraints were envisaged in opting for this type of dam:

- As the project lies in Nilgiris district mining in the project area is not allowed and same is confirmed during the reconnaissance survey.
- Shortage of clay material outside the Nilgiris district.

In view of above constraints, the option of Concrete Gravity type dam is only the option available as the construction material for Rock-fill with clay core type dam is not locally available.

5.3 Lower Dam

5.3.1 A Selection of Site

The preliminary study for identification of the lower dam axis has been done after considering the following options:

- Proposing the lower dam just upstream of Kundah Palam Forebay
- Proposing existing Kundah Palam as Lower reservoir
- Proposing the lower dam just downstream of Kundah Palam Forebay

The proposed alternatives for Lower Dam Axis are depicted in Figure-5.2.

- **Upstream of Kundah Palam Forebay**–In this option, dam axis is proposed after keeping the free stretch from the existing Kundah Palam FRL however, at this location not sufficient storage viz-a-viz head is available for generation.

- **<u>Kundah Palam Forebay as Lower reservoir</u>** –The existing Kundah palam forebay dam has been under generation from last 50 years and its storage is reduced due to the accumulation of sediment, therefore, only option is to increase the height of dam to accommodate the storage required for pumped storage project. However, this option is not feasible as it will impact the existing power generation for all the Kundah projects.

  Annex A

- **<u>Downstream of Kundah Palam Forebay</u>**- In this case the optimum head, storage capacity and free stretch are the governing criteria. The feasible location for dam axis has been identified by optimizing the required head for generation as well as storage capacity of the reservoir. The dam axis location is selected in such a way that to harness the maximum viz-z-viz optimised hydro-potential between Sillahalla stream and Kundah River.

Based on the above studies, Lower dam axis has been proposed on the Kundah River which is about 2.6 km downstream of existing Kundah Palam dam. The location/capacity of the Lower reservoir is restricted to meet the free stretch criteria between the Kundah Palam Forebay Dam and FRL of proposed Lower reservoir.

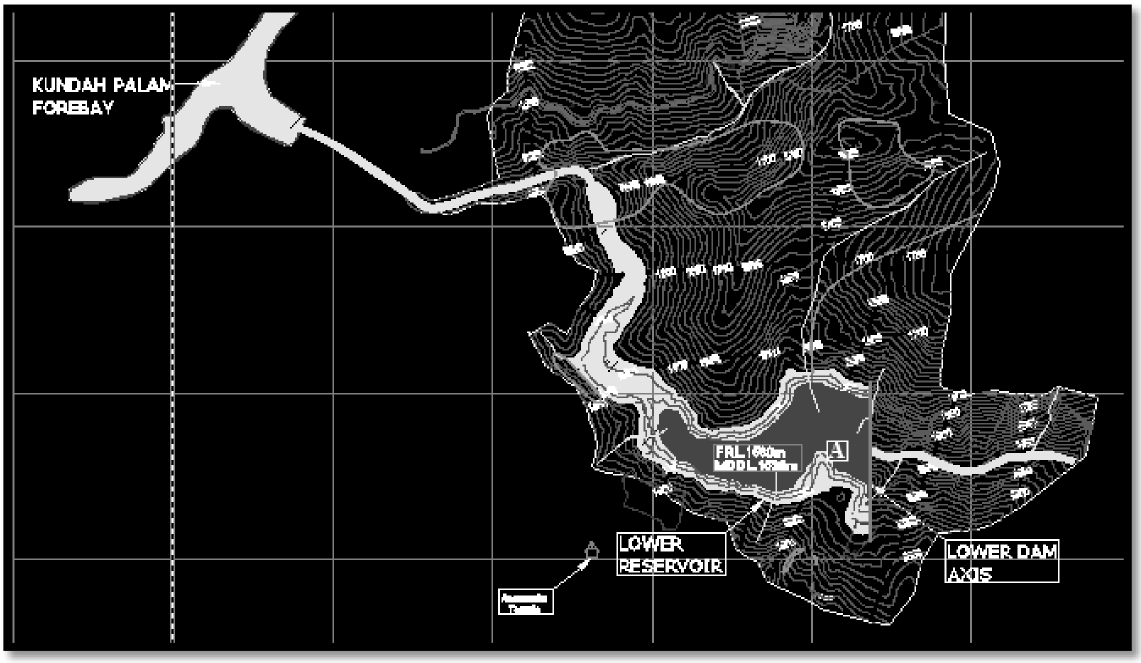


Figure-5.2: Alternate for Lower Dam axis

5.3.2 Type of Dam

For selection of type of Lower Dam, followings are considered:

As per the topographical condition, initial choice was Rock-fill with Central Clay Core type as it was best suited from cost consideration. However, during the reconnaissance site visit following likely constraints were envisaged in opting for this type of dam:

- As the project lies in Nilgiris district mining in the project area is not allowed and same is confirmed during the reconnaissance survey.
- Shortage of clay material outside the Nilgiris district.

In view of above constraints, the option of Concrete Gravity type dam is only the option available as the construction material for Rock-fill with clay core type dam is not locally available.

5.4 Water Conductor System

Three alternates of Water Conductor System (WCS) have been studied by keeping the alignment as straight as possible to minimize the losses and meeting the sufficient lateral & vertical cover criteria.

The following parameters are considered same for all the WCS alternatives:

- Upper and Lower dams are proposed as concrete gravity dam due to non-availability of construction material i.e. clay & rockfill material near by the project site and moreover mining is not allowed in Nilgiris district.
- Design discharge of 300 m^3/s is considered for the project.

➢ **Alternate I**

In alternative I, Upper and Lower dams are Concrete gravity dam for both locations having length 327 m & height 82 m for upper dam and length 470 m & height 112 m for lower dam. The FRL & MDDL of Upper reservoir is at EL.1950m & EL. 1940 m respectively, and FRL & MDDL of Lower reservoir is at EL.1560m & EL. 1530 m respectively. The water conductor system comprises of 9.0 m diameter circular HRT of length 2.86 km followed by inclined pressure shaft of 6.5 m diameter and length 533m. The tail race tunnel to discharge water from power house to lower reservoir is of diameter 9.75m of length 1.57 km (refer Figure-5.3).

- **Alternative II**

Concrete gravity dam for both dams having parameters as in Alt-I. The water conductor system comprises of 9.0 m diameter circular HRT of length 1.92 km followed by inclined pressure shaft of 6.5 m diameter and length 1280 m. The tail race tunnel to discharge water from power house to lower reservoir is of diameter 9.75 m of length 1.62 km. (refer Figure-5.3).

- **Alternative III**

Concrete gravity dam for both dam locations having length 578 m & height 103 m for upper dam and length 470 m & height 112 m at lower dam. The FRL & MDDL of Upper reservoir is at EL.1970 m & EL. 1960 m respectively, and FRL & MDDL of Lower reservoir is at EL.1560 m & EL. 1530 m respectively. The water conductor system comprises of 8.65 m diameter circular HRT of length 2.64 km followed by inclined pressure shaft of 6.1 m diameter and length 562 m. The tail race tunnel to discharge water from power house to lower reservoir is of diameter 9.40 m of length 1.58 km. (Refer Figure-5.3).

The comparison of project layouts is presented in Table-5.1.

Table-5.1: Comparison of Project Layout

Parameters	Alt -1	Alt -2	Alt -3
Upper Dam			
Length(m)	327	327	578
Height(m)	82	82	103
Lower Dam			
Length(m)	470	470	470
Height(m)	112	112	112
Head Race Tunnel (HRT)			
Diameter(m)	9.0	9.0	8.65
Length(km)	2.86	1.92	2.64
Inclined Pressure Shafts			
Diameter(m)	6.5	6.5	6.1
Inclined Length(m)	533	1280	562
Tail Race Tunnel (TRT)			
Diameter(m)	9.75	9.75	9.4
Length(km)	1.57	1.62	1.58

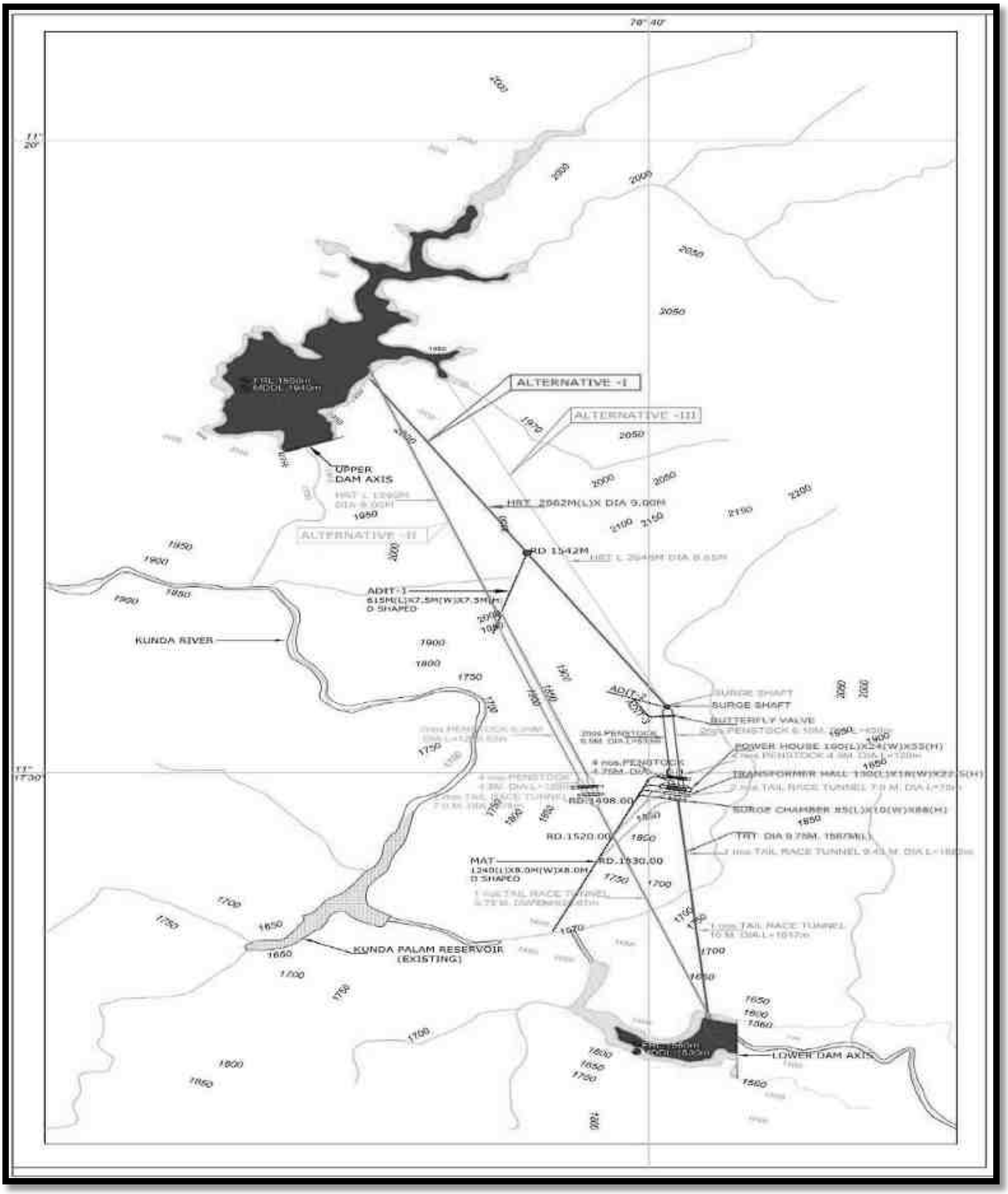


Figure-5.3: Alternatives for Alignment of Water Conductor System

All the alternatives are studies in details considering the aspects of topography, geology, technical & financial viability. Based on these aspects, the final alternate is selected by comparing the pros and cons of all the selected alignments. The brief analysis is carried out on all the alignments is given the following paragraphs.

Alternate-I: In this alignment the intake is proposed on left bank at 400m (approx.) from dam axis and the alignment of WCS is kept in such a way so that sufficient cover is available over the tunnel overt. The location of open surge shaft is proposed as per the topography. The alignment of water conductor system is keeping straight as possible to reduce the losses due to bends.

The length and height of Upper & lower dam is same as that for alternative-II.

Alternate-II: In this alignment the location of intake is kept same as of alternate-I and alignment is WCS is proposed straight form Upper intake to Lower outfall but in some portion of HRT minimum cover is not available over the overt due to topography. Moreover, at some places adequate horizontal cover is also not available in WCS.

Alternate-III: The length and height of Upper dam is more as compared to other two alternatives. The length of water conductor system is comparable to alternative-I. The location of intake is in higher reaches as compared to alternate-I. There may be considerable amount of cutting required to accommodate the intake structure as the nala section is narrow. This cutting will bear extra cost. There may be a problem of silt deposition at intake structure and the silt may not washed out as the intake is proposed far away (> 650m) from the dam. The alignment of water conductor system is keeping straight as possible to minimise the losses. The location of power house is same as Alternative-I.

An analysis has been carried out to establish the differences in construction costs that would be anticipated between the Alternatives-1, 2 & 3 is given in Table-5.2.

Table-5.2: Preliminary Comparison of Project in respect of cost

Alternative	Relative Construction Cost	
	Total (Rs. Crore)	Ratio
Alternative- I	5843	1.0
Alternative- II	7303	1.25
Alternative -III	6719	1.15

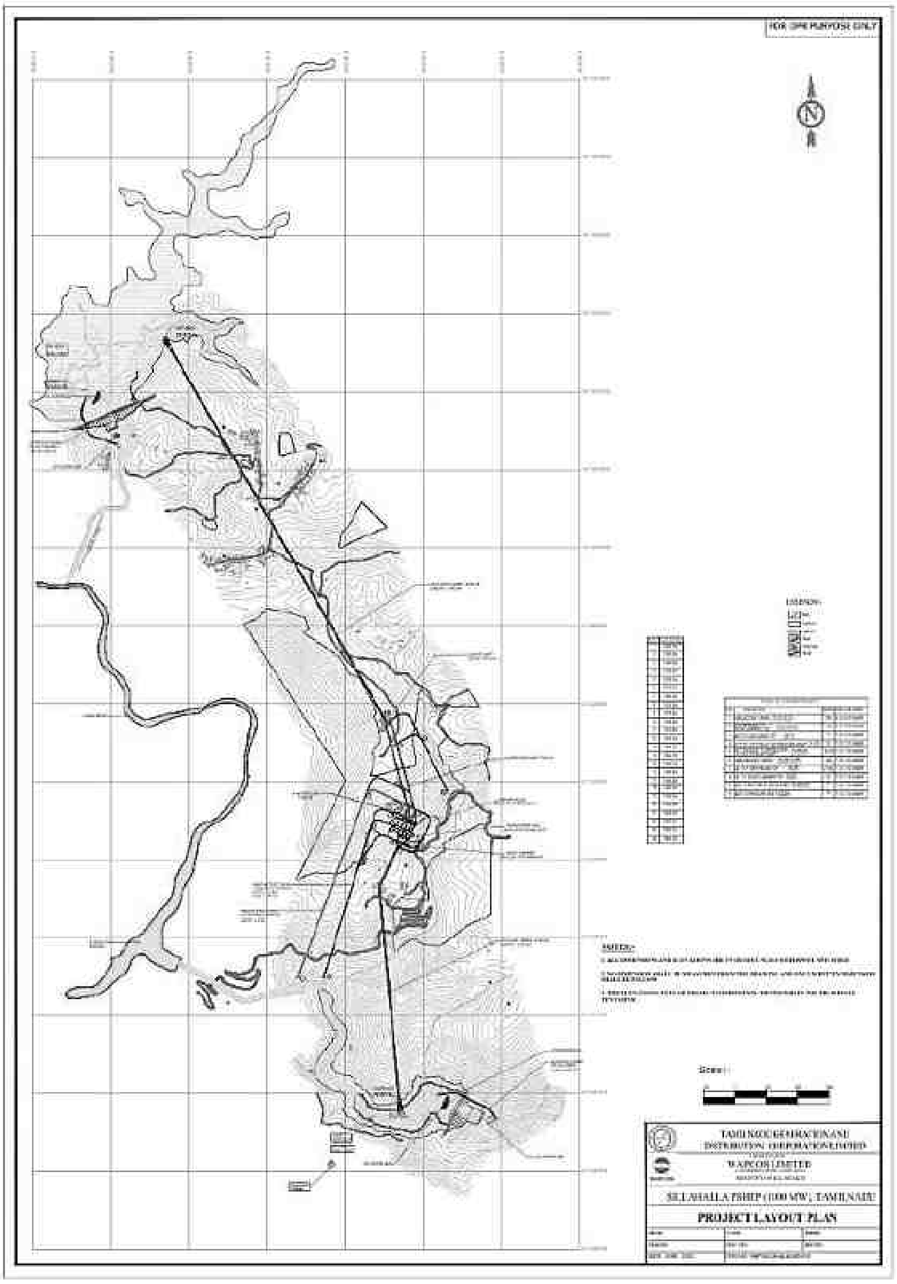


Figure-5.4: Final Project Layout

Based on above analysis, alternate-I for water conductor system is selected for further studies in DPR stage. Accordingly, detailed geological & geotechnical investigations are carried out and minor modifications in Intake, outlet, surge shaft and power house location is done.

The final project layout is enclosed as Figure-5.4.

CHAPTER-6

ENVIRONMENTAL MONITORING PROGRAMME

6.1 The Need

Monitoring is an essential component for sustainability of any water resources project. Monitoring of environmental indicators signal potential problems and facilitate timely prompt implementation of effective remedial measures. It is an integral part of any environmental assessment process. Monitoring becomes essential to ensure that the mitigation measures planned for environmental protection function effectively during the entire period of project operation. It will also allow for validation of the assumption and assessments made in the present study. 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 post-project phase. The data so generated can serve as a data bank for prediction of post project scenarios in similar projects.

6.2 Areas of Concern

Based on the findings of the Environmental Impact Assessment study in various Environmental Management Plan the important parameters viz. Catchment Area Treatment, Biodiversity Conservation & Management, Public Health Delivery System, Fish Management, Restoration of Dumping Sites, Landscaping and Restoration of Construction Area, Green Belt Development etc. have been proposed.

6.3 Water Quality

Construction Phase

It is proposed to monitor the effluent before and after treatment from STP. The frequency of monitoring could be once per month. It is assumed that 2 STPs shall be constructed to treat the sewage generated from various labour camps. A total of (2 STPs X 12 months X 2 samples, i.e. before and after treatment) 48 samples/year shall be analyzed. 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. 2,500. Thus, total cost for analysis of 48 samples is expected to be Rs. 1.20 lakh/year. The analysis work can be done by a laboratory recognized by the Tamil Nadu Pollution Control Board.

Operation phase

The surface water quality of rivers Sillahalla, Kundah and proposed reservoirs needs to be monitored thrice a year. The proposed parameters to be monitored are as follows:

pH, temperature, electrical conductivity, total suspended solids, 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 Upper Reservoir site.
- Upper Reservoir.
- 1km downstream of the proposed Upper Dam site
- 1 km upstream of Lower Reservoir site.
- Lower Reservoir.
- 1km downstream of the proposed Lower Dam site

The total cost of analysis will be Rs. 1.26 lakh 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 Tamil Nadu Pollution Control Board.

It is proposed to monitor the effluent before and after treatment from STP in project colony. The frequency of monitoring could be once per month. A total of (1 STP X 12 months X 2 samples, i.e. before and after treatment) 24 samples/year shall be analyzed. 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. 2,500. Thus, total cost for analysis of 24 samples is expected to be Rs. 0.60 lakh/year. The analysis work can be done by a laboratory recognized by the Tamil Nadu Pollution Control Board.

6.4 Ambient 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 Tamil Nadu 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 Particulate Matter less than 2.5 microns ($PM_{2.5}$), Particulate Matter less than 10 microns (PM_{10}), Sulphur dioxide (SO_2) and Nitrogen dioxide (NO_2).

Every year, ambient air quality is to be monitored for (4 stations x 2 days/week x 4 weeks x 3 seasons) 96 days. A total cost of Rs. 4.8 lakh/year @ Rs.5,000/day can be earmarked for this purpose.

In addition, an amount of Rs. 5.0 lakh has been earmarked for purchase of meteorological instruments.

6.5 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 in three months. For monitoring of noise generators an Integrating Sound Level Meter will be required. An amount of Rs. 1.0 lakh has been earmarked for the purpose.

6.6 Terrestrial Ecology

Project Construction Phase

A detailed ecological survey covering status of afforestation programmes of green belt development, terrestrial flora and fauna, is recommended during entire construction phase. The survey can be conducted once in each season for three seasons 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 shall be conducted by a reputed external agency, for which an amount of Rs.9.0 lakh/year can be earmarked.

Project Operation Phase

Status of afforestation programmes, changes in migration patterns of the aquatic and terrestrial fauna species shall be studied. The study could be undertaken with a frequency of once in each season for three seasons per year till the entire design life of the project. A provision of Rs.9.0 lakh/year can be kept for this purpose. The monitoring can be conducted by a reputed external agency.

6.7 Aquatic Ecology

Project Construction Phase

A detailed ecological survey covering during entire construction phase. The survey can be conducted once in each season for three seasons every year for the entire construction period. The survey shall cover qualitative and quantitative assessment of Aquatic Ecology. Some of the parameters to be monitored are phytoplanktons, zooplanktons, benthic life and fish composition, etc. The monitoring shall be conducted by a reputed external agency, for which an amount of Rs. 9.0 lakh/year can be earmarked.

Project Operation Phase

The key aspects to be covered shall include phytoplanktons, zooplanktons, benthic life and fish composition and migration pattern, etc. The monitoring shall be conducted by a reputed external agency. The study could be undertaken with a frequency of once in each season for three seasons per year till the entire design life of the project. A provision of Rs. 9.0 lakh/year can be kept for this purpose. The monitoring can be conducted by a reputed external agency.

6.8 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	:	Rs.5.00 lakh/year

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	:	Nearby Dispensary/PHCs
Cost	:	Rs.5.00 lakh/year

6.9 Land use Pattern

Project Operation Phase

During project operation phase, it is proposed to monitor land use pattern once in a year. An amount of Rs. 5.00 lakh/year can be earmarked for this purpose.

6.10 Summary of Environmental Monitoring Programme

The details of environmental monitoring programme are given in Tables-6.1 and 6.2 respectively.

Table-6.1: Summary of Environmental Monitoring Programme during Project Construction Phase

S. No.	Item	Parameters	Frequency	Location
1.	Effluent from STPs	pH, BOD, COD, TSS, TDS	Once in a month	Before and after treatment from each STP
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 level	Equivalent noise level (L_{eq})	Once in three months	At major construction sites.
4.	Ambient Air quality	$PM_{2.5}$, PM_{10}, SO_2 and NO_2	Once in a season	At major construction sites
5.	Meteorological aspects	Wind direction & velocity temperature humidity, rain	Once in a season	At one of the ambient air quality sampling sites
6.	Terrestrial Ecology	Status of afforestation programmes of green belt development, Terrestrial Flora and fauna	Once in a season	Afforestation sites, forest area in and around the project site
7.	Aquatic Ecology	Phytoplanktons, zooplanktons, benthic life, fish composition	Once in a season	Water bodies located in proximity to the construction sites

Table-6.2: Summary of Environmental Monitoring Programme during Project Operation Phase

S. No.	Items	Parameters	Frequency	Location
1.	Water	pH, Temperature, EC, TSS, Turbidity, Total Dissolved Solids, Calcium, Magnesium, Total Hardness, Chlorides, Sulphates, Nitrates, DO. COD, BOD, Iron, Zinc, Manganese	Once in a season	• 1 km upstream of Upper Reservoir site. • Upper Reservoir. • 1km downstream of the proposed Upper Dam

S. No.	Items	Parameters	Frequency	Location
				site • 1 km upstream of Lower Reservoir site. • Lower Reservoir. • 1km downstream of the proposed Lower Dam site
2.	Effluent from Sewage Treatment Plant (STP)	pH, BOD, COD, TSS, TDS	Once in a week	• Before and after treatment from Sewage Treatment Plant (STP)
3.	Terrestrial Ecology	Status of afforestation programmes of green belt development, Terrestrial Flora and fauna and aquatic ecology	Once in a season	-
4.	Water-related diseases	Identification of water-related diseases, sites, adequacy of local vector control measures, etc.	Once in a season	• Villages adjacent to project sites

S. No.	Items	Parameters	Frequency	Location
5.	Aquatic ecology	Phytoplanktons, zooplanktons, benthic life, fish composition	Once in a season	• 1 km upstream of Upper Reservoir site. • Upper Reservoir. • 1km downstream of the proposed Upper Dam site • 1 km upstream of Lower Reservoir site. • Lower Reservoir. • 1km downstream of the proposed Lower Dam site
6.	Landuse	Landuse pattern using satellite data	Once in a year	• Catchment area

6.11 Cost Estimate for Environmental Monitoring Programme

The cost required for implementation of the Environmental Monitoring Programme is of the order of Rs. 188.3 lakh. 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 61 months. The details are given in **Table 6.3**.

Table-6.3: Cost for Implementing Environmental Monitoring Programme during construction Phase

S. No	Item	Cost (Rs. lakh/ year)	Total cost for construction period of 61 months (5 years) with 10% escalation per year (Rs. lakh)
1	Effluent from STPs	1.2	7.32
2	Ambient Air quality	4.8	31.25
3.	Terrestrial Ecology	9.0	58.59
4.	Aquatic Ecology	9.0	58.59
5.	Incidence of water related diseases	5.0	32.55
	Total	**29.0**	**188.30**

In addition, an amount of Rs. 6.0 lakh has been earmarked for purchase of meteorological instruments and noise meter. Thus, total cost for implementation of Environmental Monitoring programme during construction phase is (188.30 +6.0) Rs. 194.30 lakh.

The cost required for implementation of the Environmental Monitoring Programme in operation phase is of the order of Rs. 29.86 lakh/year. The details are given in **Table 6.4**.

Table-6.4: Cost for Implementing Environmental Monitoring Programme during operation phase

S. No.	Item	Cost (Rs. lakh/year)
1.	Water quality	1.26
2.	Effluent from STP	0.60
3.	Ecology	18.00
4.	Incidence of water related diseases	5.00
5.	Landuse pattern	5.00
	Total	**29.86**

CHAPTER – 7
ADDITIONAL STUDIES

7.1 Introduction

The present chapter covers the following plans:

- Catchment Area Treatment Plan
- Resettlement and Rehabilitation Plan
- Local Area Development Plan

7.2 Catchment Area Treatment (CAT) Plan

7.2.1 Need for CAT Plan

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 CAT Plan. Soil erosion leads to:

- Loss in production potential
- Reduction in infiltration rates
- Reduction in water-holding capacity
- Loss of nutrients
- Increase in tillage operation costs

- Reduction in water supply

The CAT plan highlights the management techniques to control erosion in the catchment area of a water resource project. The life span of a reservoir is greatly reduced due to erosion in the catchment area. Adequate preventive measures are thus needed for the treatment of catchment for its stabilization against future erosion.

The proposed project has two dams, upper dam and lower dam. The catchment area intercepted at the upper dam site and lower dam site is 65.0 km^2 and 183.48 km^2 respectively. The sub-watersheds in the catchment area for Upper Dam and Lower Dam considered for the present study are given in **Figures-7.1 and 7.2.**

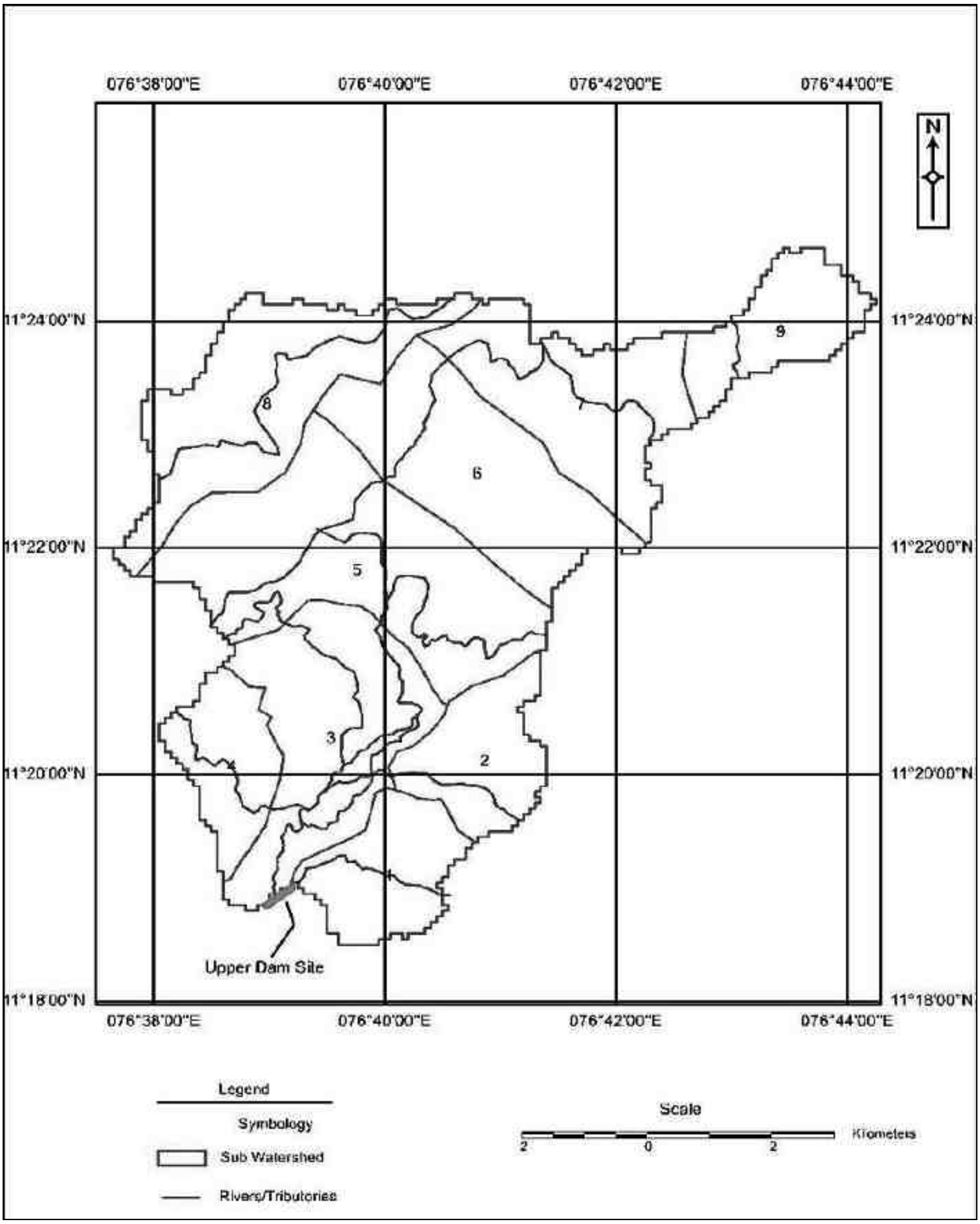


Figure-7.1: Sub-watersheds for Catchment Area for Upper Dam

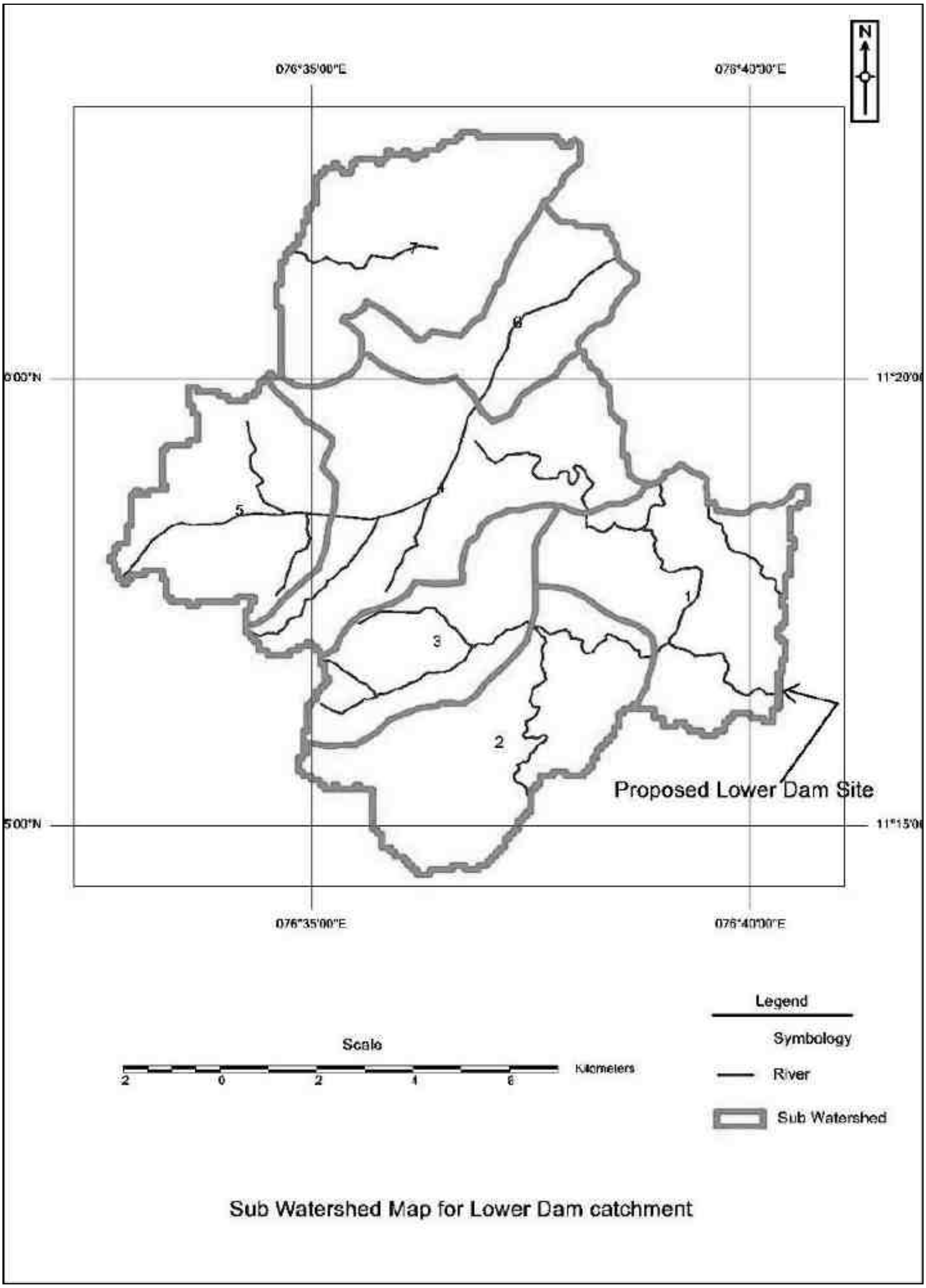


Figure-7.2: Sub-watersheds for Catchment Area for Lower Dam

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.

7.2.2 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. 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. Ground truth studies, too, have been conducted.

The various steps, covered in the study, are as follows:

- Definition of the problem
- Data acquisition and preparation
- Output presentation

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

Definition of the Problem

The requirements of the study were defined and the expected outputs were finalized. The various data layers of the catchment area to be used for the study are as follows:

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

Data Acquisition and Preparation

The data available from various sources has been 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 co-ordinates), so that overlay could be performed. A computer program using standard modeling techniques 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. Ground truthing and data collection was also included in the procedure.

For the present study, digital satellite data was used for interpretation and classification. The data has been procured in raw digital format and has been geo-referenced using Survey of India topographical sheets with the help of standard data preparation techniques in standard image processing software. The interpretation of geo-referenced satellite data has been done using standard enhancement techniques, ground checks and experiences of qualified professionals. A detailed ground truth verification exercise has been undertaken as a part of field survey to enrich the image interpretation process. The classified land use map of the catchment area intercepted at Upper and Lower dam sites, considered for the study, is shown as **Figures-7.3 and 7.4** respectively**.** The land use pattern of the catchment area of Upper and Lower damsis summarized in **Table-7.1.**

Table-7.1: Land use classification for Catchment intercepted at Upper and Lower Dam sites

Land use/Land cover	Area (ha)	Area (%)
Upper Dam		
Water Body	11	0.17
Dense Vegetation	3967	61.03
Open Vegetation/ Scrub	1266	19.48
Barren Land	258	3.97
Agricultural Land	704	10.83
Settlement	294	4.52
Total	**6500**	100
Lower Dam		
Water Body	697	3.80
Dense Vegetation	12916	70.39
Open Vegetation/ Scrub	3048	16.61
Barren Land	743	4.05
Agricultural Land	560	3.05
Settlement	385	2.10
Total	**18348**	**100.00**

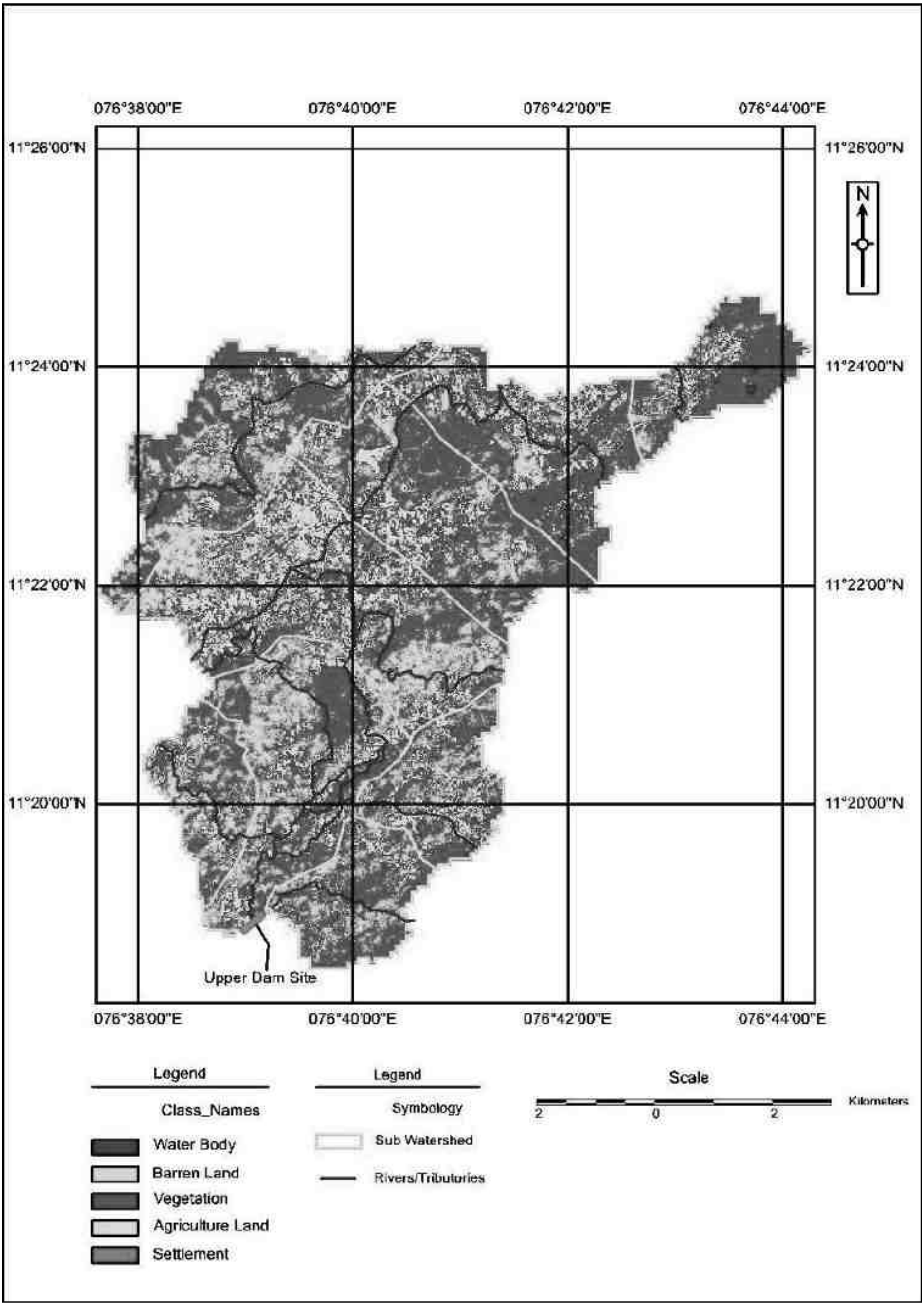


Figure-7.3: Classified Imagery of Catchment Area of Upper Dam

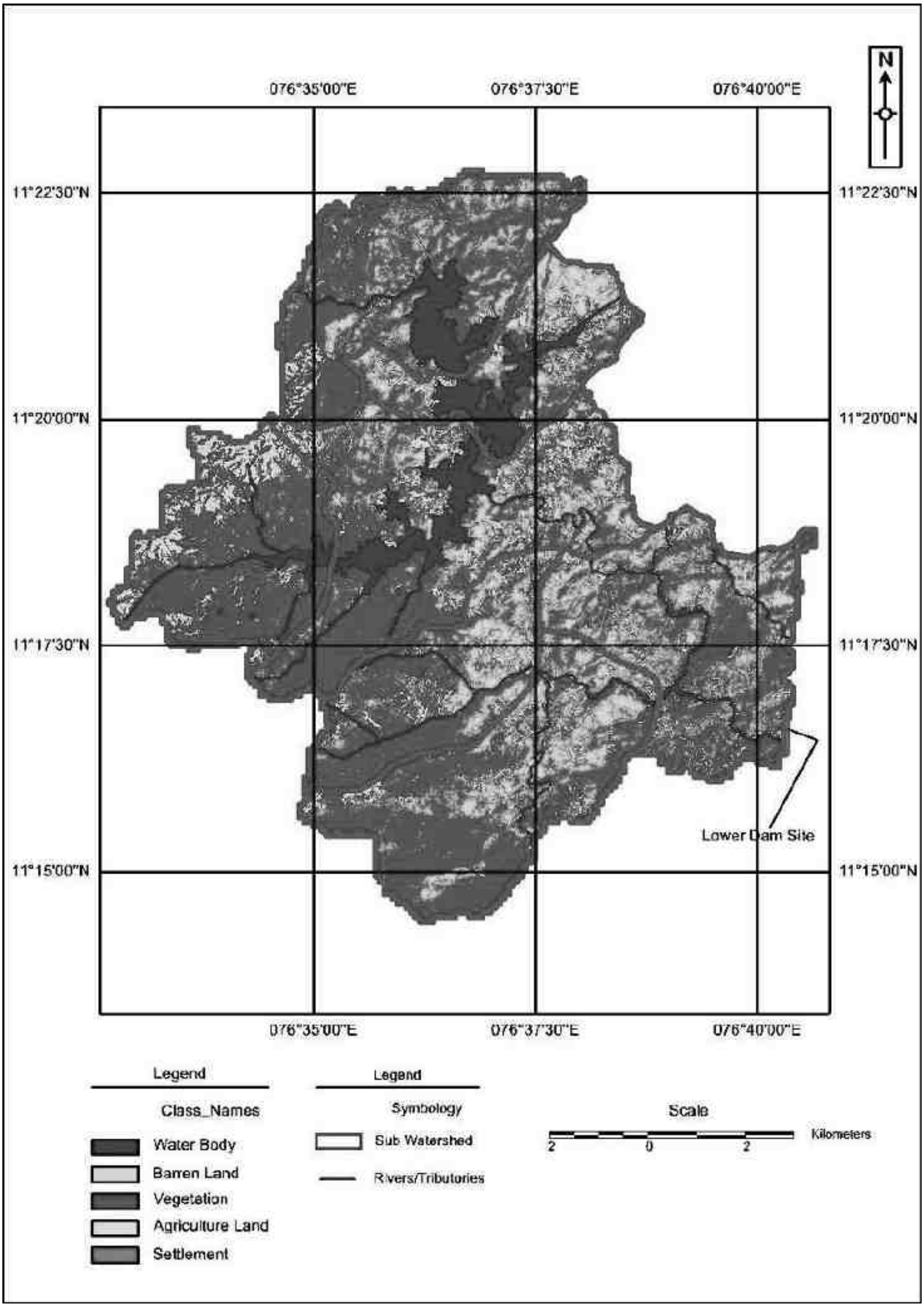


Figure-7.4: Classified Imagery of Catchment Area of Lower Dam

Derived contours from topographical maps were used for preparation of Digital Elevation Model (DEM) of the free draining 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 topographical maps were derived. The output of the digitisation procedure was the contours as well as points contours in form of x, y & z points. (x, y - location and z - their elevation). All this information was in real world co-ordinates (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 for Upper Dam and Lower Dam is enclosed as **Figures-7.5 and 7.6** respectively**.** The Area under different slope categories of Catchment of Upper and Lower Dams are given in **Table-7.2.**

Table-7.2: Area under various slope categories for Upper and Lower Dams

Slope categories (%)	Area (ha)	Area (%)
Upper Dam		
0-10	2106	32.40
10-20	3114	47.91
20-30	1140	17.53
30-40	133	2.05
>40	7	0.10
Total	**6500**	**100**
Lower Dam		
0-10	11148	60.76
10-20	4007	21.84
20-30	2316	12.62
30-40	688	3.75
>40	189	1.03
Total	**18348**	**100**

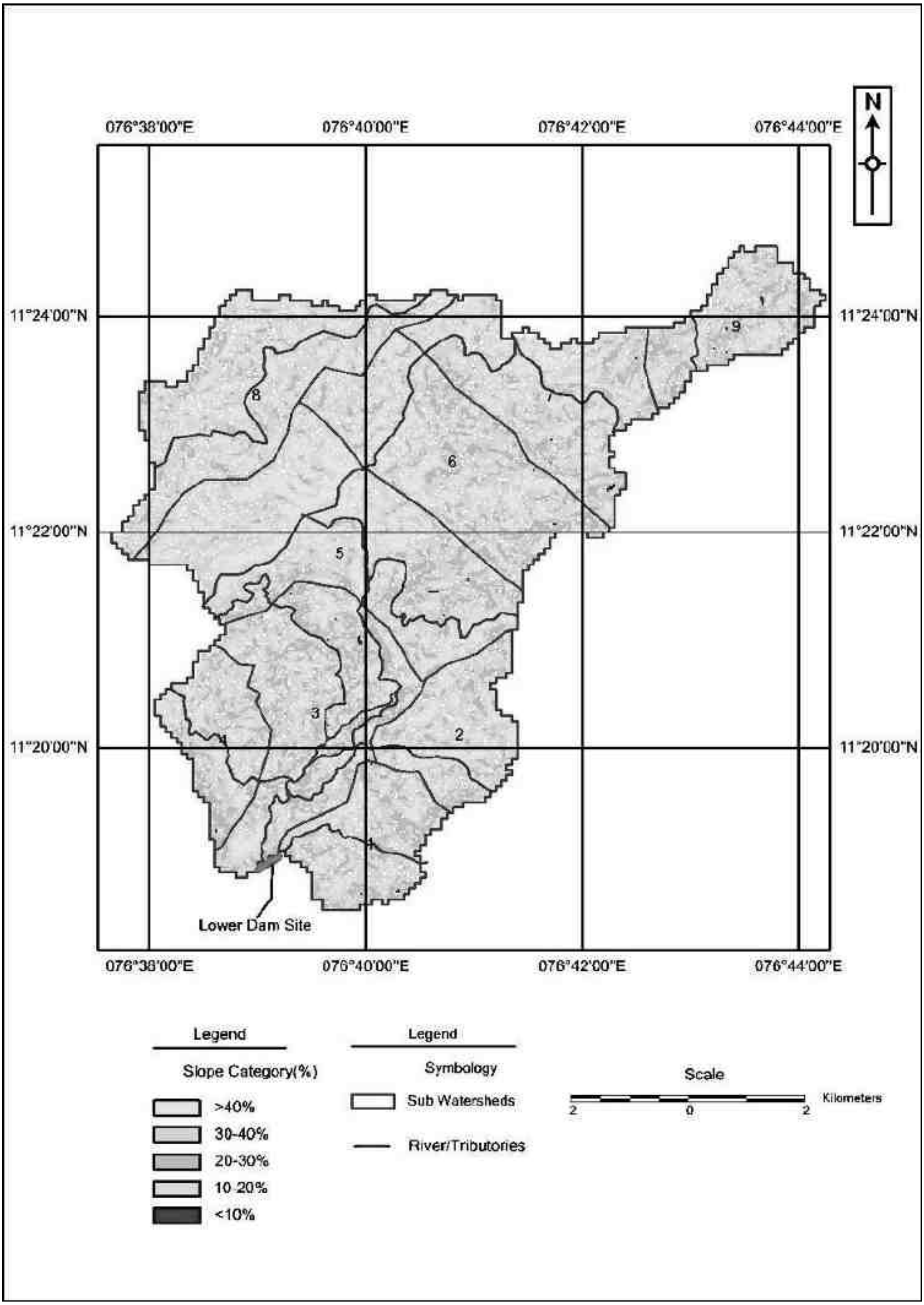


Figure-7.5: Slope Map of Catchment Area for Upper Dam

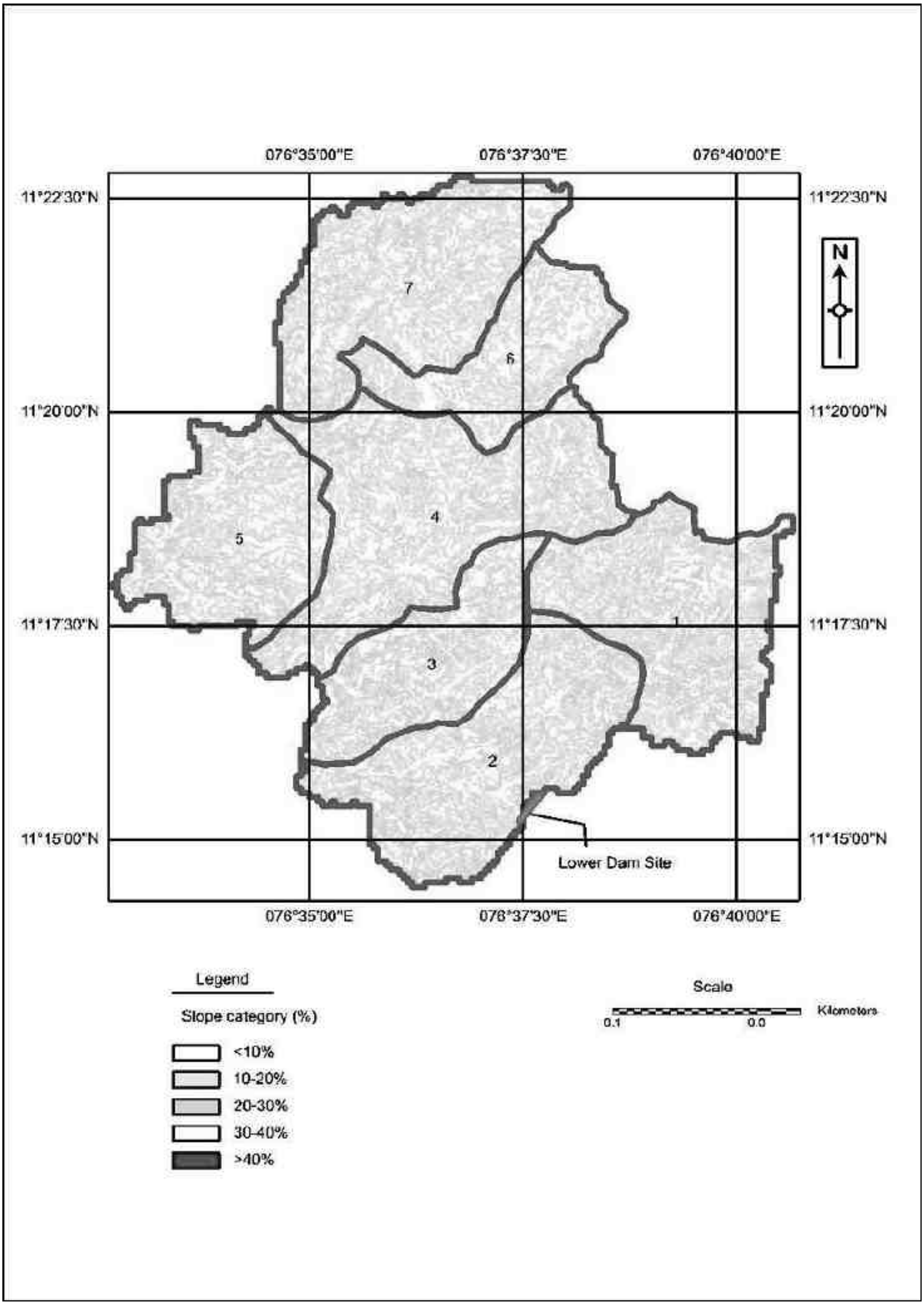


Figure-7.6: Slope Map of Catchment Area for Lower Dam

7.2.3 Estimation of Soil Loss using Silt Yield Index (SYI) Method

In Silt Yield Index' (SYI), 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.

The SYI model, 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 within river valley project catchment areas.

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)

7.2.3.1 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.

7.2.3.2 Prioritization of Watersheds/Sub-watersheds

The prioritization of smaller hydrologic units within the vast catchments is based on the 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:

- Climatic factors comprising total precipitation, its frequency and intensity,
- Geomorphic factors comprising land forms, physiography, slope and drainage characteristics,
- Surface cover factors governing the flow hydraulics and
- 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 unit was computed and silt yield indices of individual sub-watersheds were calculated using the following equations:

7.2.3.3 Estimation of Silt Yield Index

To calculate SYI, the methodology developed by All India Soil & Land Use Survey (Department of Agriculture, Govt. of India) has been followed, where each erosion intensity unit is assigned a weightage value. When considered collectively, the weightage value represents approximately the relative comparative erosion intensity. A basic factor of K = 10 was used in determining the weightage values. The value of 10 indicates a static condition of equilibrium between erosion and deposition. Any addition to the factor K (10+X) is suggestive of erosion in ascending order whereas subtraction, i.e. (10-X) is indicative of deposition possibilities.

Delivery ratios were adjusted for each of the erosion intensity unit. The delivery ratio suggests the percentage of eroded material that finally finds entry into reservoir or river/ stream. Area of each composite unit in each sub-watershed was then estimated.

SYI was calculated using following empirical formula:

$$SYI = \frac{\Sigma (Ai * Wi) * Di * 100}{Aw}; \quad \text{where } i = 1 \text{ to } n$$

where

Ai	=	Area of i^{th} unit (EIMU)
Wi	=	Weightage value of i^{th} mapping unit
n	=	No. of mapping units
Aw	=	Total area of sub-watershed.
Di	=	Delivery ratio

Delivery ratios are assigned to all erosion intensity units depending upon their distance from the nearest stream. The criteria adopted for assigning the delivery ratio are as follows:

Nearest Stream	**Delivery Ratio**
0 - 0.9 km	1.00
1.0 - 2.0 km	0.95
2.1 - 5.0 km	0.90
5.1 - 15.0 km	0.80
15.1 - 30.0 km	0.70

The SYI values for classification of various categories of erosion intensity rates are given in Table-7.3.

Table-7.3: Criteria for erosion intensity rates

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

The erosion category of various watersheds in the catchment area as per a SYI index has been estimated. The objective of the SYI method is to prioritize sub-watershed in a catchment area for treatment.

7.2.4 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 shall be suggested for the catchment area treatment depending upon the requirement and suitability:

a. Afforestation

- Normal Afforestation
- Enrichment Plantation
- Development of nurseries
- Pasture Development
- Vegetative Fencing
- Social Forestry

b. Soil & Water Conservation

- Check Dam
- Drainage line treatment

c. Research Training and Capacity Building

- Training and Capacity Building of Staff and communities
- Site Specific research

d. Infrastructure Development

- Holistic Support to Staff
- Operational Support to Staff
- Maintenance of Departmental Buildings and inspection paths

7.2.5 Prioritization of Sub Watersheds using SYI Method

In the present report, CAT Plan as per the slope, land use pattern, soil characteristics has been suggested based on the prioritization of sub watersheds using SYI method. The objective of the SYI method is to prioritize sub-watershed in a catchment area for treatment. The erosion category of various watersheds in the catchment area for Upper and Lower Dams as per SYI Index is given in **Table-7.4.** The area under different erosion categories is given in **Table-7.5.** The CAT plan has been suggested for Sub-watersheds with high erosion category.

Table-7.4: Erosion intensity categorization as per SYI classification for Catchment Area intercepted at Upper and Lower Dams

Watershed number	Area (ha)	SYI value	Category
Upper Dam			
W1	431	1020	Low
W2	430	1270	High
W3	931	1242	High
W4	370	1110	Medium
W5	1349	1240	High
W6	912	1120	Medium
W7	768	1232	High
W8	911	1140	Medium
W9	398	1080	Low
Total	**6500**		
Lower Dam			
W1	2798	1270	High
W2	3009	1120	Medium
W3	1884	1126	Medium

Watershed number	Area (ha)	SYI value	Category
Upper Dam			
W4	3773	1240	High
W5	2281	1242	High
W6	1645	1150	Medium
W7	2957	1124	Medium
Total	**18347**		

Table-7.5:Area under different erosion categories of Catchment Area of Upper and Lower Dams

Category	Area (ha)	Area (%)
Upper Dam		
Low	829	12.75
Medium	2193	33.74
High	3478	53.51
Total	**6500**	**100.00**
Lower Dam		
Low	-	-
Medium	8852	48.00
High	9496	52.00
Total	**18348**	**100.00**

The area under high erosion category has to be treated by the project proponents, which accounts for about 53.51% and 52% of the total free draining catchment area for Upper Dam and Lower Dam respectively. The area under different erosion categories of Catchment Area of Upper and Lower Dams is given in Figures 7.7 and 7.10 respectively.

The Catchment Area Treatment Plan proposed for Upper Dam and Lower Dam are shown in Figure-7.9 and 7.10 respectively. It is proposed that treatment measures shall be implemented by the Forest Department, State Government of Tamil Nadu. CAT plan will be implemented within two years.

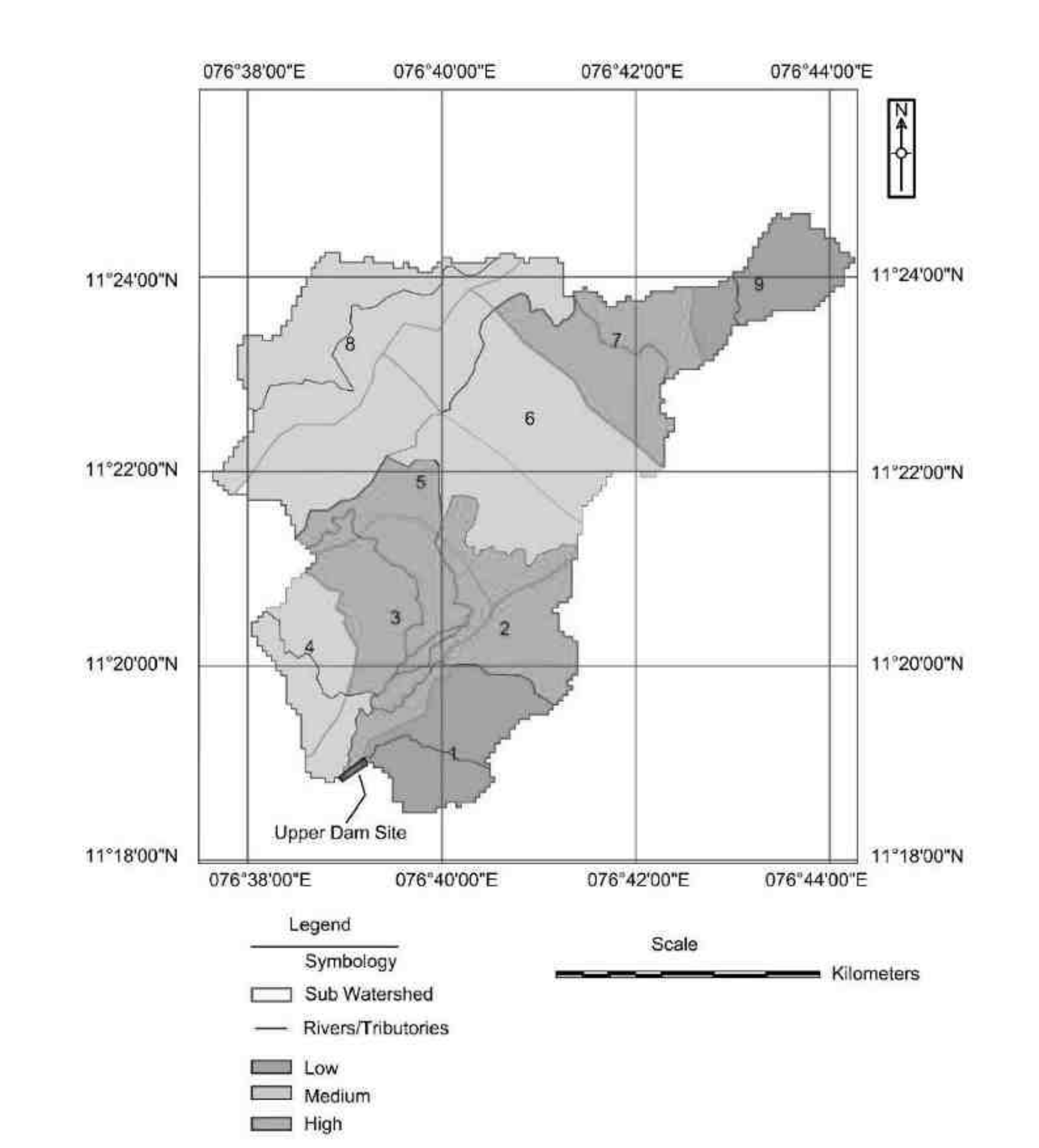


Figure-7.7: Erosion intensity categorization as per SYI classification for Catchment Area intercepted at Upper Dam

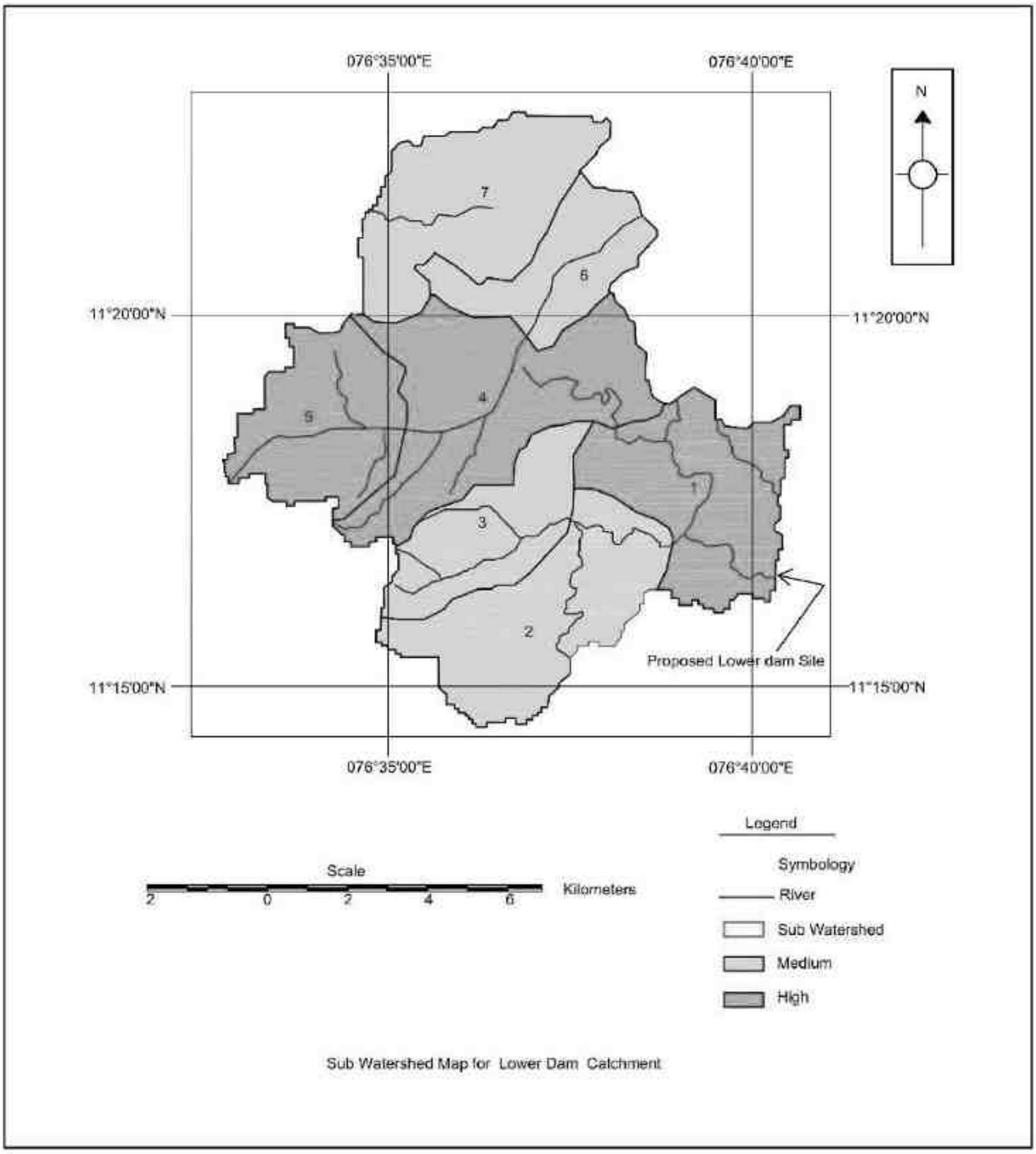


Figure-7.8: Erosion intensity categorization as per SYI classification for Catchment Area intercepted at Lower Dam

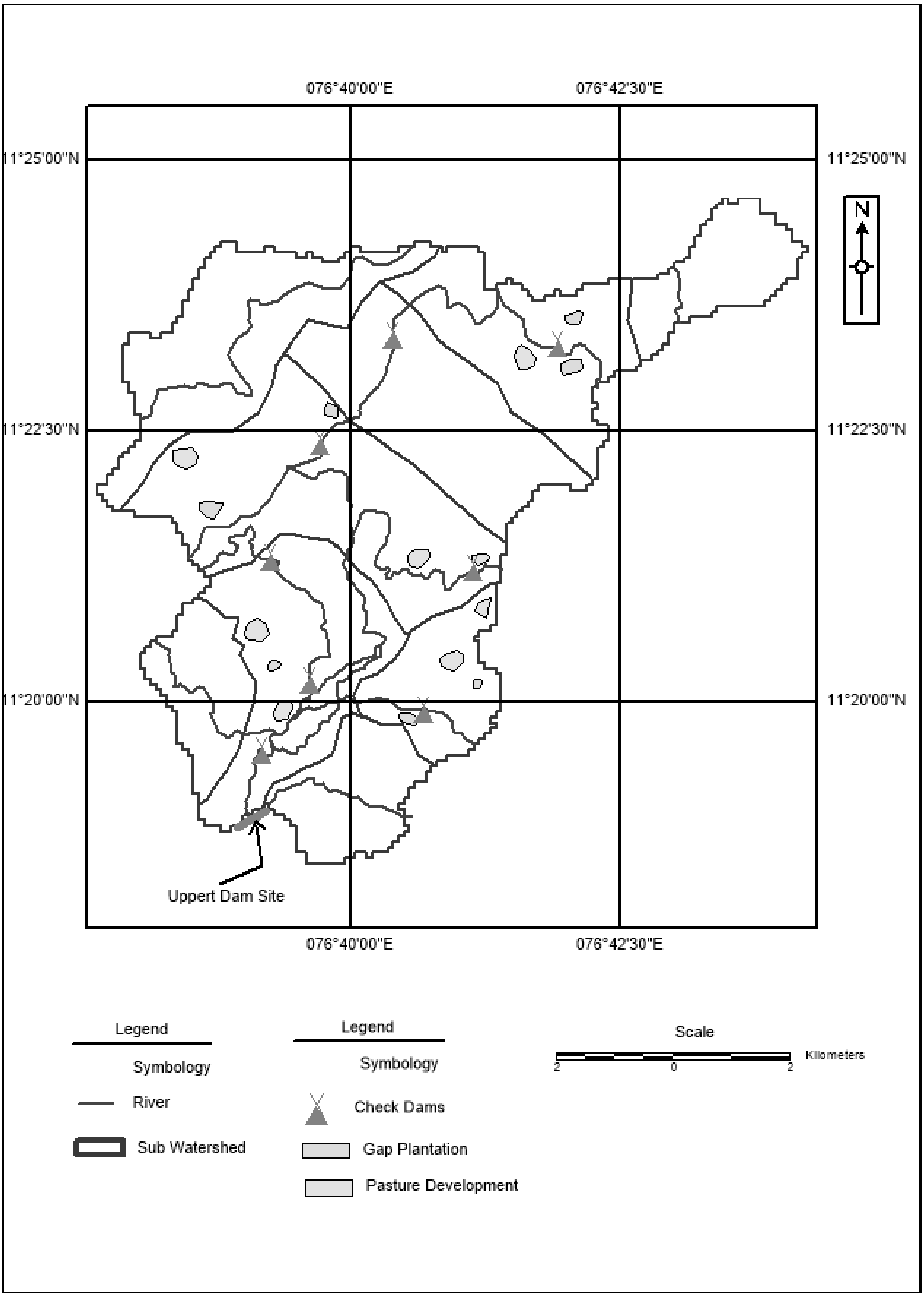


Figure-7.9: Catchment Area Treatment Measures for Upper Dam

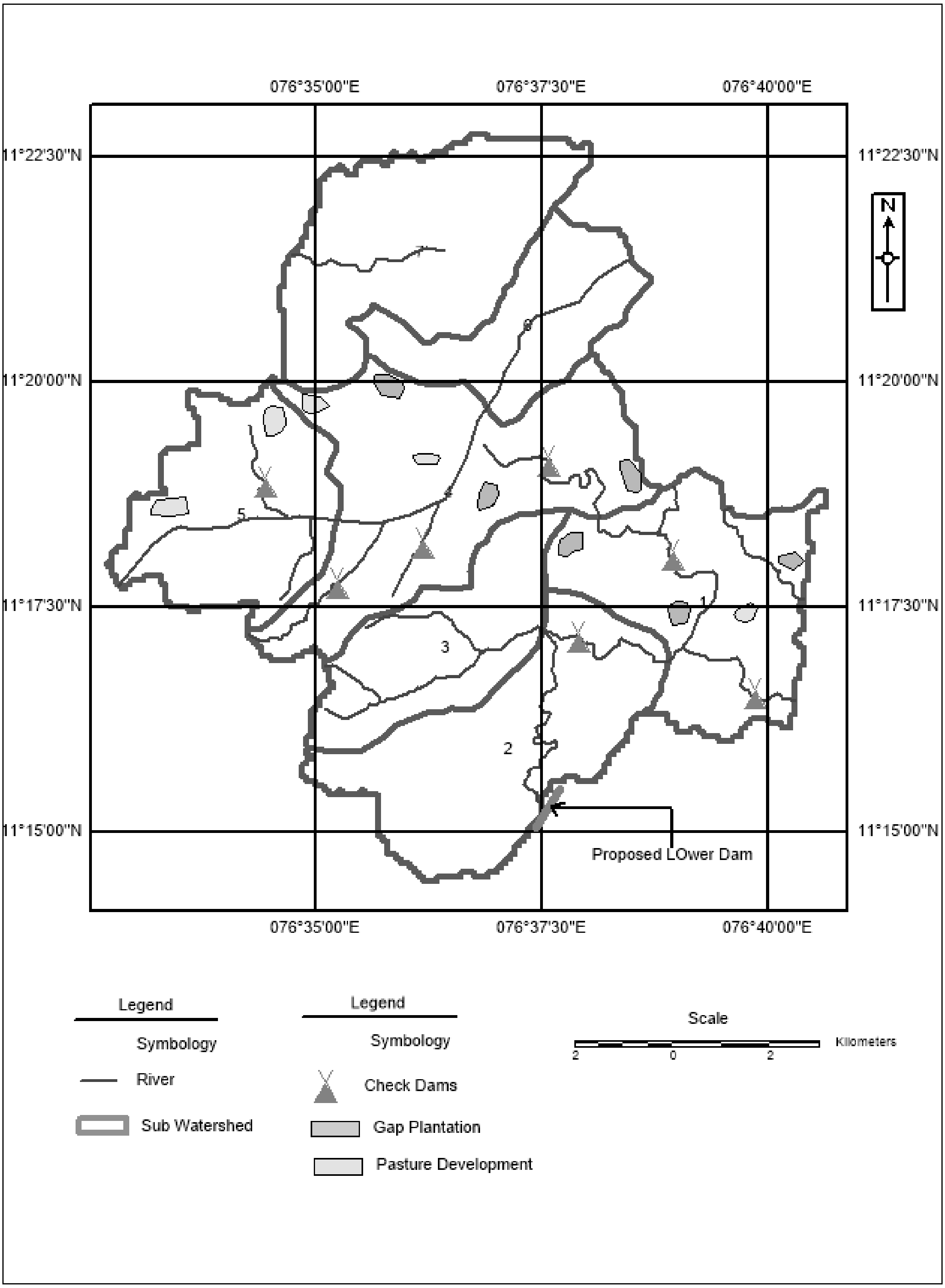


Figure-7.10: Catchment Area Treatment Measures for Lower Dam

7.2.6 Catchment Area Treatment Measures

7.2.6.1 Biological Measures

An amount of Rs. 1166.5 lakh has been earmarked for various afforestation measures. The details are given in Table-7.6.

Table-7.6: Cost Estimate for implementation of Biological measures as a part of CAT Plan

S. No.	Item	Unit Rate (Rs.)	Unit	Target	
				Physical	Financial (Rs. lakh)
	Upper Dam				
1.	Enrichment Plantation	70,000/ha	ha	100	70.0
2.	Pasture development	40,000/ha	ha	250	100.0
3.	Nursery development	10,00,000/no.	no.	6	60.0
4.	Vegetative fencing	65,000/km	km	10	6.5
5.	Watch and ward for 2 years average 10 persons per month	20,000/man-month	Man-months	240	48.0
6.	Rim Plantation	Lumpsum			50.0
7.	Social Forestry	2,66,000/ha		10	26.6
	Sub-Total (A)				**361.1**
	Lower Dam				
1.	Enrichment Plantation	60,000/ha	ha	320	224.0
2.	Pasture development	30,000/ha	ha	550	220.0
3.	Nursery development	10,00,000/no.	no.	15	150.0
4.	Vegetative fencing	65,000/km	km	25	16.25
5.	Watch and ward for 2 years average 15 persons per month	20,000/man-month	Man-months	360	72.0
6.	Rim Plantation	Lumpsum			80.0
7.	Social Forestry	2,66,000/ha		20	53.20
	Sub-Total (B)				**805.45**
	Grand Total (A+B)				**1166.55**

7.2.6.2 Soil & Water Conservation Works

An amount of Rs. 89.0 lakh has been earmarked for various Soil & Water Conservation measures. The details are given in Table-7.7.

Table-7.7: Cost estimate for implementation of Soil & Water Conservation measures as a part of CAT Plan

S. No.	Item	Unit Rate (Rs.)	Unit	Target	
				Physical	Financial (Rs. lakh)
	Upper Dam				
1.	Check Dams	3,50,000	Nos.	8	28.0
2.	Drainage line treatment	5,00,000		3	15.0
	Sub-Total (A)				**43.0**
	Upper Dam				
1.	Check Dams	3,50,000	Nos.	6	21.0
2.	Drainage line treatment	5,00,000		5	25.0
	Sub-Total (B)				**46.0**
	Grand Total (A+B)				**89.0**

7.2.6.3 Silt Observation points

One silt observation location for regular monitoring of silt load coming in tributaries of sub-watersheds falling under high category have been suggested. This would ensure monitoring efficacy of implementation of various treatment measures suggested as in CAT plan. Monitoring would be undertaken for a period of 10 years including 2 years for CAT plan implementation period. An amount of Rs. 268.6 lakh has been earmarked for this purpose. The details are given in Table-7.8.

Table-7.8: Cost earmarked for establishing Silt Observation points

S. No.	Parameter	Cost (Rs. lakh)
1	Cost of two laboratory – Rs 5,00,000/- for silt analysis per laboratory	10.0
2	Two observation hut (@ Rs 5.0 lakh/site)	10.0
3	Cost for hiring services of Two person (Average salary- Rs 15,000/- for 10 years) considering 10% escalation per year	57.4
4	Cost for hiring services of supervisor two person (Average salary Rs. 25,000/- for 10 years) considering 10% escalation per year	95.6
5	Consumables for the measurement Rs. 6.0 lacs per year for next 10 years, considering 10% escalation	95.6

S. No.	Parameter	Cost (Rs. lakh)
	per year	
	Total	**268.6**

7.2.6.4 Research Training and Capacity Building

An amount of Rs. 100 lakh has been earmarked for Training & Capacity building of forest staff as well as local community through State Forest Training Institutes and reputed organizations.

7.2.6.5 Infrastructure Development

The total budget kept for infrastructure development for Forest Department during the implementation of CAT Plan is Rs. 150.0 lakh. The details are given in Table-7.9.

Table-7.9: Summary of cost for infrastructure development for Forest Department

S. No.	Component/Item	No.	Unit Rate (Rs. lakh)	Total Cost (Rs. lakh)
1	Vehicle Including operation and maintenance	4	15.0	60.0
2	GPS equipment	5	3.0	15.0
3.	Maintenance of Departmental buildings			25.0
6.	Maintenance of Forest roads/inspection paths			50.0
	Total			**150.0**

7.2.7 Cost Estimates

The cost required for implementation of various measures is Rs. 1774.15 lakh. The details are given in Table-7.10.

Table-7.10: Cost earmarked for implementation of CAT plan

S. No.	Activity	Amount (Rs. lakh)
1	Afforestation	1166.55
2	Soil & Water Conservation Works	89.0
3	Silt Observation Points	268.6
4	Research Training and Capacity Building	100.0
5	Infrastructure Development	150.0
	Total	**1774.15**

7.3 Rehabilitation and Resettlement Plan

For the purpose of this project, the R&R plan has been devised using the norms and guidelines of the "Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013". The Consultant based on past experiences in similar projects, in the area have suggested/specified/ augmented/ enhanced the R&R provisions. The objective of the R&R Plan is to enable project planners to take appropriate measures to devise suitable compensation as a part of resettlement and rehabilitation package for the PAFs.

7.3.1 Measures for Compensation of Loss of Private Properties

7.3.1.1 Compensation for Land

The total land required for the project is approximately 310.157 ha. The details of component wise land requirement is given in Table-7.11. About 239.2444 ha of private land and 8.912 ha of forest land is proposed to be acquired for the Sillahalla Pumped Storage Project. Balance land (62.001 ha) to be acquired for the project is government land.

Table-7.11: Land requirement for the proposed Sillahalla PSHEP Stage-I

S. No.	Project Component	Forest land	Govt land	Private land	Total Land
1	Upper Reservoir		40.457	93.501	133.958
2	Lower Reservoir		12.359	16.032	28.391
3	HRT	0.391	0.708	1.877	2.976
4	TRT		0.162	1.818	1.98
5	Power House	1.8		0.2	2
6	MAT, CAT, ADIT	1.52	0.396	2.7814	4.6974
7	Surge Shaft			0.45	0.45
8	Upper Dam Axis		0.436	2.289	2.725
9	Lower Dam Axis		0.1	2.236	2.336
10	HRT Intake			2	2
11	TRT Outlet			2	2
12	Diversion Tunnel/Coffer Dam		0.068	0.655	0.723
13	Potheadyard/CCVT			0.8	0.8
14	Project Colony		2.295	17.526	19.821
15	Labour Colony			7.155	7.155

S. No.	Project Component	Forest land	Govt land	Private land	Total Land
16	Baching Plant		0.159	2.276	2.435
17	Contractor Facilities			6.5	6.5
18	Fabrication Yard/Store	4.242		3.655	7.897
19	Dumping Zone		1.947	54.863	56.81
20	Pressure Shaft	0.778		0.222	1
21	Roads	0.181	2.914	20.408	23.503
	Total	**8.912**	**62.001**	**239.2444**	**310.157**

The quantum of private land to be acquired is 239.2444 ha. About 2157 families are likely to lose land. No families are like to lose homestead. The compensation for acquisition of private land would be paid to the respective land owners/ land titleholders as per the provisions of "**Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013**".

7.3.2 Resettlement Plan

Since no families are likely to lose homestead, hence, Resettlement is not required.

7.3.3 Measures for Rehabilitation

In the proposed project, majority of the population depends on land for their livelihood. Privately owned land is also expected to be acquired. The project affected villages in which private land is to be acquired is given in Table-7.12.

Table-7.12: List of villages with private land acquisition

S. No.	Village name	Private land to be acquired (ha)
1	Balacola village	141.90
2	Ithalar village	41.32
3	Kil Kundah village	56.02
	Total Land	**239.24**

A total of 818 families in Balacola, Ithalar and Kil Kundah villages are likely to lose land. The details are given in Table-7.13.

Table-7.13: Summary of Village wise Project Affected Families

S. No.	Village	Number of PAFs
1	Balacola village	499
2	Ithalar village	86
3	Kil Kundah village	233
	Total	**818**

The Rehabilitation Plan would be formulated in line with the norms of "Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013". The cost of land is given in Table-7.14. The provisions for Rehabilitation Plan for families losing land is given in Table-7.15.

Table-7.14: Cost of Private Land to be acquired as a part of the project

S. No	Description	Amount (Rs.)
1	Guideline Amount of Land for Acquisition of **239.2444 ha**	₹ 78,70,04,379.60
	Add for Variation during field survey by Revenue Department @ 10%	₹ 7,87,00,437.96
2	Total Guideline Amount of Land for Acquisition	₹ 86,57,04,817.56
3	Multiplication factor to be applied for Project area beyond 30 km and within 50kms from Urban Area	1.5
4	Value of Land (Guideline Value of Land x Multiplication Factor)	₹ 1,29,85,57,226.34
5	Solation (100% on Total Value of Land)	₹ 1,29,85,57,226.34
6	Final Award Value (Value of Land + Solation)	₹ 2,59,71,14,452.68
7	Provision towards Interest on Basic Value @ 12% per annum for 5 years on 25% of land properties	₹ 51,94,22,890.54
8	**Total Compensation**	**₹ 3,11,65,37,343.22**
9	Establishment Charges related to revenue department and marking etc @ 5% on Guideline Amount of Land for Acquisition	₹ 4,32,85,240.88
10	Charges for Fixing Demarcation stones @ 1% on Guideline Amount of Land for Acquisition	₹ 86,57,048.18
11	Provision for Legal Charges @ 5% on Guideline Amount of Land for Acquisition	₹ 4,32,85,240.88
12	Unforessen Items @ 2% on Guideline Amount of Land for Acquisition	₹ 1,73,14,096.35
13	**Grand Total**	**₹ 3,22,90,78,969.50 say 32290 lakh**

Table-7.15: Provisions for Rehabilitation Plan for families losing land

S. No.	Description	Unit	Assumed Provision#	Cost (Rs. lakh)
1a.	**Total Market Value of the private land (A)** **(Rate to be finalized at the time of land acquisition by District Collector or District Magistrate)** **239.24 ha Private land**			32290
	Total (A)			
2.	**Rural artisans / Self-employed**			
	One-time financial assistance of a minimum of Rs. 25,000/- to each affected family of an artisan, small trader or self-employed person or an affected family which owned non-agricultural land or commercial, industrial or institutional structure in the affected area, and which has been involuntarily displaced from the affected area due to land acquisition	818	Rs. 25,000/ PAF	204.5
3.	**Choice of Annuity or Employment**			
	a) At least one member per affected family will be provided job (either in the project or arrange for a job in such other project), after providing suitable training and skill development in the required field Or **b)** Onetime payment of Rs. 500,000 per affected family Or **c)** Annuity policies that shall pay not less than Rs. 2000 per month per family for 20 years, with appropriate indexation to the Consumer Price Index for	818	Rs. 500,000/ PAF	4090

S. No.	Description	Unit	Assumed Provision#	Cost (Rs. lakh)
	Agricultural Labourers			
4.	Training of the affected persons, so as to enable such persons to take on suitable jobs	818	818 PAFs x Rs.500/month x 6 months for each PAF	24.54
5.	Scholarships and other skill development opportunities to the eligible persons from the affected families as per the criteria as may be fixed by the appropriate Government	818	818 PAFs x Rs.500/month x 12 months for each PAF	49.08
6.	Skill development opportunities to the eligible persons from the affected families as per the criteria as may be fixed by the appropriate Government	818	818 PAFs x Rs.500/month x 6 months for each PAF	24.54
7.	Affected persons shall be offered the necessary training facilities for development of entrepreneurship, technical and professional skills for self-employment	818	818 PAFs x Rs.1000/month x 6 months for each PAF	49.08
Total				**36731.74**

7.3.4 Budget

The total budget for implementation of the Rehabilitation and Resettlement Plan is Rs. 44002.51 lakh**.** (Refer Table-7.15)

7.4 Local Area Development Plan (LADP)

The key objective of the plan is to empower, upgrade and also to provide basic facilities within the vicinity to the families of the study area villages as well as partially affected villages. Villages which are going to be fully affected, relocated, shall be provided R&R benefits.

The following aspects have been proposed to be covered as a part of Local Area Development plan.

- Up gradation of Educational Facilities
- Improvement of Health Care and Medical Facilities
- Infrastructure Development
- Economic Development
- Social and Cultural Development

About 0.5 % of the project cost is to be earmarked for Local Area Development Plan. The total project cost is Rs. 5843 crore and a budget of 0.5% (Rs. 29.215 crore say Rs. 29.22 crore) of the project cost has been earmarked for implementation of Local Area Development Plan (LADP).

7.4.1 Upgradation of Educational Facilities

It is proposed to upgrade the schools of 40 villages which are identified within 10 km radius of proposed project site. Hence, Local Area Development Plan (LADP) outlined in this Section shall be implemented in various selected villages.

The following activities are proposed under Local Area Development Plan (LADP).

- Construction of new Hostel/community Hall
- Up-gradation of school fixtures, equipment
- Improvement of drinking water and sanitation facilities
- School bus service

A lump-sum amount of Rs. 37.5 lakh per school is proposed for up gradation. In addition, an amount of Rs.120.0 lakh has been earmarked for purchase of 5 school buses. Therefore, a total amount of Rs. 1685 lakh needs to be earmarked for this purpose. The details are given in Table-7.16.

Table 7.16: Breakup of cost required for up-gradation of existing primary schools

S. No.	Particular	Amount (Rs. lakh) per school	Amount (Rs. lakh) for 40 schools
1	Construction of new Hostel/community Hall*	15.0	600.00
2	Furniture, fixtures and equipment	7.5	300.00
3	Improvement of drinking water facilities	7.5	300.00

S. No.	Particular	Amount (Rs. lakh) per school	Amount (Rs. lakh) for 40 schools
4	Improvement of sanitation facilities	7.5	300.00
	Sub-Total (A)	**37.5**	**1500.00**
5	Purchase of school bus	-	120.00
6	O&M cost of bus	-	65.00
	Sub-Total (B)	**-**	**185.00**
	Total (A + B)		**1685.00**

Notes: *The above budget will be given to each of the 25 schools for up-gradation and will be disbursed by the approval of District administration.*

**Land, if required, shall be provided by District Administration or village community.*

7.4.2 Scholarships for Students

It is suggested to provide scholarships for local students studying in the nearby schools. Students presently studying in Class–I to Class-XII, an amount of Rs.1000 per month to 50 students as scholarship for a period of 12 years may be given to eradicate illiteracy and school dropouts.

On the other hand, scholarships are also suggested for students going in for higher studies. Meritorious students from the above mentioned category or students who are presently pursuing higher studies will then be supported for their college/ higher education. A scholarship provision of Rs. 24,000 per year for meeting their fee and study material requirement along with Rs. 60,000 per year for meeting their hostel expenses for a period of 4 years. About 200 students are also proposed to be covered under this scheme.

A total amount of Rs.240.0 lakh may be earmarked for providing scholarships, details of which are given in Table-7.17.

Table-7.17: Details of scholarships

S. No.	Activities	Amount (Rs. lakh)
1	Scholarship for School going students (50 students x 1000 per month for 12 years)	72.0
2	Scholarship for meritorious students–College/ higher education a) Fees/course material (@ Rs. 24,000/year x 50 student x 4 years) b) Hostel expenses (@ Rs. 60,000/years x 50 students x 4 years)	 48.0 120.0
	Total	**240.0**

7.4.3 Improvement of Public Health Facilities

It is proposed that the Primary Health Sub-Centers may be upgraded in 20 villages, which would involve renovation of existing structures, provision of new and/or latest furniture, beds, laboratory equipment/instruments, computers wherever possible, installation of new floorings and ceilings, up-gradation/ construction of new lavatories, electrification and proper lighting in rooms, facilities for cold storage of essential medicines, provision of drinking water facilities, etc. An amount of Rs. 1000.0 lakh (50.0 lakh x 20 PHSC) is being made for up-gradation of the existing PHSCs. The details are given in Table-7.18.

Table-7.18: Budget for up-gradation of Local Area Development Plan

S. No.	Item	Cost (Rs. lakh)	Cost for 20 PHSCs (Rs. lakh)
1	Furniture, Beds and other items	20.0	400.0
2	Up-gradation of Medical laboratory	10.0	200.0
3	Up-gradation of operation theatre (labour room)	20.0	400.0
	Total	**50.0**	**1000.0**

A budget of Rs. 2925 lakh has been earmarked for implementation of Local Area Development Plan (LADP). The details are given in Table-7.19.

Table-7.19 Budget for implementation of Local Area Development Plan (LADP).

S. No.	Items	Budget (Rs. lakh)
1	Construction/ Up-gradation schools in Study Area	1685.0
2	Scholarships to students in the Study Area	240.0
3	Improvement of Public Health Facility	1000.0
	Total	**2925.0**

7.5 Cost Estimates

An amount of Rs. 41430.89 lakh has been earmarked for implementation of various measures outlined under Additional Studies. The details are given in Table-7.20.

Table-7.20: Summary of Cost Estimates for implementation of measures outlined in Additional Studies

S. No.	Particular	Cost (Rs. lakh)
1.	Catchment Area Treatment Plan	1774.15
1.	Resettlement and Rehabilitation Plan	36731.74
2.	Local Area Development Plan	2925.00
	Total	**41430.89**

CHAPTER-8

PROJECT BENEFITS

8.1 Introduction

The present chapter outlines the benefits likely to accrue as a result of construction and operation of the proposed Sillahalla Pumped Storage Hydro-electric Project Stage-I. Both direct as well as indirect benefits have been covered as a part of the present chapter.

8.2 Project Benefits

8.2.1 Energy Generation

The proposed Sillahalla PSHEP Stage-I will provide peaking capacity of 1000 MW for 5 hrs 39 min block in one cycle of operation with daily energy of 5654.17 MWh. The Annual Energy generation shall be 2063.77 GWh. The increased power availability will give an impetus to agriculture and industries. The quality of life of beneficiaries will improve with impetus to electrification due to the proposed project.

8.2.2 Infrastructure improvement

Infrastructure like roads, bridges, buildings etc. will be built at a large scale at the construction stage of the project which will benefit the local people also.

8.2.3 Community Health Improvement

The project proponent will establish one health care unit at the dam site area. The improvement in road network in the project area, will ensure better access to medical health facilities.

8.2.4 Benefits to local people

The construction phase will last for about 61 months. The total number of persons inhabiting the area including the service population will be about 6400. The construction phase of the proposed project would lead to direct employment opportunities. The project would also lead to generation of indirect employment opportunities as well. Various types of businesses, such as shops, food-stalls, tea stalls, restaurants, workshops, etc. would develop in the project area and its surroundings.

The construction phase of the project will also attract, suppliers, traders, transporters, service providers, etc., as demand for almost all types of goods and services will increase significantly. The business community as a whole would be benefited. The locals would also avail these opportunities arising from the project and increase their income levels.

Local Area Development Plan (LADP) has been formulated to extend benefits not only to the residents of the project affected villages, but also to the residents of the villages adjoining to project area.

A budget of 0.5% of the project cost has been earmarked for implementation of Local Area Development Plan (LADP).

The following aspects have been covered under the Local Area Development Plan:

- Educational Facilities
- Health Care and Medical Facilities
- Infrastructure Development

8.2.5 Benefits to Environment

No emission of Greenhouse gases and toxic by-products in to Environment by burning fossil fuels in conventional Thermal Power Plants.

CHAPTER - 9
ENVIRONMENTAL COST BENEFIT ANALYSIS

9.1 Estimation of Costs and Benefits

The Environmental Cost Benefit Analysis for Sillahalla Pumped Storage Project is is presented in this Chapter. The Cost for implementing various measures suggested as a part of Comprehensive EIA Study for Sillahalla Pumped Storage Project s estimated as Rs. 46721.0 lakh. The details are given in Table-9.1. The cost for diversion of Forest Diversion is estimated as Rs. 634124.80 lakh. The details are given in Table-9.2.

The benefits of the project are estimated as Rs. 4880006.66 lakh. The details are given in Table-9.3.

Table-9.1: Cost required for implementation of Environmental Management Plan

S. No.	Activity	Budget (Rs. lakh)
1.	Cost for implementing Environmental Management Plan (Refer Table-10.12)	600.00
2.	Cost for implementing mitigation measures (Refer Table-10.13)	4495.81
3.	Cost for measures as per Additional Studies (Refer Table-10.14)	41430.89
4.	Cost for implementing Environmental Monitoring Programme during construction phase (Refer Table-10.15)	194.30
	Total	**46721.0**

Table-9.2: Estimation of Cost of Forest Diversion

<table>
<tr><th>S. No.</th><th>Parameters</th><th>MoEF & CC Guidelines</th><th>Hydel Project</th><th>Total Loss (Rs. Lakh)</th></tr>
<tr><td>1.</td><td>Ecosystem service losses due to proposed forest diversion</td><td>Economic value of loss of eco-system services due to diversion of forests shall be the net present value (NPV) of the forest land being diverted.</td><td>Ecosystem loss due to proposed Forest Diversion :
Total Forest Land: 8.712 ha
<table>
<tr><th>Division</th><th>NPV Cost (Rs./ha)</th><th>Total NPV cost (Rs. lakh)</th><th>Cost of compensatory afforestation (Rs. Lakh)*</th><th>Total (Rs. lakh)</th></tr>
<tr><td>Nilgiris</td><td>10,00,000</td><td>87.12</td><td>46.34</td><td>133.46</td></tr>
</table>
* Cost for Compensatory Afforestation :
(2x8.712 ha * Rs. 2.66 lakh/ha) Rs. 46.34 lakh</td><td>133.46</td></tr>
<tr><td>2.</td><td>Loss of animal husbandry productivity, including loss of fodder</td><td>To be quantified and expressed in monetary terms or 10% of NPV applicable whichever is maximum</td><td>10% of NPV = Rs. 87.12*0.1 lakh
= Rs. 8.71 lakh</td><td>8.71</td></tr>
<tr><td>3.</td><td>Cost of human resettlement</td><td></td><td>Nil
Based on the preliminary survey, there is no displacement or any oustsees in the project & hence there would be no resettlement. However various welfare measures under Local Area Development Plan would be taken up in the project area which will include village road development, supply of drinking water, medical facilities, employment for</td><td></td></tr>
</table>

S. No.	Parameters	MoEF & CC Guidelines	Hydel Project	Total Loss (Rs. Lakh)
			locals, scholarships for students for project affected villages etc.	
4.	Loss of public facilities and administrative infrastructure (Roads, Building, Schools, dispensaries, electric lines, railways etc.) on forest land, which would require forest land if these facilities were diverted due to the project	To be quantified and expressed in monetary terms on actual cost basis at the time of diversion	Nil Based on the preliminary survey, there is no loss of any facility or existing infrastructure in the project area.	
5.	Possession value of forest land diverted	30% of environmental costs (NPV) due to loss of forests or circle rate of adjoining area in the district should be added as a cost component as possession value of forestland whichever is maximum	30% of 87.12 = Rs. 7500.60*0.3 lakh = **Rs. 26.14 lakh**	26.14
6.	Cost of suffering to oustees	The social cost of rehabilitation of oustees (in addition to the cost likely to be incurred in providing residence, occupation and social services as per R&R plan) be worked out as 1.5 times of what oustees should have earned in two years had he not been pegged at 50%	**No. of PAFs =2157** Per Capita income in Tamil Nadu is Rs. 315,220/year (As per NSDP-2024) Cost is estimated as 1.5 times the income for 2 years 1.5x9x215879x2= **Rs. 20397.89 lakh**	20397.89

S. No.	Parameters	MoEF & CC Guidelines	Hydel Project	Total Loss (Rs. Lakh)
		of NPV applicable as a thumb rule.		
7.	Habitat Fragmentation Cost	While the relationship between fragmentation and forest goods and services is complex, for the sake of simplicity the cost due to fragmentation has been pegged at 50% of NPV applicable as a thumb rule.	Cost due to fragmentation is Rs. 87.12*0.5 lakh = **Rs. 43.56 lakh**	43.56
8.	Compensatory afforestation and soil & moisture conservation cost	The actual cost of compensatory afforestation and soil & moisture conservation and its maintenance in future at present discounted value	Cost of Compensatory afforestation is **Rs. 46.34 lakh**	Included in Table-9.1
9.	Cost of Environmental Management Plan for avoiding, mitigating, checking the adverse impacts on various environmental components during construction and operational phase of the project.		5% of total project cost 0.05x584300= **Rs. 29215 lakh**	29215
10.	Project cost			584300
Total (A)				**634124.8**

Table-9.3: Estimation of Environmental benefits of the project

S. No	Parameters	MoEF&CC Guidelines	Hydel Project	Total benefits (Rs. lakh)
1	Increase in productively attribute to the specific project	To be quantified & expressed in monetary terms avoiding double counting	Total unit generation **1877** Million Units annually. Levelised Tariff Rs.6.48/ kWh Total Revenue from this project (40 years) **Rs. 4864743.36 lakh**	**4864743.36**
2	Benefits to economy due to the specific project	The incremental economic benefit in terms due to the activities attributed to the specific project monetary	• Hydel power is one of the cleanest and eco-friendly sources of energy and one of the most important requirements for the overall development of a state and nation. The energy obtained from the hydel project will meet up the present shortage of state/national grid. • It will add direct benefit to state and national GDP for by the sale of energy. It will add more employment opportunities and give boost to economic activities in the region. • Concept of Incremental Capital Output Ration (ICOR) is used to calculate these incremental benefits in terms of addition to output (GSDP) made by this specific project: Tamil Nadu has per capita consumption 1792	

S. No	Parameters	MoEF&CC Guidelines	Hydel Project	Total benefits (Rs. lakh)
			Kwh/annum Number of population benefitted=10,47,338	
3	No. of population benefited due to specific project	As per the Detailed project report	The project will provide employment opportunities during construction and further directly benefitted from the to both skilled and unskilled operation stage. Further, the electricity generated in the power grid will directly benefit national interests such s livelihood, agriculture, industries etc.	
4	Economic benefits due to of direct and indirect employment due to the project	As per the Detailed project report	(i) During peak stage of construction, employment will be generated for skilled/semi-skilled/unskilled labour. Net benefit shall be = Rs. 10483/monthx1600x61months **Rs. 10231.41 lakh.** (ii) After completion during operation phase about 100 people will get employment for O&M, routine upkeep / maintenance of roads and buildings. Average benefit shall be Rs.10483/month**100*12*40= **Rs. 5031.84 lakh** **Total benefit = Rs. 15263.3 lakh**	**15263.3**
5.	Economic benefits due to compensatory afforestation	Benefits from such compensatory forestation accruing over next 50 years monetised and discounted to the present	Benefits from Compensatory Afforestation accruing over next 50 years monetized and discounted to the present value should be included as benefits of Compensatory Afforestation. Benefit – 8.712*2*10,00,000	**174.24**

S. No	Parameters	MoEF&CC Guidelines	Hydel Project	Total benefits (Rs. lakh)
		value should be included as benefits of compensatory afforestation. "For benefits of CA the guideline of the Ministry for NPV estimation may be consulted		
Total (C)				**4880180.9**

9.2 Environmental Costs-Benefits Ratio

The benefit cost ratio is estimated as 7.094. The details are given in Table-9.4.

Table-9.4: Estimation of Cost-Benefit Ratio

S. No.	Head	Value (Rs. Lakh)
I.	**Costs**	
1.	Cost of mitigation measures (refer Table-9.1)	53845.29
2	Cost for diversion of Forest Diversion (refer Table-9.2)	634124.8
	Total Costs-I	**687970.09**
II.	Benefits of the project (refer Table-9.3)	**4880180.9**
	Total Benefits-II	**4880180.9**
	Cost-Benefit Ratio (II/I)	**7.094**

CHAPTER-10
ENVIRONMENTAL MANAGEMENT PLAN

10.1 Introduction

The assessment of environmental impacts likely to accrue due to development activities are the key aspects on EIA study. An equally essential element of this process is to develop measures to eliminate, offset, or reduce adverse impacts to acceptable levels and enhance the beneficial ones during implementation and operation of the projects. The integration of the project planning has been done by clearly defining the environment requirements within an Environment Management Plan (EMP). The key objectives of EMP is to mitigate adverse impacts to the extent possible.

10.2 Energy Conservation Measures

Various construction and other activities of the proposed Sillahalla Pumped Storage project would lead to increased demand for fuel wood in the project area and its vicinity and would therefore exert pressure on forest areas located around the project. It is estimated that during the construction of the project, which would last for about 5 years, around 6,400 labourers, technical staff and their families will be working. Majority of the labour force will be outsiders and it will be very important to meet their energy requirement in an ecologically sustainable manner.

To provide an alternate for the energy requirement of the workers, contractor/s will be made responsible to provide subsidized kerosene/LPG to their workers which will in turn discourage them from illegal tree felling and removal of fuel wood and timber from the adjoining forests.

10.2.1 Energy Conservation during Construction Phase

The following energy conservation measures would be undertaken during construction works:

- Efficient work scheduling and methods that minimize 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 distance
- Regular maintenance of equipment to ensure optimum operations and fuel efficiency
- The specification of energy efficient construction equipment.

10.2.2 Energy conservation during Operation Phase

The following energy conservation measures would be implemented during operation phase:

- Development of heating, cooling and lighting use in buildings through climate-responsive design and conservation practices.
- Employing renewable energy sources such as day lighting and passive solar heating.
- Optimizing building performance and system control strategies, such as controlling lights with occupancy sensors and controlling comfort.
- Maximizing the use of solar power for signage and pedestrian lighting.
- Designing roads on site to reduce transportation distances.

An amount of Rs. 40 lakh has been earmarked for implementation of Energy Conservation Measures.

10.3 Public Awareness Programme

10.3.1 Objectives

The main objective is to slow down the spread of HIV/AIDS & COVID 19 infection through creation of awareness and aiming at behavioral change. The awareness programme has the following components:

- Ensuring Blood Safety
- Control of sexually transmitted diseases

- Public awareness and community support.

i. Ensuring blood safety

The training programe for the doctors and the blood bank staffs in consultation with National or State AIDS Control Organization which includes the diagnosis of AIDS cases, mandatory licensing of blood banks and promotion of voluntary blood donation.

ii. Control of Sexually Transmitted Diseases

The main strategy for prevention and control of HIV/AIDS is to control of sexually transmitted diseases in the labour camp by the suggested measures of National or State AIDS Control Organization.

iii. Public awareness and community support

A wide campaign using various media to spread awareness about the HIV/AIDS & COVID 19 in the project area shall be taken up as Environmental management programme. This includes the use of radio, print media and folk theatre by the contractor and project proponent.

The counseling centre shall be set up in near government Hospital, which have the following objectives:

i. To provide pre-test, post-test, follow-up, general and family counselling to general public, workers and technical staff coming to the hospital.
ii. To provide support services and after care services for HIV positive clients.
iii. To disseminate information regarding STD, HIV/AIDS and measures suggested by National or State AIDS Control Organization.

iv. Measures for AIDS Control

The following measures are recommended for AIDS control:

- Prevention
- Anti-retroviral treatment
- Primary health care

The above referred approaches for implementation in the project area are described briefly in the following paragraphs:

Prevention

- Awareness programme educating people to enable to make life saving need to be implemented.
- Intravenous drug users to be informed about the perils of sharing of needles.
- Use of various modes of media to educate people on AIDS, its nature, transmission and prevention.
- People in high risk groups to be refrained from donating blood, body organ, etc.
- All blood to be screened before transfusion.
- Strict sterilization practiced to be ensured in hospitals and dispensaries.
- Pre-sterilized or disposable syringes to be used as far as possible.

v. Anti-retroviral treatment

At present there is no vaccine or cure for treatment of HIV infection/AIDS. However, drugs that suppress the HIV infection rather than its complications can be used for prolonging the life of terminally ill patients.

vi. Primary health care

AIDS touches all aspects of primary health care, including mother and child, family planning and education. Thus, it is recommended that the AIDS control programme integrates various related issues into country's primary health care system. The AIDS control and awareness programs, developed by National Aids Control Society (NACO) need to be strictly implemented in the project area as well. In addition to primary health care, it is also recommended that the workers should be made aware not to hurt the traditional cultural and regions customs and practices.

An amount of Rs. 50.0 lakh has been earmarked for public awareness programme among the workers and technical labours about the HIV/AIDS in the project area.

10.4 Assessment of Environmental Flows

The flows and yield in 90% dependable year flow (1986-87) is given in Table-10.1.

Table-10.1: 90% Dependable Year Flows (1986-1987)

Month	Runoff (MCM)	Discharge (cumec)
June	1.05	0.41
July	1.66	0.62
August	2.90	1.08
September	2.00	0.77
October	1.70	0.63
November	1.91	0.74
December	0.67	0.25
January	0.50	0.19
February	0.31	0.13
March	0.19	0.07
April	0.14	0.05
May	0.27	0.10
Annual	**13.29**	**0.42**

The Gross Storage capacity of the Upper Reservoir is around 27.836 MCM. The dead storage capacity of Lower Reservoir is 2.044 MCM. The gross water storage will be 29.88 MCM.

It is proposed to fill the Upper and Lower reservoirs by storing 70% of yield in Monsoon months from June to November. During these months, 30% discharge shall be released as Environmental Flows.No water will be used for storage of reservoir in non-monsoon months. The details are given in Table-10.2.

Table-10.2: Quantum of water stored is 90% Dependable year for filling up of Upper and Lower Reservoirs

Months	Runoff (MCM)	Percentage of water stores (%)	Quantum of water stored (MCM)
June	1.05	70	0.735
July	1.66	70	1.16
August	2.90	70	2.03
September	2.00	70	1.40
October	1.70	70	1.19

Months	Runoff (MCM)	Percentage of water stores (%)	Quantum of water stored (MCM)
November	1.91	70	1.33
December	0.67	-	-
January	0.50	-	-
February	0.31	-	-
March	0.19	-	-
April	0.14	-	-
May	0.27	-	-
Annual	**13.29**		**7.845**

The total water to be stored in the Upper Reservoir (Gross Storage capacity) is 27.836 MCM and upto Dead storage level in Lower Reservoir is 2.044 MCM. The total water be stored shall be (27.836 + 2.044) 29.88 MCM, say 30 MCM. Thus, time required to fill the Upper Reservoir upto FRL and Lower Reservoir upto MDDL shall be (30/7.845) 3.82 years or 3 years and 10 months. After filling of reservoirs, the entire discharge shall be released into the river Sillahalla. The same is depicted in Table-10.2.

10.5 Disaster Management Plan

Based on standard recommended guidelines for the safety inspection of existing dam a manual should be prepared by the project proponents in respect of dam safety surveillance and monitoring aspects. This should be updated with the availability of instrumentation data and observation data with periodical review. The need for greater vigil has to be emphasized during first reservoir impoundment and first few years of operation. The manual should also delve on the routine maintenance schedule of all hydro-mechanical and electrical instruments. It should be eloquent in respect of quantum of specific construction material needed for emergency repair along with delineation of the suitable locations for its stocking and also identify the much needed machinery and equipment for executing emergency repair work and for accomplishing the evacuation plan.

I. Emergency Action Plan (EAP)

Project safety programme as indicated above includes the formation of an Emergency Action Plan. An emergency is defined as a condition of serious nature which develops unexpectedly and endangers downstream property and human life and required immediate attention. Emergency Action Plan should include all potential indicators of likely failure of the dam, since the primary concern is for timely and reliable identification and evaluation of existing of potential emergency.

This EAP presents warning and notification procedures to follow during the monsoon season in case of failure or potential failure. The objective is to provide timely warning to nearby residents and alert key personnel responsible for taking action in case of emergency.

II. Administration and Procedural Aspects

The administrative and procedural aspects of the Emergency Action Plan consist of flow chart depicting the names and addresses of the responsible personnel of project proponent and the Dist. Administration. In order of hierarchy, the following system will usually be appropriate. In the event that the failure is imminent or the failure has occurred or a potential emergency conditions is developing, the observer at the site is required to report it to the Junior Engineer who will report to the Executive Engineer / Superintending Engineer for their reporting to the Chief Engineer through a wireless system or by any available fastest communication system. The Engineer-in-Charge is usually responsible for making cognizant with the developing situation to the Civil Administration. Each personnel are to acknowledge his/her responsibilities under the EAP in an appropriate format at a priority.

The technical aspects of the EAP consist of preventive action to be taken with regards to the structural safety of the project. The EAP is drawn at a priority for the regular inspection of the project. For this purpose, providing an adequate and easy access to the intake/project site is a necessity. The project, its sluices, overflows and non-overflow sections should be properly illuminated for effective operations during night time. Whenever sinkholes, boils, increased leakages, movement of masonry rock, gate failure, rapid rise or fall of the level in the reservoir, rise in the level of reservoir beyond the maximum working level, or wave overrun of the project crest are observed, the personnel on patrol is required to inform immediately to the Junior Engineer (JE) / Assistant Engineer (AE) for initiation of the execution of EAP. They are required to inform the Engineer-in-Charge and the local administrative authorities. It is desirable if the downstream inhabitants are warned using siren, if available, so as to make them aware the likely imminent danger.

The other preventive measures may include availability of sufficient number of sandbags at several selected downstream locations and logs (for holding sandbags) and at the dam site, one tractor, two motor boats, gas lanterns, Manila ropes and life jackets. Areas from where the labour can be mobilized should be chalked out at a priority. In addition to these, public participation in the process of execution of the EAP may further help in amelioration of the adverse impacts of the likely disaster. For this, it is necessary that the public should be made aware of its responsibilities.

III. Preventive Action

Once the likelihood of an emergency situation is suspected, action has to be initiated to prevent a failure. The point at which each situation reaches an emergency status shall be specified and at that stage the vigilance and surveillance shall be upgraded both in respect of time and level. At this stage a thorough inspection of the project should be carried out to locate any visible sign(s) of distress.

Engineers responsible for preventive action should identify sources of equipment needed for repair, materials, labour and expertise for use during an emergency. The amount and type of material required for emergency repairs should be determined for project, depending upon its characteristics, design, construction history and past behavior. It is desirable to stockpile suitable construction materials at appropriate sites. The anticipated need of equipment should be evaluated and if these are not available at the project site, the exact location and availability of these equipments should be determined and specified. The sources/agencies must have necessary instructions for assistance during emergency. Due to the inherent uncertainties about their effectiveness, preventive actions should usually be carried out simultaneously with the appropriate notification on alert situation or a warning situation.

IV. Communication System

An effective communication system and a downstream warning system are absolutely essential for the success of an emergency preparedness plan. The difference between a high flood situation must be made clear to the downstream population.

V. Evacuation Plans

Emergency Action Plan includes evacuation plans and procedures for implementation based on local needs. These could be:

- Demarcation / prioritization of areas to be evacuated.
- Notification procedures and evacuation instructions.
- Safe routes, transport and traffic control.
- Safe areas/shelters.
- Functions and responsibilities of members of evacuation team.

Any precarious situation during floods will be communicated either by an alert situation or by an alert situation followed by a warning situation. An alert situation would indicate that although failure of flooding is not imminent, a more serious situation could occur unless conditions improve. A warning situation would indicate that flooding is imminent as a result of an impending failure of the project. It would normally include an order for evacuation of delineated inundation areas.

VI. Evacuation Team

It will comprise of following official / Representative:

- District Magistrate (D. M.)/ His Nominated officer (To peacefully relocate the people to places at higher elevation with state administration).
- Engineer in charge of the project (Team Leader)
- Superintendent of Police (S. P.) / Nominated Police Officer (To maintain law and order)
- Chief Medical Officer (C. M. O.), (To tackle morbidity of affected people)
- Head of affected village to execute the resettlement operation with the aid of state machinery and project proponents.
- Sub committees at village level

The Engineer-in-Charge will be responsible for the entire operation including prompt determination of the flood situation time to time. Once the red alert is declared the whole state machinery will come into swing and will start evacuating people in the inundation areas delineated in the inundation maps. For successful execution, annually demo exercise will be done. The D.M. is to monitor the entire operation.

VII. Public Awareness for Disaster Mitigation

In addition, guidelines that have to be followed by the inhabitants of flood prone areas, in the event of flood resulting from project failure, which form part of public awareness for disaster mitigation may also include following:

- Listen to the radio for advance information and advice.
- Disconnect all electrical appliances and move all valuable personal and household goods beyond the reach of floodwater, if one is warned or if one suspects that flood waters may enter the house.
- Move vehicles, farm animals and movables goods to the higher place nearby.
- Keep sources of water pollution i.e. insecticides out of the reach of water.
- Turn off electricity and LPG gas before one has to leave the house.
- Lock all outside doors and windows if one has to leave the house.
- Do not enter floodwaters.
- Never wander around a flood area.

VIII. Notifications

Notification procedures are an integral part of any emergency action plan. Separate procedures should be established for slowly and rapidly developing situations and failure. Notifications would include communication of either an alert situation or an alert situation followed by a warning situation. An alert situation would indicate that although failure or flooding is not imminent, a more serious situation could occur unless conditions improve. A warning situation would indicate that flooding is imminent as a result of an impending failure of the dam. It would normally include an order for evacuation of delineated inundation areas.

IX. Notification Procedures

Copies of the EAP that also include the above described inundation map are displayed at prominent locations, in the rooms and locations of the personnel named in the notification chart. For a regular watch on the flood level situation, it is necessary that the flood cells be manned by two or more people so that an alternative person is always available for notification round the clock. For speedy and unhindered communication, a wireless system is a preferable mode of communication. Telephones may be kept for back up, wherever available. It is also preferred that the entire flood cells, if more that one, are tuned in the same wireless channel. It will ensure communication from the project site to the control rooms. The communication can be established by messenger service in the absence of such modes of communication.

X. Management after receding of Flood Water

It is to be accepted that in the event of project break, even with maximum efforts, the loss of human lives, livestock and property would be inevitable. Under such a scenario, a massive effort would be used by various government agencies to provide various relief measures to the evacuees. Formulation of a plan delineating such measures is beyond the scope of work of this document. However, some of the measures which need to be implemented are listed as below:

- Provision of various food items and shelter to the evacuees.
- Provision of fuel for various evacuees.
- Provision of adequate fodder supply.
- Arrangements for potable water supply.
- Commissioning of low cost sewage treatment and sanitation facilities, and disposal of treatment sewage.
- Expeditious disposal of dead bodies of human and livestock.
- Immunization programmes for prevention of outbreak of epidemics of various water related diseases.
- Adequate stocks of medicines of various diseases, especially water-related diseases.

The budget for different activities required to be carried out for mitigation and prevention of project break hazard exclusively from the project is Rs 60.00 lakh as per details given in Table-10.3.

Table-10.3 Budget earmarked for implementation of Disaster Management Plan

S. No.	Particular	Cost (Rs. lakh)
1.	Installation of alert system in control room	10.0
2	Setting up of communication between various locations on river Sillahalla and Kundah	10.0
3	Setting up of communication system between project and d/s settlements	15.0
4	Public information system	15.0
5	Training and miscellaneous expenses	10.0
	Total	**60.0**

10.6 Greenbelt Development

Green belt around the reservoir would be created to avoid erosion of soil and prevention of land slips from the banks. The green belt will start from the immediate vicinity of the reservoir rim on both the banks, where moderate slopes are available for plantation. The average width of the green belt will be around 10 m varying depending upon the physiographic and land features and the area shall be about 50 ha. There would be at least 3 layers of plantation. Water loving species will be planted in the row nearest to the reservoir rim. The soil present at this level and the air moisture are favorable for the survival and growth of these species.

The forest loss due to various project appurtenances shall be compensated as a part of compensatory afforestation. However, it is proposed to develop greenbelt around the perimeter of various project appurtenances, selected stretches along reservoir periphery, etc. The main objectives of creating a green belt around a reservoir are to:

- Check soil erosion around the reservoir
- Check landslides and slips around the reservoir
- Develop the habitat for wildlife particularly avi-fauna

10.6.1 Planning Aspects for Greenbelt Development

The general consideration involved while developing the greenbelt are:

- Trees growing up to 10 m or above in height with perennial foliage should be planted around various appurtenances of the proposed project.
- Planting of trees should be undertaken in appropriate encircling rows around the project site.
- Generally fast growing species should be planted.
- Since, the tree trunk is normally devoid of foliage up to a height of 3 m, it may be useful to have shrubbery in front of the trees so as to gives coverage to this portion.

The tree plantation will be done at a spacing of 2.5 x 2.5 m. About 1600 trees per ha will be planted. The maintenance of the plantation area will also be done by the project proponent. The treated waste water and the manure generated by composting of solid waste generated for labour camps will be used for the greenbelt development. The species for greenbelt development shall be selected in consultation with Forest Department.

The cost of plantation per hectare is estimated at Rs. 100,000 per ha which includes sapling cost, nursery cost, labour cost, cost of manure, weeding etc. It is proposed to afforest about 50 ha of land as a part of Greenbelt development. The total cost works out to be Rs. 50.0 lakh.

The green belt is proposed to be developed within the project area around reservoir periphery, along the network of approach roads, residential areas and other working areas like crushing and aggregate processing plant, batching plant and workshops. The strategy worked out for development of green belt consists of the following:

- Broad leaf trees growing above 10 m in height should be planted along the roads, offices and infrastructure facilities.
- Form a dense crown cover
- Form a litter in abundance on the plantation flow
- Local/indigenous fast-growing trees shrubs should be planted in consultation with the Forest Department

- The trees should be protected by plantation of non-palatable shrub species to avoid browsing by animals.
- Placement of tree guards (metal tree guard, pre-fab RCC tree guard, Fibre tree guard etc.), should be provided to save avenue plantation.
- For protection against biotic interference thorn fencing around the plantation, circular trench around the planting pit and sown with fast growing thorny shrubs on the ridge should be planted.

10.6.2 Nursery Development

An area of 0.2 ha has been earmarked for moderation of saplings.

- Nursery shall be readily accessible all the year round in order to facilitate transportation of materials required in the nursery and dispatch of seedlings from the nursery.
- Organic fertilizer produced through domestic organic waste coupled with vermin-compost through solid waste management shall be used in the nurseries.

10.6.3 Plantation Measures

- Nursery shall have perennial water supply.
- Open grazing is practiced in general in the area; therefore, protection should be provided in advance.
- Polyculture should be practiced. Mixture by group should be preferred over intimate mixture.
- Species mentioned should be planted in sufficient numbers so as to increase their population size in the area.
- Multipurpose species should be planted in large numbers, so as to provide direct benefit to people living around.

10.6.4 Road side plantation

Cost of the plantation has been calculated as per the existing schedule of rate, material cost (plants, FYM, tree guard, etc.) and the total area of treatment. One row each for tree, shrub and bio-fencing has been proposed with a spacing of 3 m x 3 m for trees and 2 m x 2 m for shrubs (to take care of the mortality in the next season). The pit size has been recommended as 45 x 45 x 45 cm for trees and 30 x 30 x 30 cm for shrubs. For the protection of trees from the cattle and other losses, tree guards are required. Along the approach roads plantation will be done on both sides wherever feasible. Plantation along roads must take into account visibility aspects on curves so as to ensure safe driving.

10.6.5 Greenbelt around Residential Area and Office Complex

Plantation around the office complexes is proposed to be done so that greenery is developed. Precaution should be exercised by not planting large size trees around buildings and other similar structures as during winter the sun rays are obstructed by them invariably and much wanted sunshine is impaired. Besides this, it is also proposed to develop green belt around the working areas for trapping the dust and noise. Plantation of avenue, ornamental and fruit trees is proposed in these areas along with the area around office complex. The ornamental, fruit plants will be procured from the local market while the avenue plants will be raised in the project nursery.

10.7 Hazardous Waste Management

Hazardous waste *inter alia* include burnt mobile oil from vehicles and construction machinery and equipment, batteries and like items specified in column (3) of Schedule-I of Hazardous and other Wastes (Management & Trans boundary Movement) Rules, 2016. These will be disposed of by auctioning them to the recycling vendors approved by the CPCB or State Pollution Control Board in consonance with Hazardous and other Wastes (Management & Trans boundary Movement) Rules,2016. The project proponent shall earmark a suitable site for storage of hazardous waste, prior to collection by an authorized vendor for handling the hazardous work.

Hazardous waste shall be sent or sold by the occupier to an authorized actual user or disposed in an authorized disposal facility only. Occupier shall transport wastes through an authorized or certified transporter to an authorized actual user or to an authorized disposal facility as per the provisions of these rules.

A sum of Rs 30.0 lakh has been earmarked for storage and handling of the waste.

10.8 E- Waste Management

E-Waste (Management) Rules, 2016, applies to consumer electrical and electronic equipment listed in Schedule I, including their components, consumables, parts and spares which make the product operational. Electrical equipment (LED/LCD TV sets, refrigerators, air conditioners, fluorescent and mercury lamps) and electronic equipment (Telex, Telephones, Computers, Printers, Cartridges) including their components, consumables, parts and spares mentioned under Schedule-I are covered under the rules.

Under clause 9 (1) of E-Waste (Management) Rules, 2016, consumers or bulk consumers of electrical and electronic equipment listed in Schedule I shall ensure that e-waste generated by them is channelized through collection center or dealer of authorized producer or dismantler or recycler or through the designated take back service provider of the producer to authorized dismantler or recycler. The collection, storage, transportation, segregation, refurbishment, dismantling, recycling and disposal of e-waste shall be in accordance with the procedures prescribed in the guidelines published by the Central Pollution Control Board from time to time. Implementation of e-waste (Management and Handling) Amendment Rules, 2016 shall be in accordance with the guidelines prescribed by the Central Pollution Control Board from time to time. For properly storage of e-waste before its disposal, as sum of Rs.20.0 lakh has been earmarked.

10.9 Labour Management Plan

Construction projects, engage large number of contract workers, are highly prone to hazards pertaining to site activities. The proposed project like any other construction project has significant impact on health and safety during project construction and its operation stage, which need to be adequately addressed.

10.9.1 Legal Framework for Health and Safety Management

The Indian Standard applicable for handling Occupational health and Safety Management are listed in Table-10.4.

Table-10.4: International standards of Health & Safety

S. No	IS: Code	Title
1.	15793:2007	Managing Environment, Occupation Health and Safety Legal Compliance – Requirement of good practices.
2.	15883 (part-I) :2009	Guidelines for construction project management.
3.	18001:2007	Occupational Health and Safety Management System
4.	IS 15883 (Part 5)	Guidelines for construction project Management-Health and Safety Management

10.9.2 Health and Management Safety Requirements

It is recommended that the contractors involved in project construction activities prepare a Health and Safety Plan. These shall include the following aspects:

- Project specific health and safety objectives, targets and programmes in line with health and safety policy
- Hazard identification and risk assessment
- Health and safety organization
- Resources, roles, responsibility and authority
- General health and safety rules
- Health and safety requirements to be followed by sub-contractors
- Operation control procedure
- Activities requiring work permit system and its procedure
- Management of traffic safety inside the project
- Access control of employees
- Safety of visitors

- Management of critical activities such as work at a height, material handling and working with plant and machinery
- Fire prevention and firefighting plan
- Emergency preparedness and response plan
- Traffic management plan
- Training matrix
- Provision of Personal Protective Equipment as per work requirement
- Health and safety performance monitoring measures such as Inspection, Audit Incident reporting and investigation procedure

10.9.3 Resource, Roles, Responsibility and Authority

Project manager shall define, document and communicate the roles, responsibilities and authorities of all personnel like health and safety officer and supervisor who manage, perform and verify activities influencing health and safety risks.

- Health and safety officers shall report to the project manager and functionally report to the senior Health and Safety Representative of the organization.
- Health and safety supervisors shall be engaged to assist the health and safety officers in performing their duties.
- Adequate resources to effectively manage the health and safety management system shall be possible.

10.9.4 Competence, Training and Awareness

It shall be ensured that all employees are competent to perform the assigned work safely based on appropriate education, training or experience. The objectives of health and safety Training are to:

- Equip the employee with necessary knowledge and skill to perform the work assigned to him in a safe manner;
- Foster continual improvement; and
- Develop safety culture.

A training matrix shall be formulated based on capability and the job requirement. The workers shall be trained based on the requirements delineated in training matrix. The objective is to ensure that the work is performed in a time bound manner, monitoring for the highest level of safety.

10.9.5 Health and Safety Reporting

Procedures shall be established for timely recording and reporting of information required for continual improvement of health and safety performance. Reporting procedures shall cover:

- Incident reporting
- Non-conformance reporting
- Health and safety performance reporting
- Hazard Identification reporting
- Statutory reporting requirements
- Stakeholder reporting
- The recording of health and safety performance shall be clearly documented in the project health and safety plan.

10.9. 6 Certification of Plant and Machinery, Lifting

- Contractor will be mandatorily get various equipment tested and examined by a competent person once in a year as per the provision of Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 and other relevant central and state rules and regulations.
- Statutory testing and examination, project specific procedures shall be established to ensure the fitness of machinery and equipment being deployed at the project for the first time.
- Regular Inspections shall be carried out to ensure that machinery and equipment continue to be in safe condition.

10.9.7 Traffic and Logistics Management

- Traffic management plan shall be prepared as a part of the project health and safety plan at the initial stage of the project to manage the traffic inside the project site. Traffic management plan shall include:
- Measures for segregating pedestrian and vehicle traffic
- Establish project specific traffic rules such as speed limit and one-way etc.
- Managing the flow of traffic such that blind zones and hazardous junctions are not present
- Managing the flow of traffic such that reversing can be avoided as far as possible
- Use of traffic control devices such as road humps, convex mirrors, delineators traffic signals and barriers. It shall be planned to deploy flag man, security personnel and traffic marshals at critical areas to regulate traffic.

10.10 Safety Practices during Construction Phase

10.10.1 Personal safety equipment

- All the personnel as well as the site representatives and visitors shall be equipped with appropriate personal safety equipment. The use of such equipment shall be compulsory.
- Every person entering the working area in open air or in underground shall wear a protective helmet. Every person entering into underground works shall have an battery operated electric lamp.
- Safety-lock footwear with steel caps shall be worn by all employees engaged in work having an inherent danger to the feet.
- Light footwear such as sandals, canvas or tennis shoes shall not be permitted for construction work.
- During drilling works and in the areas where the employees are exposed to harmful noise levels, ear protectors shall be made available and required to wear.

- Employees engaged in work having an inherent danger of eye or face injury shall be furnished and required to wear protection glasses, goggles or masks where irritant or toxic substances may come in contact with the skin or clothing, employees shall be wearing the protective clothing or shall be required to apply a protective ointment prescribed by a competent physician.
- Employees working on steep slopes or otherwise subject to possible falls from levels not protected by fixed guardrails or safety nets, shall be secured by safety belts and lifelines.

10.10.2 Requirements for Underground Works

Emergency material shall be provided at each underground excavation heading. This equipment shall consist of the following, as a minimum:

- 3 stretchers
- 3 woolen blankets
- 2 appliances for artificial breathing
- I oxygen flask
- 3 explosion-proof lamps
- wound dressing and disinfecting material
- pain-killing injections
- gas masks

At least two members of the Rescue Team as described hereinafter, properly instructed and trained in the rescue procedures, shall be in each crew working underground

10.10.3 Rescue Team

- Prior to the commencement of construction, a Rescue Team shall be formed. This Rescue Team shall be capable to render help after accidents caused by fire, gas explosion, avalanche, etc.

- Rescue Team shall be organized in such a way that sufficient number of members will be ready for action at any time until the Completion of Works.
- Rescue Team members shall be instructed and trained for their task by a qualified and experienced person. If required, an outside specialist shall be hired to perform such training. A refresher training for all members of the Rescue Team shall be conducted at least every six months.
- Each Rescue Team member shall be skilled in giving the first aid, dealing with the appliances for artificial respiration, and firefighting equipment and shall possess a good local knowledge. Adequate equipment for reaching even the remotest working area shall be at their disposal.

10.10.4 Illumination and Earthing

- All working sites in the open, transit areas, excavation sites, access to tunnels, etc., shall be adequately illuminated during night work by electrical lights as specified in the Section "Site Installations and Services".
- Illumination of Underground Works
- Each working face shall be brightly illuminated.
- The vaults along the entire length of the tunnel adits and shaft shall be illuminated with electrical light throughout the duration of construction works.

The lamps shall be located as follows;

a) Every 25 m in unlined stretches,
b) Every 50 m in lined stretches.

The lamps shall be installed in a particular area immediately after the rock supporting measures have been completed.

- Electrical cables shall be well insulated, protected and firmly fixed to tunnel walls by means of adequate insulators.
- Lamps shall be well protected against damage.
- Lighting by flame is expressly forbidden in the underground.

10.10.5 Earthling, Wet Work Areas, Control of Electric Discharges

- All equipment and appliances, which are exposed to lightning, shall be earthed electrically, and the effectiveness of such earthling shall be periodically checked by the specialized personnel.
- No equipment electrically powered by more than 24 Volts shall be operated by personnel standing in water.
- Only air, battery-powered or hydraulic tools shall be permitted in the wet areas.
- Where electrical blasting will be used, equipment shall be installed to control possible electric discharges in the ground due to storms, electrical motors, etc. As soon as such discharges are noted, electrical blasting operations shall be suspended, or the detonator type changed.

10.10.6 Maintenance of traffic and safety on public roads

- All necessary precautions for the protection of the work and the safety of the public on the roads affected by these activities shall be taken. Where the work will be carried out at the site of, or close to an existing road, the vehicular and pedestrian traffic shall be maintained safe at all times. If any operations can cause traffic hazards, the repair or fence or any such other measures shall be taken for ensuring safety.
- Roads subject to interference by the work shall be kept open or suitable detours shall be provided and maintained, and all necessary barricades, suitable and sufficient flashlights, flagmen, danger signals, and signs be provided.
- Roads, which will be closed to traffic, shall be protected by effective barricades on which acceptable warning and detour signs shall be placed. All barricades shall be kept illuminated and all lights shall be kept on from sunset to sunrise.
- The temporary passes and bridges shall be provided lo give an access to the existing villages, houses, etc., to the satisfaction of the authorities concerned whenever he disturbs such existing way during the execution of the Works.

10.10.7 Blasting

- All blasting shall be carried out in a workmanlike and safe manner by a competent, licensed and experienced blasting engineer or foreman. Blasting shall be done under their supervision.
- Blasting will be permitted only after adequate provisions have been made for the protection of persons, the Works, and public or private property. Responsibility for the safety of persons and property shall be ensured.
- All claims resulting from personal injury and damage to property and equipment that may resulting from its blasting operations shall be taken care of. Any damage done to the Works or property by blasting shall be repaired.
- Blasting in open air shall be carried out only at certain hours of the day in accordance with a schedule. Barriers shall be erected and warning shall be given to the workers at the Site and to the public immediately before blasting, so that no person will enter the danger zone until blasting is finished.
- Upon completion of blasting, an "all clear" signal shall be given by the responsible blasting engineer after he has satisfied himself that all charges loaded have detonated and that no delay-explosions or misfiring arc to be expected.
- Such methods of blasting shall be employed that shock and vibration are minimized.
- No blasts involving charges larger than 200 kg shall be carried without at least one hour prior to the blast.
- No blasting shall be permitted within 25 m of any concrete placed within the previous 7 days, except backfill concrete behind steel ribs. After 7 days. Blasting will not be permitted within 10 m of structures or installations vulnerable to damage by blasting.
- No charging and firing will be permitted during thunderstorms and other electrical disturbances.
- Mats or rubber tires tied together with rope shall be used as protection from flying debris to cover the charges where blasting may expose persons or properly to injury or damage.

10.10.8 Management of Explosives

- All persons charged with, responsible for or involved in the storage, transportation and handling of explosives are to have received appropriate training, are to be suitably qualified and experienced and are to be familiar with the details and guidelines of this chapter.
- Persons responsible in whatever capacity for the storage, transportation and/or handling explosives are to be in good health.
- Persons not qualified to store, transport or handle explosives may carry, load and unload dangerous material into vehicles or storage under supervision of a qualified person, provided they are verbally briefed on safety measures prior to handling explosives.
- All transportation and storage of explosives, temporarily or permanent must be recorded in a log book showing the amount of explosives transported or stored and the amount of explosives being used.

10.10.9 Storage requirements

The following are the minimum general rules and guidelines for the storage of explosives:

- Permanent and/or main storage facilities are to have ventilation, installed in such a way that it cannot be closed, blocked or allow water to penetrate.
- Permanent and/or main storage facilities are to be fitted with lightning conductors.
- Permanent and/or main storage facilities are to have separate rooms or a substantial barrier for separating explosives and detonators/blasting caps.
- In all circumstances, where possible explosives shall be stored in their original packaging.
- All boxes are to be placed at least 100mm above the floor, e.g. on wooden pallets.
- When boxes are stacked the height will not exceed 1.5 metres. The space between the top of the boxes and the ceiling will not be less than 600mm.

- When stacked on shelves boxes are to be at least 100mm away from the upper shelf, and 500mm away from the walls of the room.
- When stacking boxes the width of the base is to be bigger than the height of stacked boxes.
- Blasting caps and electric detonators may be stacked only if packed in boxes and on wooden shelves maximum two layers on a shelf. Total height of stacked boxes will not exceed 1.4 meters.
- If portable lanterns or pocket torches of any description are required they will be switched on before entering the store. The person holding the torch will not handle explosives or detonators or blasting caps.
- Materials used for packaging explosives are to be destroyed and not discarded after use.
- Fire extinguishers shall be available in storage facility.

10.11 Traffic Management during Construction Phase

Temporary diversions will be constructed with the approval of the Engineer. Detailed Traffic Control Plans will be prepared and submitted to the Engineer for approval, at least 5 days prior to commencement of works on any section of road. The traffic control plans shall contain details of temporary diversions, details of arrangements for construction under traffic, details of traffic arrangement after cessation of work each day, safety measures for transport of hazardous material and arrangement of flagmen.

The Contractor will ensure that the diversion/detour is always maintained in running condition, particularly during the monsoon to avoid disruption to traffic flow. He shall inform local community of changes to traffic routes, conditions and pedestrian access arrangements. The temporary traffic detours will be kept free of dust by frequent application of water.

10.12 Measures to be taken during Excavation of Earth

While planning or executing excavation the contractor shall take all adequate precautions against soil erosion, water pollution etc and take appropriate drainage measures to keep the site free of water, through use of mulches, grasses, slope drains and other devices. The contractor shall take adequate protective measures to ensure that excavation operations do not affect or damage adjoining structures and water bodies.

The recommended measures are listed as below:

- Ensure unobstructed natural drainage through proper drainage channels/ structures.
- Dispose surplus excavated earth at identified sites. Ensure minimum hindrance to locals.
- All excavations will be done in such a manner that the suitable materials available from excavation are satisfactorily utilized as decided upon beforehand. The excavations shall conform to the lines, grades, side slopes and levels shown in the drawings or as directed by the engineer.

10.13 Fire protection in labour Camp and Staff Colonies

It has been envisaged that the fire protection planning shall be taken up in the following manner:

10.13.1 Fire Protection Equipment

It has been planned that all facilities to be constructed shall be fully equipped with the fire protection equipment as per IS standards. The analysis of fire hazard in the construction of labour camps, colonies and other facilities alongwith management measures is summarized in Table-10.5. The budget shall be earmarked in the RFP for the contractor involved in construction activities.

Table-10.5: Analysis of fire hazard in the construction of labour camps, colonies and other facilities

S. No.	Stage	Potential hazard	Remedial Measures
1.	Construction of Camp/colony	• Fire prevention and firefighting not considered in design • In adequate fire protection measures during construction	**By Project Proponent** • While construction of Field hostels, Guest House/office and other facilities owned by TNGECL. • The project proponent shall provide the fire protection system as per IS Standards for Fire code. • Proper housekeeping will also be ensured and maintained during these facilities to protect them from any fire related incidents. • It will be ensured that the fire-fighting equipment are placed at common place also including work place preferably within 15 meters of work place. **By Contractors** • Clear term of reference will be given to contractor at tendering stage for incorporating fire code as per IS Standard. • Firefighting equipment will be placed at all common places (within 15 meters of work place)

10.13.2 Maintenance of Safety Equipment

During construction, it has been envisaged to set up full-fledged Environment Health & Safety (EHS) department reporting directly to Head of Project. This department shall also take care of the adequacy of Fire Safety measures set up in all facilities created either owned by TNGECL The analysis of responsibility for this EHS team in respect of Fire protection system is outlined in Table-10.6.

Table-10.6 Analysis of responsibility for this EHS team

S. No	Stage	Potential hazard	Remedial Measures
1.	During Occupation	• Fire incident due to electrical short circuit/LPG Leakage/ Improper handling of flammable liquids/lack of precaution • Improper access to and from the location • In adequate firefighting arrangements • Lack communication • Lack of Knowledge on fighting fire and handling fire equipment • Inadequate Emergency response	**By Project Proponent** • Residential complex will be constructed as per the approved design and will be checked for completeness on fire aspect before allotment to residents • Each Block Colony/ camp will be provided with rated estimated trip off circuit breaker will be installed on each block. • All residents are made aware of fire hazard by training, regular campaigns and by placing posters and signs • LPG Cylinders/Flammable liquids will be stored at designated storage area . The storage will be well protected, ventilated with adequate provision of fire equipment. • Each block of the colony will be provided with 10 kg DCP fire extinguishers. • Additionally fire point containing fire buckets, CO_2 extinguishers, DCP Extinguisher will be provided at the common place covering four residential blocks in labour Camp. • Placement of written posters of preventive measures in each accommodation block • Regular EHS inspection of the camp site • Placement of placard of emergency numbers to be contacted in case of Emergency • Dedicated phone line will be provided in labour camps for

S. No	Stage	Potential hazard	Remedial Measures
			effective communication. • Ensure proper access is maintained around and to the residential blocks • Identification of emergency Muster points at safe distance

10.13.3 Responsibility

Project In charge is responsible for implementation of plan through his authorized representative on site. Site EHS Team shall monitor the implementation of plan and report noncompliance to site management.

10.13.4 Training and Awareness

Training of employees on fire prevention and firefighting is important to prevent occurrence of fire incident in project area. All employees will be given brief overview of fire prevention, firefighting procedure and response process at the time EHS Induction training. Project proponent will also carry out regular campaigns on fire prevention around the site. EHS Department is responsible for providing required training.

10.13.5 Implementation of Safety Plan

The implementation of this plan will be mandatory for all contractors involved in the projects. The requirements of this plan will be part of contract agreement; therefore no cost has been kept under this plan in the EMP. The budget shall be earmarked in the RFP for the contractor involved in construction activities.

10.14 Occupational Health Management Plan

10.14.1 Safety of Machine Use at Project Site

The major machinery to be deployed at site shall include excavators/JCB, Backhoe and loaders which can excavate earth mix with boulders / rock mass and load on to vehicles. The area where machinery shall be operated will be under supervision of trained operators and helpers besides technically qualified foreman to ensure that the machinery is operated as per specified design parameters of the manufacturer.

- Before the work is initiated every day, the routine check-up especially with regard to its hydraulic systems, mechanical conditions, and other operating systems shall be performed.
- Movement of trucks/trippers/tractors for loading /transportation of material within the project area and haul road area shall be regulated by a trained supervisor who shall be responsible for the safety of vehicle movement and prevention of accidents or incidents associated with the vehicular movement.
- All staff working with the construction machinery shall be trained in first-aid and other safety measures, accident or incident prevention and reporting and communication mechanisms.

10.14.2 Occupational Health & Safety (OHS)

The excavated material and construction material do not contain any toxic element. Therefore, the likelihood of any health hazard does not arise due to their handling..

- Process of excavation / quarrying leads to some health hazards.
- Dust generated due to excavation loading and movement on Kutcha/riverbed haul road creates air borne dust which has silica content.
- Working in open during summer can expose workers to the direct sun rays causing heat strokes, cramps and burns besides leading to exhaustion.
- Medical examination of employees at the initial stage and periodically, shall be done by a team of qualified medical officers provided by the project proponent.
- Initial medical examination for all workers must be arranged during the first year of appointment and the periodical check-up during subsequent years as per the requirements.
- Regular medical check-up camps shall also be arranged for detection of occupational diseases and minor disease in the nearby rural population.

- Free check-up and medicine for treatment for their acute and chronic illness shall be provided.

10.14.3 Occupational Health & Safety Measures to Control Dust Inhalation

- Periodical health check-ups
- Implementation of safety and health management system
- Provision of necessary personal protective equipment.
- Establishing and maintaining a system of medical surveillance for employees
- Ensuring employees at all levels receive appropriate training and are competent to carry out their duties and responsibilities.
- Checking the efficacy measures through audits at regular intervals.

10.14.4 Noise Induced Hearing Loss (NIHL)

Blasting causes intermittent high level of noises whereas the continuous running of construction machinery / compressors / wagon drills / rock breakers leads to high noise level in the immediate vicinity of the point of noise emission. Hearing conservation programmes exists at all operations. Baseline audiogram forms the basis for future assessment of employees in terms of hearing loss.

Using engineering initiatives to reduce noise at source is the priority management tool. The hearing conservation programme includes the provision of Hearing Protection Devises (HPDs) and annual audiometry examination of all employees. Apart from provision of HPDs emphasis is also laid on training the employees’ responsibility to protect his / her hearing.

10.14.5 Occupational Lung Diseases (OLD)

There will be regular health camps for all the workers and nearby rural people. Lung function tests, chest X-rays etc. shall be carried out and any health disorders will be evaluated. The budget shall be earmarked for the necessary protective devices and training needs in the RFP for the contractor involved in construction activities.

10.15 Conservation Plan for Schedule-I Species Reported in Conservation Areas

The Red list of threatened species, prepared by IUCN has listed 132 species of plants and animals as Critically Endangered (CR), the most threatened category, from India during its assessment in 2019 Ver-3. Plants seemed to be the most threatened life form with 60 species being listed as Critically Endangered (CR) and 141 as Endangered (EN). The Critically Endangered (CR) list included 18 species of amphibians, 14 fishes and 14 mammals. There are also 15 bird species in the category. The agency listed 310 species as endangered (EN) ones, including 69 fishes, 38 mammals and 32 amphibians.

Wild Life (Protection) Act, 1972 and its Amendment Act, 2022 for the protection of wild animals, birds and plants and for matters connected therewith or ancillary or incidental thereto with a view to ensuring the ecological and environmental security of the country.

During the present survey, a total of 9 Schedule-I Species including 4 Mammalian species and 5 Avi-faunal species has been reported/ observed. However, amongst, Herpetofauna, no Schedule-I species was observed or reported in the project site and its environs (10 km radius).

10.15.1 Conservation Status of Schedule-I Mammalian Species

A detailed biological survey was carried out in the Study Area. The data was collected by the primary as well as secondary sources, including interaction with locals. The data was also collected through signs like scats, pugmarks, and vocalizations were recorded during the survey walk for the presence of fauna.

A total of 4 mammalian species reported from the study area. The list of Schedule-I Mammalian species reported or observed in the study area is given in Table-10.7.

Table-10.7: Schedule-I Mammalian species reported/observed in the study area

S. No	Common Name	Zoological name	IUCN Status
1.	Nilgiri Langur	*Trachyopithecus johnii*	Vulnerable
2.	Indian Chevrotain	*Moschiola meminna*	Least Concern

S. No	Common Name	Zoological name	IUCN Status
3.	Gaur	*Bos gaurus*	Vulnerable
4.	Nilgiri Tahr	*Nilgiritragus hylocrius*	Endangered

Description of Schedule-I Mammalian Species:

I. Nilgiri Langur (*Trachypithecus johnii*)

Introduction

The Nilgiri Langur (*Trachypithecus johnii*) is listed under Schedule-I of the Wildlife Protection Act, 1972 and listed as Vulnerable on the IUCN Red List. They are found primarily in secondary moist deciduous forests and wet evergreen to semi evergreen forests. They prefer locations that are as close to water, and as far away from humans, as possible. They are an arboreal species, found in the middle or lower canopy in trees of medium height.

Classification

Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Family: Cercopithecidae
Genus: *Semnopithecus*
Species: *S. johnii*

Habit and Habitat

Trachypithecus johnii typically inhabits a wide range of forest habitats in the Western Ghats. They are found primarily in secondary moist deciduous forests and wet evergreen to semi evergreen forests. They prefer locations which are close to water, and far from humans. They are an arboreal species, sleeping in the middle or lower canopy in trees of medium height.

Morphology

The hair on the crown and sides of the head is long and light brown with a tint of yellow in colour. The body is covered by long glossy fur, black to dark brown in colour. They are sexually dimorphic, with males slightly larger than females. The males of this species have a total body length ranging from between 78 to 80 cm and weighing up to 15 kg. The females' lengths range from 58 to 60 cm, weighing between 10 and 12 kg. The tails of both males and females vary in length between 68.5 and 96.5 cm. The young are red-brown in colour that darkens and has a full adult colouration by 4 to 5 months.

Feeding Ecology

A folivorous species and eat many kinds of leaves, which make up the majority of their diet. They also take in nutrients from fruits, seeds, nuts, stems, bark, flowers, and soil and carnivorous aspect of their diet is the occasional consumption of insects.

Reproduction

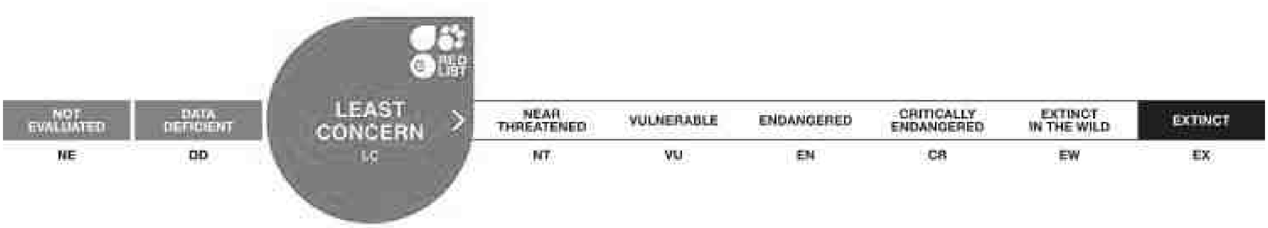
Trachypithecus johnii are sexually dimorphic, and exist in uni-male or multi-male groups. The frequency of uni-male groups is dependent on the ability of individual males to defend and retain groups of females. There are small numbers of females in these uni-male groups because larger numbers of females above a certain threshold are able to exert control over the number of males in their groups. Distance between groups, or population density, also has an effect on the proportion of uni-male to multi-male groups. When groups are more spread out, it is more advantageous for a male to remain in his current group than to risk predation while traveling alone to another group.

Birth rate for *T. johnii* at two points in the year. Most notably in the months of May and June, and secondarily between September and November. This seasonality of breeding may reflect a regular seasonal depletion of resources, which would affect females' ability to ovulate and therefore conceive. *T. johnii* typically have only one offspring at a time.

Threats to the Species

The two main threats to *T. johnii* are destruction of their natural habitat and poaching for various purposes. This species is hunted for its skin, which is used for making drums, as well as for other parts of the body, which are used for meat as well as in traditional medicine.

II. Indian Chevrotain (*Moschiola meminna*)



Introduction

The Indian Chevrotain (*Moschiola meminna*) is protected under Schedule-I of the Wildlife Protection Act, 1972 and listed as Least Concern on the IUCN Red List. India’s smallest deer is a very timid and nocturnal animal difficult to spot in the wild. This species is found over widespread area.

Classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Artiodactyla
Family:	Tragulidae
Genus:	*Moschiola*
Species:	*M. meminna*

Morphology

M. meminna stands 20 to 40 cm high at the shoulder and are sexual dimorphic as males are smaller than females. No sexual dimorphism of skull and skeleton measurements is found in *M. meminna*. The average body mass is 3 kg. Limbs are short and slender with four-toed feet. The fur color of tragulids differs among species. Pelage is medium to dark brown on the back and white on the belly, and has four or five light longitudinal stripes or spot-rows on the back.

Ecology and Behavior

M. meminna is found in tropical deciduous, moist evergreen and semi-evergreen forests. During the day, Chevrotains stay concealed in dense that may be in hollows at the base of trees or in rocky crevices. Occasionally, they may also be encountered resting in the leaf litter of the forest floor where their dappled pelage acts as an effective camouflage as long as the animal stays immobile. They are of a shy and retiring disposition, avoiding open areas and ready to scurry away at the least hint of alarm. They forage for herbs and shrubs and fallen fruit from the forest floor.

Feeding Ecology

M. meminna are able to digest grasses and leaves that are indigestible to most non-ruminants. They favor young shoots, forbs, fruits, which have fallen to the ground, and seeds, in addition, occasionally they also eat arthropods and small animals.

Reproduction

The reproductive biology of most chevrotain species is poorly known, though most are polygamous. When a female enters estrus, males seek out and follow her while making cry-like vocalizations. After repeating a pattern of cries and physical contact, copulation takes place.

Gestation lasts six to nine months, depending on the species, and females give birth to one young a year. The female has four mammae, leading some researchers to suggest that chevrotains may be capable of larger litters. Females ingest the placenta after giving birth. Offspring are precocial, capable of standing within an hour after birth, yet the young remain hidden on the forest floor. Females do not stay with young, except for brief feeding/suckling periods. Young are weaned at three to six months and disperse from the mother's home range when they reach sexual maturity between nine to 26 months. Individuals live to an age of 11 to 13 years.

Threats to the Species

The destruction of their habitat, as well as from hunting and trapping the mouse-deer for meats, their pelts, and for pets. Poaching for meat by local communities is one of the serious threats.

III. Gaur (*Bos gaurus*)

Introduction

The Gaur (*Bos gaurus*) is protected under Schedule-I of the Wildlife Protection Act, 1972 and listed as Vulnerable as per the IUCN Red List. The Gaur is also known as Indian bison, is the largest extant bovine, native to South Asia and South-east Asia.

Classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Cetartiodactyla
Family:	Bovidae
Genus:	*Bos*
Species:	*B. gaurus*

Morphology

The gaur has a head-and-body length of 250 to 330 cm with a 70 to 105cm long tail, and is 165 to 220 cm high at the shoulder. The average weight of adult gaur is 650 to 1,000 kg, with an occasional large bull weighing up to 1,500 kg. Males are about one-fourth larger and heavier than females.

Gaur does not have a distinct dewlap on the throat and chest. Both sexes carry horns, which grow from the sides of the head, curving upwards. Between the horns is a high convex ridge on the forehead. The hair is short, fine and glossy with narrow and pointed hooves. At their bases they present an elliptical cross-section, a characteristic that is more strongly marked in bulls than in cows. The horns are decidedly flattened at the base and regularly curved throughout their length, and are bent inward and slightly backward at their tips. The colour of the horns is some shade of pale green or yellow throughout the greater part of their length, but the tips are black. The horns, of medium size by large bovid standards, grow to a length of 60 to 115 cm.

Ecology and Behavior

Gaurs are basically diurnal, they have become largely nocturnal due to forest molestation caused by humans. During dry season, herds congregate and remain in small areas, dispersing into the hills with the arrival of monsoons. In January and February, they live in small herds of 8 to 11 individuals, one of which is a bull.

In the months of April or May, more bulls may join the herd for mating, and individual bulls may move from herd to herd, each mating with many cows. In May or June, they leave the herd and either form herds of only bulls or live alone. Herds move about 2 to 5 km each day.

The herds are led by an old adult female, the matriarch. Adult males may be solitary. During the peak of the breeding season, unattached males wander widely in search of receptive females. No serious fighting between males has been recorded, with size being the major factor in determining dominance. Males make a mating call of clear, resonant tones which may carry for more than 1.6 km. They have also been known to make a whistling snort as an alarm call, and a low, cow-like moo.

Feeding Ecology

They are primarily intermediate or adaptable mixed feeders. They eat herbs, shrubs, and grasses, and avoid woody plants for most of the year. Seasonal changes in the chemical composition of the feces were related to changes in phenology.

Reproduction

Gaur have one calf (or occasionally two) after a gestation period of about 275 days, about nine months, a few days' less than domestic cattle. Calves are typically weaned after 7 to 12 months. Sexual maturity occurs in the second or third year. Breeding takes place year-round, but typically peaks between December and June. The lifespan of a gaur in captivity is up to 30 years.

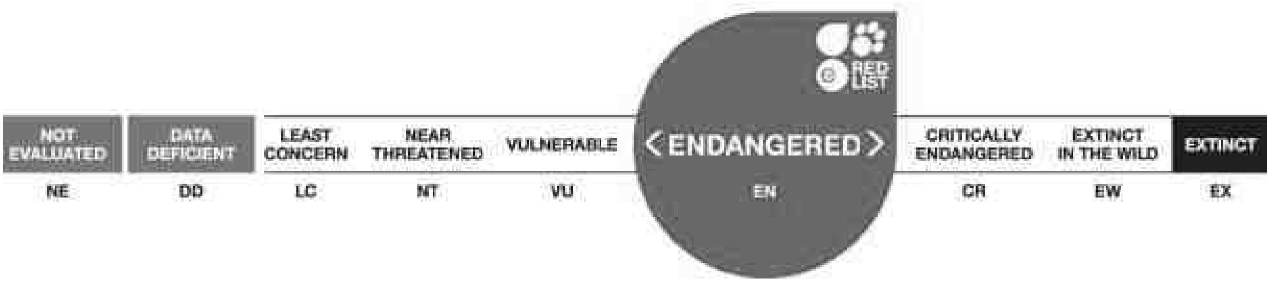
Threats to the Species

Habitat loss has been largely responsible for the large scale decline of gaur range and it remains a major threat to gaur conservation in Asia. The habitat degradation and fragmentation affect gaur population. They are-

- Physical disturbance caused by people such as wood cutting and forest fire.
- Loss of food availability due to extensive cattle grazing.

Poaching of Gaur for meat and horns is one of the serious threats for conservation of gaur even in protected areas and every year shooting of guar is regularly takes place in the boundary of protected areas.

IV. Nilgiri Tahr (*Nilgiritragus hylocrius*)



Classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Cetartiodactyla
Family:	Bovidae
Genus:	Hemitragus
Species:	*hylocrius*

Morphology

The Nilgiri tahr is a stocky goat with short, coarse fur and a bristly mane. Males are larger than females and of darker colour when mature. Both sexes have curved horns, reaching up to 40 cm (16 in) for males and 30 cm (12 in) for females.

Ecology and Behavior

The Nilgiri tahr is found at high elevations on cliffs, grass-covered hills, and open terrain (Nilgiri Tahr Trust, retrieved 03 January 2007). Females gestate for about 180 days, and usually give birth to one kid per pregnancy (Rice, 1984). Animals are sexually mature in the wild at around three years of age (Wilson, 1980; Rice, 1990), though they are only expected to live three or 3.5 years on average, their potential life span is at least 9 years (Rice, 1988; Rice, 1990). The species is diurnal, but are most active grazing in the early morning and late afternoon (Prater, 1971; Nowak, 1991).

Feeding Ecology

The Nilgiri tahr is a herbivore that eats a variety of plants, including grasses, shrubs, herbs, leguminous plants, and some tree species.

Reproduction

The main breeding season for the Nilgiri tahr is from June to August during monsoons. Females can give birth twice a year, and the gestation period is about 178–190 days.

Threats to the Species

Principal threats are habitat loss (mainly from domestic livestock and spread of invasive plants) and poaching (Daniels et al. 2008). The general trends of decline even in the best managed Tahr habitats indicate that the total population of the species does not exceed 2000 at present and a conservative estimate would place the numbers within the 1,800-2,000 range (Daniels et al., 2006). Currently, the only populations with more than 300 individuals are in Eravikulam National Park and in the Grass Hills in Anamalai. The most recent information from the Nilgiri hills

(Mukurti Wildlife Sanctuary), which previously had more than 300 tahr (Davidar, 1978; Rice, 1984; Schaller, 1971), indicates that only between 75 and 100 individuals remain. Wattle (Acacia mearnsii) plantations and cattle apparently no longer threaten the Mukurti population, so their decline is probably due solely to illegal hunting. The status of the other smaller populations (many of which are less than 100 individuals), which are also subject to continued illegal hunting, can be considered precarious. Similar population decreases and threats to the species were reported in a survey in Kalakad-Mundanthurai Tiger Reserve (Rai and Johnsingh, 1992)

10.15.2 Conservation Status of Schedule-I Avi-faunal Species

As a part of CEIA study, detailed study was conducted to assess the presence of avi-fauna in Study Area. To prepare inventory of the birds in the project influence area, bird species are recorded while walking to and from the survey areas and identification done through their calls. Birds were identified using the field guide of birds by Ali & Ripley (1983), Grimmett et al. (1998), Fleming et al. (1984) and Kazmierczak and Perlo (2000). The data was collected through primary as well as secondary sources, including interaction with locals.

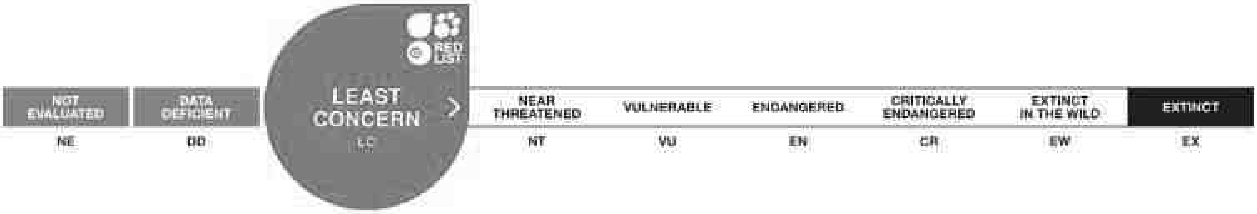
A total of 5 Avi-faunal species reported from the study area. The list of Schedule-I Avi-faunal species reported/observed n the study area is given in Table-10.8.

Table-10.8: Schedule-I Avi-faunal species reported/observed in the Study Area

S. No	Common name	Zoological name	IUCN Status
1.	Indian Peafowl	*Pavo cristatus*	Least Concern
2.	Shikra	*Accipiter badius*	Least Concern
3.	Great Indian Hornbill	*Buceros bicornis*	Vulnerable
4.	Hill Myna	*Gracula religiosa*	Least Concern
5.	Crested Goshawk	*Accipiter trivirgatus*	Least Concern

Description of Schedule-I Avi-faunal Species:

I. Peafowl (*Pavo cristatus*)



Introduction

The Peafowl (*Pavo cristatus*) is protected under Schedule-I of the Wildlife Protection Act, 1972 and is listed as Least Concern on the IUCN Red List. The Peacock or Indian peafowl (*Pavo cristatus*) is a familiar and universally known large pheasant. They are found in moist and dry-deciduous forests near water, in montane forests, and can also adapt to live in cultivated regions and around human habitations.

Classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Aves
Family:	Phasianidae
Genus:	*Pavo*
Species:	*P. Cristatus*

Morphology

The male has a spectacular glossy green long tail feathers and account for more than 60% of the total body length of the bird. These feathers have blue, golden green and copper colored ocelli (eyes). The long tail feathers are used for mating rituals like courtship displays. The feathers are arched into a magnificent fan shaped form across the back of the bird and almost touching the found on both sides. Females do not have these graceful tail feathers. They have the fan like crest with whitish face and throat, chestnut brown crown and hind neck, metallic green upper breast and mantle, white belly and brown back rump and tail. Their primaries are dark brown.

Reproduction

P. cristatus are polygynous (one male to several females), and their breeding season usually depends on the rain. The peak season in southern India is April to May, January to March in Sri Lanka, and June in northern India. During this time, several males may congregate at a leks site and these males are often closely related. Males at leks appear to maintain small territories next to each other and they allow females to visit them and make no attempt to guard harems. Females do not appear to favor specific males. The males display in courtship by raising the upper-tail coverts into an arched fan. The wings are held half open and dropped and it periodically vibrates the long feathers producing a ruffling sound. The cock faces the hen initially and struts and prances around and sometimes turns around to display the tail. Males may also freeze over food to invite a female in a form of courtship feeding. Males may display even in the absence of females. When a male is displaying, females do not appear to show any interest and usually continue their foraging.

Indian peafowl nests on the ground; it is a shallow scrape lined with leaves, sticks, and other debris. The clutch consists of 4 to 8 fawn-to-buff white eggs which are incubated only by the female for about 28 days. The chicks are precocial (fully developed) and follow the mother around soon after hatching. Downy young may sometimes climb on their mother's back and she may carry them in flight to a safe tree branch. The chicks can fly about one week after hatching and become self-sufficient in 8 weeks. They usually reach reproductive maturity at the age of 2 to 3 years old.

Food Habit

P. cristatus are omnivorous and eat seeds, insects, fruits, small mammals, and reptiles. They feed on small snakes but keep their distance from larger ones. Around cultivated areas, peafowl feed on a wide range of crops such as groundnut, tomato, paddy, chili, and even bananas.

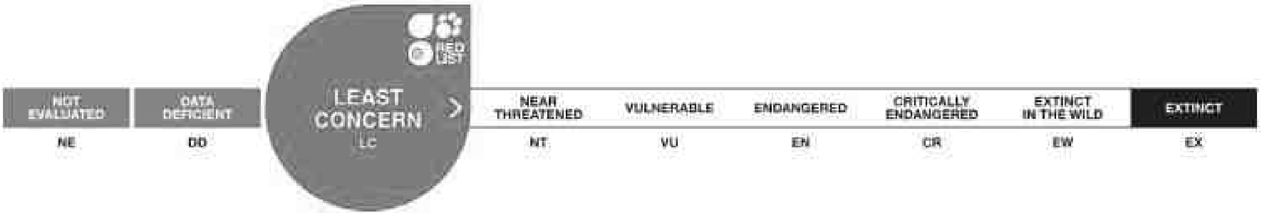
Behavior of Species

Peacocks are gregarious by nature. In the breeding season they are usually seen in small parties of one male with three to five females, whereas in the non-breeding season, they remain in separate parties of adult males and females with juveniles. Peacocks roost in tall trees and emerge from the dense thickets to feed in fields and openings in forests and fields.

Threats to Species

Peacocks are threatened due to habitat loss, hunting and predation. The poaching of peacocks for their feathers is one of the main reason for decrease in peacock population. Peacocks face habitat loss like most bird species, causing them to have fewer sources of food, shelter and water. Mining, timber harvesting, animal agriculture, acquisition of their eggs, and hunting for its meat are all contributing to reduced numbers of peacocks.

II. Shikra (*Accipiter badius*)



Introduction

The Shikra (*Accipiter badius*) is protected under Schedule-I of the Wildlife Protection Act, 1972 and is listed as Least Concern on the IUCN Red List. The Shikra is a small bird of prey in the family Accipitridae found widely distributed in Asia and Africa where it is also called the little banded goshawk.

Classification

Kingdom: Animalia
Phylum: Chordata
Class: Aves
Family: Accipitridae
Genus: *Accipiter*

Species: *A. badius*

Morphology

The Shikra is a small raptor up to 30 cm long. This species has short rounded wings and a narrow and somewhat long tail. Adults are whitish on the underside with fine rufous bars while the upperparts are grey. The lower belly is less barred and the thighs are whitish. Males have a red iris while the females have a less red (yellowish orange) iris and brownish upperparts apart from heavier barring on the underparts. The females are slightly larger. The mesial stripe on the throat is dark but narrow. In flight, the male seen from below shows a light wing lining (underwing coverts) and has blackish wing tips. When seen from above the tail bands are faintly marked on the lateral tail feathers. The central tail feathers are unbanded and only have a dark terminal band. Juveniles have dark streaks and spots on the upper breast and the wing is narrowly barred while the tail has dark but narrow bands. A post-juvenile transitional plumage is found with very strong barring on the contour feathers of the underside.

Habitat and Food

The Shikra is found in a range of habitats including forests, farmland and urban areas. Their flight usually draws alarms among smaller birds and squirrels. They feed on rodents (including *Meriones hurrianae*), squirrels, small birds, small reptiles (mainly lizards, but sometimes small snakes) and insects.

Reproduction

The breeding season in India is in summer from March to June. The nest is a platform similar to that of crows lined with grass. Both sexes help build the nest, twigs being carried in their feet. Like crows, they may also make use of metal wires. The usual clutch is 3 to 4 eggs which are pale bluish grey stippled on the broad end in black. The incubation period is 18 to 21 days.

Behavior of the Species

They are usually seen singly or in pairs. The flight is typical with flaps and glides. During breeding season, pairs will soar on thermals and stoop at each other.

Threats to the species

- Habitat degradation owing to wood harvesting, burning and overgrazing.
- Hunted for its meat
- Perch on electric wires and are frequent victims of electrocution.
- Habit of swooping to pick up dead rodents or other road kill leads to collisions with vehicles.

III. Great Indian Hornbill (*Buceros bicornis)*

Introduction

The Great Indian Hornbill (*Buceros bicornis*) is protected under Schedule-I of the Wildlife Protection Act-1972, and is listed as Vulnerable on the IUCN Red List. It is observed in the Indian subcontinent and Southeast Asia. It is predominantly frugivorous, but also preys on small mammals, reptiles and birds.

Classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Aves
Family:	Bucerotidae
Genus:	*Buceros*
Species:	*B.bicornis*

Morphology

Great hornbills are fairly large, ranging from 95 to 120 cm in length and with a wingspan of 151 to 178 cm. On an average, they weigh 3 kg. They are vividly colored and easily recognizable. The body, head, and wings are primarily black; the abdomen and neck are white. The tail is white and is crossed by a sub terminal black band. A preen gland near the tail secretes tinted oil, which is spread across the feathers by the bird during grooming. This may give the bill, neck, casque, and tail and wing feathers coloration varying from yellow to red. The most recognizable feature of hornbill is the casque, which is a hollow structure located on top of the bill. It may be used by males to fight with other males and attract females. These birds have prominent eyelashes. Males and females are similar, except that the irises of males are red while those of females are white, and males have slightly larger bills and casques.

Food and Habitat

Great hornbills are arboreal and live mainly in wet, tall, evergreen forests. Great hornbills are predominantly frugivores that feed on both lipid-rich and sugar-rich fruits, and feed on small mammals, birds, amphibians, reptiles, and insects as well. Old-growth trees that extend beyond the height of the canopy are preferred for nesting. The height of the tree and the presence of a natural cavity large enough to hold a female and her eggs are more important than the type of tree. The same nesting site is used year after year, if possible.

Reproduction

Great hornbills breed between the months of February and May. Male casque size is important in attracting and fighting for mates. Males compete for females by butting into each other in the presence of a female prior to the breeding season. This could possibly be a display of superiority in competition for a mate. Mates, or potential mates, also perform duets where the male calls, the female replies, and they continue on in a loud volley.

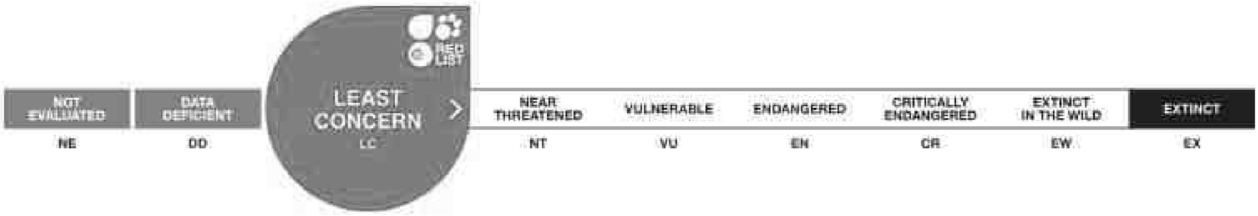
Behavior

Great hornbills tend to stay in small groups of monogamous pairs with their offsprings. They are active during the day and at night, and gather in large communal roosts, which may contain hundreds of individuals. They are a non-migratory species but generally move within an area of about 15 square kilometers. Males fight each other by butting their casques, possibly as a display of dominance in competition for females. One notable behavioral feature is the sealing up of the female in the nest tree during the breeding season.

Threats to the species

- Deforestation
- Hunted for meat, fat and body parts like casque and tail feathers
- Young birds are considered a delicacy

IV. Hill Myna (*Gracula religiosa*)



Introduction

The Hill Myna (*Gracula religiosa*) is protected under Schedule-I of the Wildlife Protection Act, 1972 and is listed as Least Concern on the IUCN Red List. It is a member of the starling family, resident in hill regions of South Asia and Southeast Asia.

Classification

Kingdom	Animalia
Phylum	Chordata
Class	Aves
Family	Sturnidae
Genus	*Gracula*
Species	*G. religiosa*

Morphology

The Hill myna averages 27 to 30 cm in length. It has a glossy black appearance with feathers that vary in undertone. The crown, nape, and breast has a purple glow while the rest of the body is tinted with green and the tail is polished turquoise. The wings are black with a white patch on primaries 3 to 9. The face consists of a red bill that fades into a yellow hooked tip and fleshy wattles, or flaps of bare skin that extends out to the middle of the nape.

Food Habits

The Hill myna is generally an arboreal frugivore, but also includes nectar, insects, and lizards in its diet. It's prefers the areas, where rainfall and humidity are both high. Therefore, inhabiting most of the jungles, evergreen, and wet deciduous forests in its range. Figs are eaten most frequently, followed by berries and seeds from a variety of trees and shrubs.

Behavior Ecology

G. religiosa are usually seen singly or in pairs. They are diurnal birds that spend daylight hours flying high searching for prey. Their flight is typical with flaps and glides. During the breeding season, pairs soar on thermals and stoop at each other.

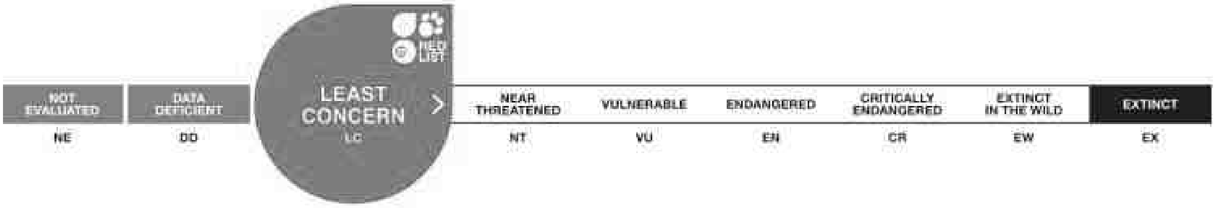
Reproduction

The breeding season for the Hill myna varies slightly depending on range, but most breed in April to July. A monogamous pair searches for a small hole in a tree at the forest edge. Both sexes fill the hole with twigs, leaves, and feathers and the female produces ~2 eggs that are blue with brownish spotting's. The female spends more time incubating than the male, however, both parents tend the young equally, once they hatch. The young fledge after a month and soon after the parents begin a new clutch. The Hill myna averages 2 to 3 broods annually.

Threats to Species

- Habitat destruction and fragmentation
- Hunted for food
- Hunted for keeping as pets

V. Crested Goshawk (*Accipiter trivirgatus*)



Introduction

The Crested Goshawk *(Accipiter trivirgatus)* is protected under Schedule-I of the Wildlife Protection Act, 1972 and listed as Least Concern on the IUCN Red List. The crested goshawk is a bird of prey from tropical Asia. It is related to other diurnal raptors such as eagles, buzzards and harriers and is thus placed in the family Accipitridae.

Classification

Kingdom	Animalia
Phylum	Chordata
Class	Aves
Family	Accipitridae
Genus	Accipiter
Species	*A.trivirgatus*

Morphology

The crested goshawk is a small bird of prey, measuring 30 to 45 cm in length and weighing about 350 gram. The female goshawk is larger than the male and weighs around 550 gram. The wingspan is 50 to 80 cm. The male has a dark brown crown. The head and sides are grey. The eyes are yellow to reddish orange or orange-yellow; cere is greenish yellow to yellow; feet are yellow to orange-yellow. The throat is white with a conspicuous black central (mesial) stripe from chin to breast. The underparts are pale and the belly bears rufous bars. The breast is patterned with rufous streaks. The female goshawk has brown plumage. Its call is a screaming sound.

Habitat and Feeding

The crested goshawk inhabits deciduous and evergreen forests in humid lowlands and foothills. Its range is limited to tropical and warm subtropical areas. The Crested Goshawk feeds on small mammals, lizards, frogs, large insects and birds. It usually watches from a perch in the forest, capturing prey after a short, rapid attack.

Reproduction

They breed from March to July in India. The breeding is a spectacular winnowing display flights by male, gliding over territory with white under tail coverts widely spread and wings drooped, before diving steeply back down into canopy. A large nest is built by the breeding pair above the ground in a large tree. The nest is lined with green leaves and placed near a creek or pond. They lay a clutch of 2 to 3 eggs. The incubation period is 34 to 39 day. The fledgling period is 45 to 48 days.

Threats to Species

- Loss of forest cover and increased human activities in its habitats
- Hunted for its meat
- Perch on electric wires and are frequent victims of electrocution.
- Habit of swooping to pick up dead rodents or other road kills, leads to collisions with vehicles.

10.15.3 Conservation Measures

Direct and indirect approach is required to provide effective conservation, which is recommended as under:-

- Increasing the tree cover in the project areas which will provide shelter and roosting to the avifauna. By encouraging people for plantation of native tree in vacant places such as edges of agricultural fields, common land, neighborhood of people inhibiting, road side avenue tree plantation, open scrubs, school compounds, etc.
- Native species shall be used for plantation

- Carrying out census and research projects to know the potential threats and population status of the species in collaboration of local schools, colleges, panchayats and forest department.
- Regular interaction of forest department officials with villagers to create awareness on optimal utilization of forest resources.
- Create awareness among local people and build effective information system against hunting and poaching activities.
- Involvement of local people in conservation activities will be ensured by organizing meetings and interaction from village to village on regular basis to create awareness about wildlife conservation.
- Functions like *Van Mahotsav*, Wildlife Week, World Forestry Day, and World Environment Day will be organized in which village heads and other members of gram panchayat, local leaders and members of regional NGO shall be invited. The objective is to evolve around habitat loss, human-wildlife conflicts, Wildlife conservation etc.
- Information on Wildlife policies and Government regulation and penalties shall be disseminated.
- Effective communication network will be developed between local people, forest officers and conservation experts to reduce the risk of the human conflict with wildlife, hunting and poaching activities.
- No pressure horn would be allowed on vehicle plying in the project area.
- Poaching and hunting of wildlife will be continuously monitored and action will be taken against poachers as per the norms of Indian Wildlife Protection Act-1972.
- Separate funds have been earmarked to Forest Department for Anti-Poaching from poachers and Protection & Conservation of Wildlife. The details of anti-poaching measures are outlined in Section- 4.9 of this Report
- Detailed research studies and conservation projects should be launched both by the public and private sectors for the conservation, management, and improvement of the species in and around the project areas.
- Speed limit of vehicles would be fixed and operators would be educated and advised regularly to drive vehicle safely and slowly.

- All operators would also be advised to stop the vehicle on seeing a fauna/wild animal and let it go away before moving the vehicle further.
- All the drivers would be advised to make minimum use of horn in the project areas.
- Efforts shall be made to cover the lights suitably with paint so that strong beam of head light is not formed and light falls in front of the vehicle only.
- Install visibility enhancement objects such as marker balls, bird deterrents, bird flight diverters, ultra-violet emitters, and/ suspended devices on the earth wire to increase line visibility to birds and reduce bird-line collisions in the areas.
- Rewards to informer's local people and employees watch would be kept on the wild life as well as illegal tree felling.
- Forest and a Police Departments would be informed if such incident occurs, to take legal action against the offenders. For this they would be trained for motivation.

10.15.4 Conservation Action Plan

- **Habitat Improvement Action Plan**

Habitat improvement programme in the different villages will be under taken in the study area for shelter of the wild animals. This will be achieved by plantation of local varieties of the tree species near villages in study area. Plantation will also be carried in some forest patches identified by local forest department. Habitat improvement programme will include plantation of native plants species and other species reported from the study are should be taken in to priority. In order to improve vegetation cover, it is suggested to carry out extensive afforestation program different phases. These species will help to provide habitat for faunal species, and also increase the species diversity and maintain the naturalness of the surrounding area.

- **Seed/Saplings distribution among the villagers**

During this habitat improvement programme the seeds and Saplings of indigenous fruit trees/plants will be distributed in the various villages of the study area. Compost packets will be also provided at the intervals of every six months by the proponent (in consultation of forest department).

- **Training and Awareness Programme**

This is the most important aspect of biodiversity conservation. People will be educated regarding the importance of biodiversity conservation through mass publicity by installing sign boards, conducting audio visual classes and distributing literature in respective villages in the Study area. Experts in the field of biodiversity conservation will also be invited to deliver talks through slides.

- **Special Staff or the Protection and Anti-poaching**

Special Staffs will be deployed by the forest department for patrolling and protection of the fauna and flora under their jurisdiction because the regular staff deployed for this purpose, due to their busy schedule, is unable to perform their work properly. Each of the special staff will be equipped with dress, raincoat, gumboots, sticks and wireless set for communication. Financial burden for the same has been included in financial projection of this report.

10.15.5 Budget for Implementation of Conservation Plan

An amount of Rs. 350.0/- lakhs has been proposed for the Wildlife Conservation Plan under the following heads. The budgetary allocation is given in Table 10.9 and Table 10.10.

Table 10.9: Budgetary allocation for Wildlife Conservation Plan

S. No.	Component	Budget (Rs. lakhs)
1.	Fund to forest department for Patrolling equipment such as camera traps and their maintenance to Forest Department	100.0
2.	Plantation of native plants species	100.0
3.	Awards to the informer (local people and employees watch would be kept on the wild life as well as illegal tree felling)	100.0
4.	Awareness programs (community, schools etc.) for	50.0

S. No.	Component	Budget (Rs. lakhs)
	wildlife conservation	
	Total	**350.0**

Rs. 350.0/- lakhs will be taken for biodiversity conservation measures in and around the project during its construction and operation phase based on recommendations by various statutory authorities such as Chief Wildlife Warden, Forest/ Wildlife Department.

10.16 Composition of Environmental Management Cell

It is strongly recommended that Project authorities establish an Environmental Management Unit at project site. The manpower required are an Environmental Officer, 2 Ecologist, 2 Technical Assistants (Terrestrial Ecologist), 1 Technical Assistants (Socio Economist). The Environment Management Cell (EMC) shall be under the Head of Project.

The manpower required for Environmental Management Unit are given in Table-10.10

Table-10.10: Manpower Requirement for Environmental Management Unit

S. No	Position	Number
1.	Environmental Officer	1
2.	Ecologist	2
3.	Technical Assistant (Terrestrial Ecologist)	2
4.	Technical Assistant (Social Expert)	1
	Total	**6**

The key tasks of the Environmental Management Unit will be to coordinate specific studies to:

- Monitor implementation of Environmental Mitigatory measures
- Coordinate activities outlined as a part on Environmental Audit
- Coordinate Environmental Monitoring Programme

- Suggestion of additional measures/studies, if any.

The Environmental Management Cell (EMC) will report to the appropriate authority having adequate powers to implement the required measures.

The cost of setting up EMC is considered in the project cost. Hence, No additional cost has been earmarked for this purpose.

The Organization Chart of Environment management Unit is enclosed as Figure-10.1.

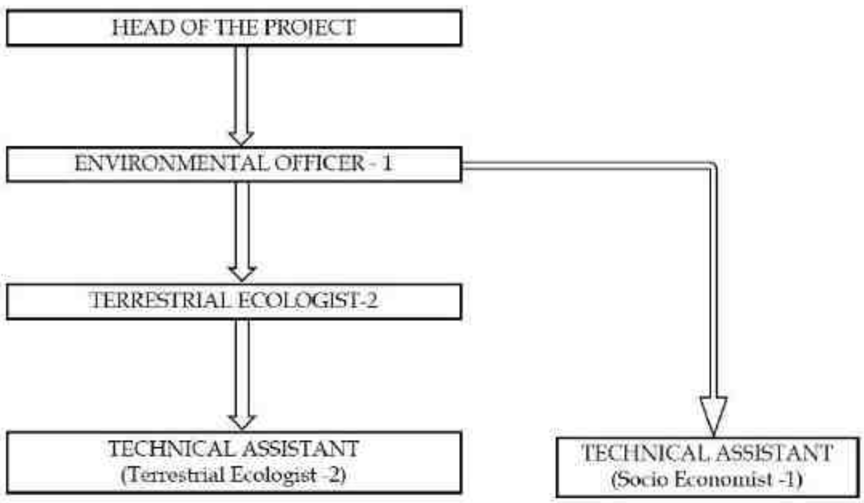


Figure-10.1: Organization Chart of Environmental Management Unit

10.17 Impact Evaluation

The matrix of impacts likely to accrue as a result of the proposal Sillahalla PSP is given in Table-10.11.

Table-10.11: Matrix of Impacts due to proposed Sillahalla PSHEP Stage-I

Environmental Domain	Phase	Likely Impacts	Environmental Impacts: Rating – Magnitude	Extent	Duration	Significance of Impacts
Physico-chemical Aspects	Construction Phase	Conflict with locals and immigrant labors	Mo	L	ST	Insignificant
		Loss of aesthetic value	Mo	L	Mt	Moderately significant
		Changes in land use	Mo	Sp	Lt	Moderately significant
		Changes in topography	Mi	Sp	Lt	Insignificant
		Changes in ambient noise level	Mi	Sp	St	Insignificant
		Changes in land stability, erosion and sedimentation	Mo	L	Mt	Moderately significant
		Loss of fertile top soil during project construction activities	Mi	Sp	Mt	Insignificant
		Construction Workforce related influence on local culture and tradition	Mo	L	St	Insignificant
		Issue pertaining to landslides, slope stability at tunnel portals, reservoir rim treatment	Mo	L	Mt	Moderately significant
		Possibility of drying existing springs during tunneling	Mo	L	St	Insignificant
		Assessment of actual or potential barrage to drinking water and/or irrigation projects at/around project site due to tunnel alignment	Mo	Sp	St	Insignificant
		Increased generation of solid waste in the project area	Mo	Sp	Mt	Insignificant
		Impacts due to construction of access roads	Mo	Sp	Lt	Insignificant

Environmental Domain	Phase	Likely Impacts	Environmental Impacts Rating: Magnitude	Extent	Duration	Significance of Impacts
		Impacts on ambient air quality	Mo	Sp	Mt	Insignificant
		Impacts on river water quality due to leakage and disposal of lubricant oils from power house and switchyard	Mi	L	St	Insignificant
		Impacts on reservoir water quality	Mi	Sp	Lt	Moderately significant
		Contamination of soil and water by lubricants, oils or construction material	Mo	L	Mt	Moderately significant
		Spoil and other camp / construction waste related land pollution	Mo	Sp	St	Insignificant
		Changes in river flow and river morphology	Mi	L	Lt	Moderately Significant
		Sedimentation and erosion at the Dam site	Mo	L	Lt	Moderately significant
		Erosion downstream of tail race disposal site	Mo	Sp	Lt	Moderately significant
	Operation Phase	Possibility of landslide and slope instability especially at intake area, tunnel portal area and penstock	Mo	Sp	Lt	Moderately
		River water quality changes in the dewatered section	Mo	Sp	Lt	Moderately Significant
		Loss of forest and vegetation	Mo	L	Lt	Moderately significant
		Loss of plant biodiversity	Mo	L	Lt	Moderately significant
		Loss of rare/endangered/endemic plant species	Mo	L	Lt	Moderately significant
		Influence of road and workforce on the forest and vegetation resources	Mo	L	Mt	Moderately significant

Environmental Domain	Phase	Likely Impacts	Environmental Impacts			Significance of Impacts
			Rating			
			Magnitude	Extent	Duration	
		Loss of wildlife and wildlife habitats	Mo	L	Mt	Moderately significant
		Loss of the habitats of rare/endangered/endemic wildlife	Mo	L	Mt	Moderately significant
Biological Aspects	Construction Phase	Influence of the project roads and workforce on the wildlife and wildlife habitats	Mo	L	St	Insignificant
		Loss of aquatic habitats	Mi	S	ST	Insignificant
		Influence of workforce, construction noise, spoils, and other solid and liquid wastes on the wildlife and aquatic life/fisheries	Mo	L	Mt	Moderately significant
		Breeding/Migration/Movement of wildlife	Mo	L	Mt	Moderately significant
		Impacts on forest due to cutting of fuel wood	Mo	L	Mt	Moderately significant
		Impediment to movement of migratory fish species by barrage	Mo	L	Lt	Insignificant
		Dewatering influenced changes in fishery habitats and aquatic life in the stretch of river between barrage and tailrace	Mi	L	ST	Insignificant
		Risk to terrestrial wildlife and aquatic wildlife in the downstream river stretch due to sudden release of water from barrage	Mi	S	ST	Insignificant
		Land acquisition and population displacement/involuntary resettlement	Mo	Sp	Lt	Moderately significant

Environmental Domain	Phase	Likely Impacts	Environmental Impacts			Significance of Impacts
			Rating			
			Magnitude	Extent	Duration	
		Impact on social services like: Educational, Health, communication, Water Supply, Consumer Goods, and Sanitation etc.	Mo	L	St	Insignificant
		Influence on community health, prevalence of communicable diseases (STD/HIV AIDS)	Mo	L	Mt	Moderately significant
		Influence on occupational health, and accidental risks	Mo	Sp	Mt	Insignificant
	Operation Phase	Impacts due to blasting on people and structures	M	SP	SE	Insignificant
		Impacts on existing settlements due to tunnel alignment	Mo	SP	SE	Insignificant
		Impacts due to occupational health and safety	Mo	Sp	Mt	Insignificant
Social and Economic aspects	Construction Phase	Impacts on fishing community	Mi	Sp	SE	Insignificant
		Issue of scarcity of drinking water and degradation in its quality due to influx of people from outside	Mo	L	Mt	Moderately significant
		Decline in construction related economic activities and its influence	Mo	L	St	Insignificant
		Risks due failure of upper and lower dam	Mi	L	St	Significant

Notes: H=High/Major, Mo=Moderate, Mi=Minor, R= Regional, L=Local, Sp=Site specific, Lt=Long term; Mt= Medium term; St=Short term

10.18 Cost Estimates

10.18.1 Cost for Implementing Environmental Management Plan

The total amount to be spent for implementation of Environmental Management Plan (EMP) would be Rs.600.0 lakh. The details of the cost are given in Table-10.12.

Table-10.12: Cost for Implementing Environmental Management Plan

S. No.	Item	Cost (Rs. lakh)
1.	Energy Conservation Measures	40.0
2.	Public Awareness Programme	50.0
3.	Disaster Management Plan	60.0
4.	Greenbelt Development Plan	50.0
5.	Hazardous Waste Management	30.0
6.	E-Waste Management	20.0
7.	Budget for Conservation of Schedule-I Species	350.0
	Total	**600.0**

10.18.2 Cost Estimates for Implementing Mitigation Measures

The cost for implementation of mitigation measures is Rs. 4495.81 lakh. The details are given in Table-10.13.

Table-10.13: Cost for Implementing Mitigation Measures

S. No.	Item	Cost (Rs. lakh)
1.	Landscaping and Restoration of Construction Areas	100.00
2.	Stabilization of Muck Disposal Sites	1020.00
3.	Environmental Management in Road Construction	800.00
4.	Solid waste Management	108.92
5.	Sanitary facilities in labour camps	188.00
6.	Treatment of Effluents from Crushers	50.0
7.	Treatment of effluents from batching plants	50.0
8.	Treatment of effluent from fabrication units and workshops	50.0
9.	Air Pollution Control Measures	256.30
10.	Provision of Free Fuel	419.75
11.	Compensatory Afforestation	46.34
12.	Biodiversity Conservation Plan	250.00

S. No.	Item	Cost (Rs. lakh)
13.	Wildlife protection Plan	407.12
14.	Habitat Improvement for Avi-Fauna	88.30
15.	Development of Hatcheries	146.48
16.	Public Health Delivery System	514.60
	Total	**4495.81**

10.18.3 Cost Estimates for Implementing Additional Studies

An amount of Rs. 41430.89 lakh has been earmarked for implementation of various measures outlined under Additional Studies. The details are given in Table-10.14.

Table-10.14: Summary of Cost Estimates for implementation of measures outlined in Additional Studies

S. No.	Particular	Cost (Rs. lakh)
1.	Catchment Area Treatment Plan (**Refer** Table 7.10)	1774.15
1.	Resettlement and Rehabilitation Plan (**Refer** Table 7.15)	36731.74
2.	Local Area Development Plan (**Refer** Table 7.19)	2925.00
	Total	**41430.89**

10.18.4 Cost Estimates for Implementing Environmental Monitoring Programme

The cost required for implementation of the Environmental Monitoring Programme is of the order of Rs. 194.30 lakh. 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 61 months. The details are given in Table-10.15.

Table-10.15: Cost for Implementing Environmental Monitoring Programme during construction Phase

S. No	Item	Cost (Rs. lakh/ year)	Total cost for construction period of 61 months (5 years) with 10% escalation per year (Rs. lakh)
1	Water quality	1.20	7.32
2	Ambient air quality	4.80	31.25
3.	Ecology	18.00	117.18
4.	Incidence of water related diseases	5.00	32.55
5.	Purchase of meteorological instruments and noise meter	-	6.0
	Total	**29.00**	**194.30**

The cost required for implementation of the Environmental Monitoring Programme in operation phase is of the order of Rs. 29.26 lakh/year. The details are given in Table -10.16.

Table-10.16: Cost for Implementing Environmental Monitoring Programme during operation phase

S. No.	Item	Cost (Rs. lakh/year)
1.	Water quality	1.26
2.	Ecology	18.00
3.	Incidence of water related diseases	5.00
4.	Landuse pattern	5.00
	Total	**29.26**

10.18.5 Budget for Implementation of Various Environmental Measures

An amount of Rs. 46721.0 lakh or Rs. 467.21 crore has been earmarked for implementation of various Environmental measures during construction phase outlined in chapter. The details are given in Table-10.17.

Table-10.17: Total Budget for various Environmental Measures

S. No.	Activity	Cost (Rs. lakh)
1.	Cost for implementing Environmental Management Plan (Refer Table-10.12)	600.00
2.	Cost for implementing mitigation measures (Refer Table-10.13)	4495.81
3.	Cost for measures as per Additional Studies (Refer Table-	41430.89

S. No.	Activity	Cost (Rs. lakh)
	10.14)	
4.	Cost for implementing Environmental Monitoring Programme during construction phase (Refer Table-10.15)	194.30
	Total	**46721.0**

In addition, an amount of Rs.29.26 lakh / year has been earmarked (Refer Table 10.16) for implementation of various Environmental measures during operation phase outlined in chapter.

10.18.6 Implementation and Monitoring of Environmental Parameters

An inhouse environment cell of TANGECO shall be involved in implementation and monitoring of Environmental parameters including implementation of Mitigation measures at site and various Environment Management Plans to ameliorate the impacts due to the project. The following proposed team shall be involved in monitoring the environment compliances.

- Executive Engineer – 1 No – with experience in implementation of environment management plan / Mitigation measures
- Assistant Executive Engineer – 2 Nos – with experience in implementation of environment management plan / Mitigation measures
- Assistant Engineer – 1 No - with experience in implementation of environment management plan / Mitigation measures

CHAPTER-11
SUMMARY AND CONCLUSIONS

11.1 Introduction

Sillahalla Pumped Storage Hydro-Electric Project Stage-I (1000 MW) is planned in the Nilgiris district of the southern Indian state of Tamil Nadu. The coordinates of the propose Upper Dam site are 11° 18' 57.64" N and 76° 39' 2.74" E (Left Bank) and 11° 18' 53.11" N, and 76° 38' 51.74" E (Right Bank) respectively. The coordinates of the proposed Lower Dam site are 11 ˚ 16' 34.11" N, 76 ˚ 40' 11.72" E (Left Bank) and 11 ˚ 16' 22.77" N, 76 ˚ 40' 5.96" E (Right Bank) respectively.

The present scheme is a very attractive scheme both in terms of technical feasibility and from economical consideration. The scheme envisages utilization of the waters of Sillahalla River (tributary of Kundah River) through underground Power house by a water conductor system. The proposed pumped scheme envisages peak power generation on a Pumped storage type development, harnessing a head of about 430+ m between proposed upper reservoir and lower reservoir.

To satisfy the energy needs of the State, Tamil Nadu Generation and Distribution Corporation Limited has a total installed capacity of 18747.28 MW which includes TNGEDCO owned State projects, share from the Central Generating Stations (CGS) and Private Power Purchase. Other than this, the State has installations in renewable energy sources like wind mill, solar, biomass and cogeneration up to 10479.61 MW.

TNGECL has proposed new generation projects in next 5 years for meeting the increasing energy demands. TNGECL has exploited the hydroelectric potential available in the state. However, to balance the excess power available during off peak hours and to tide over the peak hour shortage, Kundah Pumped Storage Hydro Electric Scheme (4x125 MW) has been proposed in the Nilgiris.

Since the Upper and Lower reservoirs of Sillahalla Pumped Storage Project (Sillahalla PSP) have an effective storage capacity equivalent to five (5) to Six (6) hours of generation daily at full rated output, hence it is not possible for Sillahalla

PSHEP to operate on weekly or seasonal basis. Therefore, the project is deemed to be operational on Daily basis.

The proposed Sillahalla PSHEP Stage-I envisages the following components:

- Construction of concrete gravity upper dam of 82 m height and 327 m length across Sillahalla River.
- 1 no. Power intake with trash rack having mechanical raking arrangement and gate shaft.
- 1 no. 2862 m long, 9 m dia. circular concrete lined head race tunnel.
- 1 no. 70 m high, 20 m dia. circular concrete lined HRT surge shaft.
- 2 nos. 533 m long, 6.5 m dia. inclined circular steel lined pressure shaft.
- 4 nos. 55 m long, 4.75 m dia. circular steel lined Penstocks.
- An underground powerhouse cavern of size of 160m x24m x 55m to house 4 no. Francis reversible pump turbine generating units of 250 MW capacity each.
- 1 no. Transformer cavern 130m x 18m x 22.5m to house 4 nos. generator transformers.
- 4 nos. of draft tube tunnels of 5 m dia and 81 m length.
- 1 no. TRT surge chamber of size 85m x 10m x 88m.
- 1 no. 1567 m long, 9.75 m dia. circular concrete lined tail race tunnel to carry the water from power house to lower reservoir.
- 1 no. of Tail Race outlet with 1 no gate shaft and trash rack having mechanical raking arrangement.
- Construction of concrete gravity lower dam of 112 m height and 470 m length across Kundah River.
- 1 no. Main Access Tunnel (MAT) D- shaped of 1240 m long 8m width & 8m height.
- 3 nos. construction adit's – 1 no. adit 1 to HRT, 1 no. adit 2 to HRT surge shaft, 1 no. adit 3 to butterfly valve.

11.2 Conclusions

The proposed Sillahalla Pumped Storage HEP Stage-I will provide peaking capacity of 1000 MW for 5 hrs 39 min block in one cycle of operation with daily energy of 5654.17 MWh. The Annual Energy generation shall be 2063.77 GWh. The increased power availability will give an impetus to agriculture and industries. The quality of life of beneficiaries will improve with impetus to electrification due to the proposed project.

The 1000 MW power generated at 18 kV will be stepped up to 400 kV. This power shall be further evacuated from Switch yard area by following two (02) nos. of power evacuation schemes which are proposed at this stage for Sillahalla PSP:

- 400 kV Double Circuit Transmission Line with twin Moose conductor from Sillahalla PSP to Karamdai 400 kV Substation and Sillahalla PSP to Arasur 400 kV Substation.
- One no. of double circuit and two nos of single circuit Transmission lines of twin Moose conductor are proposed to be constructed from Sillahalla PSP to Arasur 400 kV Substation, Karamdai 400 kV or Rasipallam 400 kV substation for evacuation of generated power or receiving of power for pumping purpose.

It can be concluded that the proposed Sillahalla Pumped Storage project is likely to entail certain adverse environmental impacts. However, these impacts shall be ameliorated to a large extent by implementing appropriate mitigation measures (Chapter-4). Appropriate management measures too has been suggested and delineated as a part of Environmental Management Plan (EMP) (Chapter-10).

CHAPTER-12

DECLARATION BY EXPERTS CONTRIBUTING TO THE EIA

I, hereby, certify that I was a part of the EIA team in the following capacity that developed the above EIA.

EIA coordinator: Name: Dr. Aman Sharma

Signature:

Period of involvement:

Contact information:

WAPCOS Limited.

Plot no 76/C, Institutional Area, Sector-18, Gurgaon, Haryana

Phone: 0124 2397396

S. No.	Functional Areas	Name of the experts	Signature
1.	Deputy Coordinator	Mr. A. S. Leo	
2.	WP	Dr. Aman Sharma	
3.	AP	Mr. A. S. Leo	
4.	SHW	Dr. Aman Sharma	
5.	EB	Dr. S.K. Tyagi	
6.	HG	Dr. Aman Sharma	
7.	LU	Mrs. Moumita Mondal Ghosh	

S. No.	Functional Areas	Name of the experts	Signature
8.	GEO	Dr. A.K. Srivastava	
9.	SC	Dr. K.P.S Malik	
10.	AQ	Mr. S.M. Dixit	
11.	RH	Pinaki Das Gupta	
12.	SE	Dr. K K Gaur	
13.	NV	Mr. Sanjeev Sharma	

Declaration by the Head of the Accredited Consultant Organization/authorized person

I, Dr. Aman Sharma, hereby, confirm that the above mentioned experts prepared the EIA report entitled "Environmental Impact Assessment Study for Sillahalla Pumped Storage Hydro-electric Project Stage-I, Tamil Nadu". I also confirm that the consultant organization shall be fully accountable for any misleading information mentioned in this statement.

Signature	:	
Name	:	Dr. Aman Sharma
Designation	:	Chief Executive Director (Envt., CM & Admin)
Name of the EIA consultant organization	:	WAPCOS Limited
NABET Certificate No.& Issue Date	:	NABET/EIA/2124/RA 0222 Dated :15/12/2021

Annexure-I: TOR Compliance Matrix for Sillahalla PSHEP Stage-I

S. No.	TOR Point	Compliance
	General TOR	
1	**Scope of the EIA Studies**	
	The EIA Report should identify the relevant environmental concerns and focus on potential impacts that may change due to the construction of proposed project. Based on the baseline data collected for three (3) seasons (Pre-monsoon, Monsoon and Winter seasons), the status of the existing environment in the area and capacity to bear the impact on this should be analysed. Based on this analysis, the mitigation measures for minimizing the impact shall be suggested in the EIA/EMP study.	Baseline status has been covered in Chapter-3 of EIA report. The same has been established through 3 season survey conducted as below:- The detailed assessment of environment impacts with their mitigation measures for minimizing the impact has been done in Chapter-4 of the EIA Report.
2	**Details of the Project and Site**	
	General introduction about the proposed project.	Covered in Chapters-1 and 2 of EIA report
	Details of project and site giving L-sections of all U/S and D/S projects of River with all relevant maps and figures. Connect such information as to establish the total length of interference of Natural River, the total length of tunnelling of the river and the committed unrestricted release from the site of diversion into the main river.	Covered in Section -4.6 of Chapter-4.
	A map of boundary of the project site giving details of protected areas in the vicinity of project location.	The Upper Dam site and Lower Dam Site are located about 11.4 and 4.78 km respectively from the boundary Mukurthi National Park. The map showing location of Upper and Lower Reservoirs, w.r.t Mukurthi National Park is enclosed as Figure-4.4 of Chapter-4.
	Location details on a map of the project area with contours indicating main project features. The project layout shall be superimposed on a contour map of ground elevation showing main project features (viz. location of dam, Head works, main canal, branch canals, quarrying etc.) shall be depicted in a scaled map.	Location map of the project is enclosed as Figure 1.1 of Chapter-1. The project layout map alongwith contours is enclosed as Figure-2.2 of Chapter-2.
	Layout details and map of the project	The project layout map alongwith

S. No.	TOR Point	Compliance
	along with contours with project components clearly marked with proper scale maps of at least a 1:50,000 scale and printed at least on A3 scale for clarity.	contours is enclosed as Figure-2.2 of Chapter-2.
	Existence of National Park, Sanctuary, Biosphere Reserve etc. in the study area, if any, should be detailed and presented on a map with distinct distances from the project components.	Mukurthi National Park was established in the year 2001 in the Nilgiris Districts and covers an area of 7,846 ha, and is part of the Nilgiri Biosphere Reserve. The Upper Dam site and Lower Dam Site are located about 11.4 and 4.78 km respectively from the boundary Mukurthi National Park. The map showing location of Upper and Lower Reservoirs, w.r.t Mukurthi National Park is enclosed as Figure-4.4 of Chapter-4.
	Drainage pattern and map of the river catchment up to the proposed project site.	Watershed maps for Upper and Lower reservoirs is enclosed as Figures-7.1 and 7.2 in Section 7.2 of Chapter-7.
	Delineation of critically degraded areas in the directly draining catchment on the basis of Silt Yield Index as per the methodology of All India Soil and Land Use Survey of India.	Covered in Section 7.2.3.1 of Chapter-7
	Soil characteristics and map of the project area	Covered in Section 3.3.7 of Chapter-3.
	Geological and Seismo-tectonic details and maps of the area surrounding the proposed project site showing location of dam site and powerhouse site.	Covered in Section 3.3.2 to 3.3.5 of Chapter-3. Project layout is enclosed as Figure-2.2 in Chapter-2.
	Remote Sensing studies, interpretation of satellite imagery, topographic sheets along with ground verification shall be used to develop the land use/land cover pattern of the study using overlaying mapping techniques viz. Geographic Information System {GIS), False Color Composite (FCC) generated from satellite data of project area.	Enclosed as Figures 3.15 to 3.17 in Section 3.3.6 of Chapter-3
	Land details including forests, private and other land.	Covered in Section 2.7 of Chapter-2
	Demarcation of snow fed and rain fed areas for a realistic estimate of the	The entire watershed is rainfed. There is no snowfed area in

S. No.	TOR Point	Compliance
	water availability.	watershed area of the project. The estimate of water availability is given in Section 3.3.8 of Chapter-3.
	Different riverine habitats like rapids, pools, side pools and variations in the river substratum-bedrocks, rocks, boulders, sand/silt or clay etc. need to be covered under the study.	Covered in Sections 3.3.2 and 3.3.3 of Chapter-3.
3	**Description of Environment and Baseline Data**	
	To know the present status of environment in the area, baseline data with respect to environmental components air, water, noise, soil, land and biology & biodiversity (flora & fauna), wildlife, socio-economic status etc. Should be collected with 10 km radius of the main components of the project site i.e. Dam site and power house site. The air quality and noise are to be monitored at such locations which are environmentally & ecologically more sensitive in the study area. The baseline studies should be collected for 3 seasons (Pre-Monsoon, Monsoon and Post Monsoon seasons). The study area should comprise of the following: • Catchment area up-to the dam site • Submergence Area Project area or the direct impact area should comprise of area falling within 10 km radius from the periphery of reservoir, land coming under submergence and area downstream of dam upto the point where Tail Race Tunnel (TRT) meets the river. • Downstream upto 10 km from tip of Tail Race Tunnel (TRT).	The Study area details are given in Section-3.2. The baseline data of various aspects has been covered in Sections 3.3 to 3.6 of Chapter-3.
4	**Details of the Methodology**	
	The methodology followed for collection of base line data along with details of number of samples and their locations in the map should be included. Study area should be demarcated properly'. On the appropriate scale map. Sampling sites should be depicted on map for each	The methodology for collecting the baseline data has been outlined in various Sections of Chapter-3. The Study area demarcation details are covered in Section-3.2. of Chapter-3.

S. No.	TOR Point	Compliance
	parameter with proper legends. For forest classification, Champion and Seth (1968) classification should be followed	
5	**Methodology for collection of Biodiversity Data**	
	The number of sampling locations should be adequate to get a reasonable idea of the diversity and other attributes of flora and fauna. The guiding principles should be the size of the study area (larger area should have larger number of sampling locations) and inherent diversity at the location, as known from secondary sources (e.g. eastern Himalayan and low altitude sites should have a larger number of sampling locations owing to higher diversity).	Covered in Section 3.4 of Chapter-3.
	The entire area should be divided in grids of 5km X 5km preferably on a GIS domain. There after 25% of the grids should be randomly selected for sampling of which half should be in the directly affected area (grids including project components such as reservoir, dam, powerhouse, tunnel, canal etc.) and the remaining in the rest of the area (areas of influence in 10 km radius for project components). At such chosen location, the size and number of sampling units (e.g. quadrats in case of flora/transects in case of fauna) must be decided by species area curves and the details of the same (graphs and cumulative number of species in a tabulated form) should be provided in the EIA report. Some of the grids on the edges may not be completely overlapping with the study area boundaries. However these should be counted and considered for selecting 25% of the grids. The number of grids to be surveyed may come out as a decimal number (i.e. it has an integral and a fractional part) which should be rounded to the next whole number.	Covered in Section 3.4 of Chapter-3.
	The conventional sampling is likely to	Covered in Section 3.4 Chapter-3.

S. No.	TOR Point	Compliance
	miss the presence of rare, endangered and threatened (R.E.T.) species since they often occur in low densities and in case of faunal species are usually secretive in behaviour. Reaching the conclusion about the absence of such species in the study area based on such methodology is misleading.	
	It is very important to document the status of such species owing to their high conservation value. Hence presence of such species should be ascertained from secondary sources by a proper literature survey for the said area including referring to field guides which are now available for many taxonomic groups in India. Even literature from studies/surveys in the larger landscapes which include the study area for the concerned project must be referred to since most species from adjoining catchments is likely to be present in the catchments in question. In fact such literature form the entire state can be referred to. Once a listing of possible R.E.T. species form the said area is developed, species specific methodologies should be adopted to ascertain their presence in the study area which would be far more conclusive as compared to the conventional sampling. If the need be, modern methods like camera trapping can be resorted to, particularly for areas in the eastern Himalayas and for secretive/nocturnal species. A detailed listing of the literature referred to, for developing lists of R.E.T. Species should be provided in the EIA reports.	Status of various floral and faunal species has been covered in Sections 3.4.1 and 3.4.2 of Chapter-3.
	R.E.T. species referred to in this point should include species listed in Schedule I and II of Wildlife (Protection) Act, 1972 and those listed in the red data books (BSI, ZSI and IUCN).	List of RET floral and faunal species is covered in Section 3.4 of Chapter-3.
6	**Components of the EIA Study**	
	Various aspects to be studied and provided in the EIA/EMP report are as	

S. No.	TOR Point	Compliance
	follows:	
	A. Physical and Chemical Environment Geological & Geophysical Aspects and Seismo - Tectonics	
	Physical geography, Topography, Regional Geological aspects and structure of the Catchment	Covered in Section 3.3 of Chapter-3.
	Tectonics, seismicity and history of past earthquakes in the area. A site specific study of the earthquake parameters will be done. The results of the site specific earthquake design shall be sent for approval of the NCSDP (National committee of Seismic Design Parameters, Central water commission, New Delhi for large dams.	The project lies in Seismic Zone-II as per Seismic Zoning Map of India. The details are given in Section 3.3.5 of Chapter-3.
	Landslide zone or area prone to landslide existing in the study area should be examined.	There are no landslide prone areas in the Study Area
	Presence of important economic mineral deposit, if any.	There are no mineral deposits in the project area and its surrounding area.
	Justification for location & execution of the project in relation to structural components (dam height).	Covered in Chapter 5
	Impact of project on geological environment	No impact on geological environment is anticipated due to the proposed project.
	Meteorology, Air and Noise:	
	Meteorology (viz. Temperature, Relative humidity, wind speed/direction etc.) to be collected from nearest IMO station.	Covered in Section 3.3.1 of Chapter-3.
	Ambient Air Quality with parameters viz. Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (RSPM) i.e. suspended particulate materials <10 microns, Sulphur Dioxide (SO_2) and Oxides of Nitrogen (NOx) in the study area at 6 locations.	Covered in Section 3.3.10 of Chapter-3
	Existing noise levels and traffic density in the study area at 6 locations.	Covered in Section 3.3.11 of Chapter-3
	Soil Characteristics:	
	• Soil classification, physical parameters(viz., texture, porosity, bulk density and water holding capacity)	Covered in Section 3.3.7 of Chapter-3.

S. No.	TOR Point	Compliance
	and chemical parameters (viz. pH, electrical conductivity, magnesium, calcium, total alkalinity, chlorides, sodium, potassium, organic carbon, available potassium, available phosphorus, SAR, nitrogen and salinity, etc.) (6 locations).	
	Remote sensing and GIS Studies	
	• Generation of thematic maps viz., slope map, drainage map, soil map, land use and land cover map, etc. Based on these, thematic maps, an erosion intensity map should be prepared	Covered in Figures 2.2, 3.6 to 3.14 of Chapter-3.
	Water Quality:	
	History of the ground water table fluctuation in the study area	Covered in Section 3.3.4 of Chapter-3.
	Water quality for both surface water and ground water for (i) Physical parameters (pH, temperature, electrical conductivity, TSS); (ii) Chemical parameters (Alkalinity, Hardness, BOD, COD, N02, P04, Cl, S04, Na, K, Ca, Mg, Silica, Oil & Grease, phenolic compounds, residual sodium carbonate); (iii) Bacteriological parameter (MPN, Total coliform) and (iv) Heavy Metals (Pb, As, Hg, Cd, Cr-6, total Cr, Cu, Zn, Fe) (6 locations).	Surface water quality is described in Section 3.3.9 of Chapter-3. Ground Water abstraction is not done in the project area.
	Delineation of sub and micro-watersheds, their locations and extent based on the All India Soil and Land Use Survey of India (AISLUS), Department of Agriculture, Government of India. Erosion levels in each micro-watershed and prioritization of micro-watershed through silt yield index (SYI) method of AISLUS.	Various measures are outlined in Section 7.2.4 of Chapter 7. An amount of Rs. 1774.15 lakh has been earmarked for implementation of Catchment Area Treatment Plan.
	Water Environment & Hydrology	
	Hydro-Meteorology of the project viz. precipitation (snowfall, rainfall), temperature, relative humidity, etc. Hydro-meteorological studies in the catchment area should be established along-with real time telemetry and data acquisition system for inflows monitoring.	Covered in Sections 3.3.1 and 3.3.8 of Chapter-3.
	Run off, discharge, water availability	Covered in Section 3.3.8 of Chapter-3

S. No.	TOR Point	Compliance
	for the project, sedimentation rate, etc.	
	Basin characteristics	Covered in Section 3.3.8 of Chapter-3
	Catastrophic events like cloud bursts and flash floods, if any, should be documented.	Catastrophic events like cloud bursts and flash floods, have not been recorded from the project area
	For estimation of Sedimentation Rate, direct sampling of river flow is to be done during the EIA study. The study should be conducted for minimum one year. Actual silt flow rate to be expressed in ha-m km^2 year-1.	Details are covered in Section 4.4 of Chapter-4
	Set up a G&D monitoring station and a few rain gauge stations in the catchment area for collecting data during the investigation.	Not Applicable
	Flow series, 10 daily with 90% 75% and 50% dependable years discharges.	Covered in Section 3.3.8 of Chapter-3
	Information on the 10-daily flow basis for the 90 per cent dependable year the flow intercepted at the dam, the flow diverted to the power house and the spill comprising the environmental flow and additional flow towards downstream of the dam for the project may be given	Covered in Section 3.3.8 of Chapter-3 Covered in Section 10.4 of Chapter-10
	The minimum environmental flow shall be 20% of the flow of four consecutive lean months of 90% dependable year, 30% of the average monsoon flow. The flow for remaining months shall be in between 20-30%, depending on the site specific requirements. A site specific study shall be carried out by an expert organization.	
	Hydrological studies/data as approved by CWC shall be utilized in the preparation of EINEMP report. Actual hydrological annual yield may also be given in the report.	Covered in Section 3.3.8 of Chapter-3.
	Sedimentation data available with CWC may be used to find out the loss in storage over the years.	Covered in Section 4.4 of Chapter-4
	A minimum of 1 km distance from the tip of the reservoir to the tail race tunnel should be maintained between upstream and downstream projects.	Covered in Section 4.6 of Chapter-4
	C Biological Environment	
	Besides primary studies, review of	

S. No.	TOR Point	Compliance
	secondary data/literature published for project area on flora & fauna including RET species shall be reported in EIA/EMP report	
	Flora:	
	Characterization of forest types (as per Champion and Seth method) in the study area and extent of each forest type as per the Forest Working Plan.	Covered in Section 3.4.1 of the Chapter-3.
	Documentation of all plant species i.e. Angiosperm, Gymnosperm, pteridophytes Bryophytes (all groups).	Covered in Tables 3.27, 3.28 and 3.29 under Section 3.4.1 and Table-3.30, 3.31 of Chapter-3
	General vegetation profile and floral diversity covering all groups of flora including lichens and orchids. A species wise list may be provided	Covered in Section 3.4.1 of Chapter-3
	Assessment of plant species with respect to dominance, density, frequency, abundance, diversity index, similarity index, importance value index (IVI) , Shannon Weiner index etc. of the species to be provided. Methodology used for calculating various diversity indices along with details of locations of quadrates, size of quadrates etc. to be reported within the study area in different ecosystems.	Covered in Section 3.4.1 of the Chapter-3
	Existence of National park, Sanctuary, Biosphere Reserve etc. in the study area, if any, should be detailed	Covered in Section 4.10.1.4.
	Economically important species like medicinal plants, timber, fuel wood etc.	Covered in Table 3.33 of Chapter-3.
	Details of endemic species found in the project area.	Covered in Section 3.4.1 of Chapter-3.
	Flora under RET categories should be documented using International Union for the Conservation of Nature and Natural Resources (IUCN) criteria and Botanical Survey of India's Red Data list along-with economic significance. Species diversity curve for RET species should be given.	Covered in Section 3.4.1 of Chapter-3.
	Cropping pattern and Horticultural Practices in the study area	Covered in Section 3.6 of Chapter-3
	Fauna	
	Fauna study and inventorisation should be carried out for all groups of animals in the study area. Their present status along with Schedule of the species.	Covered in Section 3.4.2 of Chapter-3.

S. No.	TOR Point	Compliance
	Documentation of fauna plankton (phyto and zooplankton), periphyton, benthos and fish should be done and analysed.	Documented in Tables 3.47 to 3.56 under Section 3.4.3 of Chapter-3.
	Information (authenticated) on Avi-fauna and wildlife in the study area	Covered in Section 3.4.2 of Chapter-3.
	Status of avifauna their resident/ migratory/ passage migrants etc.	Status of Avi-fauna has been covered in Tables 3.37 to 3.39 of Chapter-3
	Documentation of butterflies, if any, found in the area.	Covered in Tables 3.43 to 3.45 of Chapter-3
	Details of endemic species found in the project area.	Covered in Section 3.4.2 of Chapter-3
	RET species-voucher specimens should be collected along-with GPS readings to facilitate rehabilitation. RET faunal species to be classified as per IUCN Red Data list and as per different schedule of Indian Wildlife (Protection) Act, 1972.	Covered in Section 3.4.2 of Chapter-3
	Existence of barriers and corridors, if any, for wild animals.	Existence of barriers and corridors is not reported in the project area
	Compensatory afforestation to compensate the green belt area that will be removed, if any, as part of the proposed project development and loss of biodiversity.	Covered in Section 4.9.1.2 of Chapter-4.
	Collection of primary data on agricultural activity, crop and their productivity and irrigation facilities components.	Not Applicable
	D. Aquatic Ecology	
	Documentation of aquatic fauna like macro-invertebrates, zooplankton, phytoplantktons, benthos etc.	Covered in Section 3.4.3 of Chapter-3.
	Fish and fisheries, their migration and breeding grounds.	Covered in Section 3.4.3 of Chapter-3.
	Fish diversity composition and maximum length & weight of the measured populations to be studied for estimation of environmental flow.	Covered in Section 3.4.3 of Chapter-3.
	Conservation status of aquatic fauna.	Covered in Section 3.4.3 of Chapter-3.
	Sampling for aquatic ecology and fisheries and fisheries must be conducted during three seasons - Pre-monsoon (summer), monsoon and winter. Sizes (length & weight) of important fish species need to be	Covered in Section 3.4.3 of Chapter-3.

S. No.	TOR Point	Compliance
	collected and breeding and feeding grounds should also be identified along the project site or in vicinity.	
	E Socio-Economic	
	Collection of baseline data on human settlements, health status of the community and existing infrastructure facilities for social welfare including sources of livelihood, job opportunities and safety and security of workers and surroundings population	Covered in Section 3.5 of Chapter-3.
	Collection of information with respect to social awareness about the developmental activity in the area and social welfare measures existing and proposed by project proponent	Not Applicable
	Collection of information on sensitive habitat of historical, cultural and religious and ecological importance	Mukurthi National Park was established in the year 2001 in the Nilgiris Districts and covers an area of 7,846 ha. It is located in Tamil Nadu, India, is part of the Nilgiri Biosphere Reserve. The Upper Dam site and Lower Dam Site are located about 11.4 and 4.78 km respectively from the boundary Mukurthi National Park. The map showing location of Upper and Lower Reservoirs, w.r.t Mukurthi National Park is enclosed as Figure-4.4 of Chapter-4.
	The socio-economic survey/ profile within 10 km of the study area for demographic profile; Economic Structure; Developmental Profile; Agricultural Practices; Infrastructure, education facilities; health and sanitation facilities; available communication network, etc.	Covered in Section 3.5 of Chapter-3.
	Documentation of demographic, Ethnographic, Economic Structure and development profile of the area	Covered in Section 3.5 of Chapter-3.
	Information on Agricultural Practices, Cultural and aesthetic sites, Infrastructure facilities etc.	Covered in Section 3.6 of Chapter-3.
	Information on the dependence of the local people on minor forest produce and their cattle grazing rights in the forest land	

S. No.	TOR Point	Compliance
	List of all the Project Affected Families with their name, age, educational qualification, family size, sex, religion, caste, sources of income, land & house holdings, other properties, occupation, source of income, house/land to be acquired for the project and house/land left with the family, any other property, possession of cattle, type of house etc.	Covered in Section 7.3 of Chapter-7. List of PAFs is included in the Land Plan Schedule
	Special attention has to be given to vulnerable groups like women, aged persons etc. and to any ethnic/indigenous groups that are getting affected by the project.	Covered in Section 7.3 of Chapter-7.
7	**Impact Prediction and Mitigation Measures**	
	The adverse impact due to the proposed project should be assessed and effective mitigation steps to abate these impacts should be described.	Covered in Chapter-4.
	Air Environment:	
	Changes in ambient and ground level concentrations due to total emissions from point, line and area sources.	Covered in Section 4.7 of Chapter 4.
	Effect on soil, material, vegetation and human health.	Covered in Section 4.7 of Chapter 4.
	Impact of emissions from DG set used for power during the construction, if any, on air environment.	Covered in Section 4.7 of Chapter 4.
	Pollution due to fuel combustion in equipment and vehicles.	Covered in Section 4.7 of Chapter 4.
	Fugitive emissions from various sources.	Covered in Section 4.7 of Chapter 4.
	Water Environment:	
	Changes in surface and ground water quality	Covered in Section 4.3 of Chapter 4.
	Steps to develop pisci-culture and recreational facilities.	Covered in Section 4.3 of Chapter 4.
	Changes in hydraulic regime and downstream flow	Covered in Section 4.5 of Chapter 4.
	Water pollution due to disposal of sewage.	Covered in Section 4.3 of Chapter 4.
	Water pollution from labour colonies/ camps and washing equipment.	Covered in Section 4.3 of Chapter 4.
	Land Environment:	
	Adverse impact on land stability,	Covered in Section 4.2 of Chapter 4

S. No.	TOR Point	Compliance
	catchment of soil erosion, reservoir sedimentation and spring flow (if any) (a) due to considerable road construction I widening activity (b) interference of reservoir with the inflowing stream (c) blasting for commissioning of HRT, TRT and some other structures.	
	Changes in land use / land cover and drainage pattern.	Covered in Section 4.2.1.5 of Chapter 4
	Immigration of labour population.	Covered in Section 4.2, 4.3, 4.10, 4.13 and 4.14 of Chapter 4
	Quarrying operation and muck disposal.	Covered in Section 4.2.1.2 and 4.2.1.3 of Chapter 4
	Changes in land quality including effects of waste disposal.	Covered in Section 4.2.1.5 of Chapter 4
	River bank and their stability.	No impact envisaged.
	Impact due to submergence.	Covered in Sections 4.2.1.1, 4.2.1.5 4.8, 4.10 and 4.12 of Chapter 4
	Biological Environment:	
	Impact on forests, flora, fauna including wildlife, migratory avi-fauna, rare and endangered species, medicinal plants etc.	Covered in Section 4.9 of Chapter 4
	Pressure on existing natural resources.	Covered in Section 4.9 of Chapter 4
	Deforestation and disturbance to wildlife, habitat fragmentation and wild animal's migratory corridors.	Covered in Section 4.9 of Chapter 4
	Compensatory afforestation-identification of suitable native tree species for compensatory afforestation and green belt	Covered in Section 4.9.1.2 of Chapter 4
	Impact on fish migration and habitat degradation due to decreased flow of water.	Covered in Section 4.12 of Chapter 4
	Impact on breeding and nesting grounds of animals and fish.	Covered in Section 4.12 of Chapter 4
	Socio-Economic Aspects:	
	Impact on local community including demographic profile	Covered in Section 4.14 of Chapter-4.
	Impact on socio-economic status.	Covered in Section 4.14 of Chapter-4.
	Impact on economic status.	Covered in Section 4.14 of Chapter-4.
	Impact on human health due to water/ vector borne disease.	Covered in Section 4.14 of Chapter-4.
	Impact on increased traffic.	Covered in Sections 4.7.1.5 and 4.8 of Chapter-4.
	Impact on Holy Places and Tourism	There are no major historical or religious places around the project

S. No.	TOR Point	Compliance
		area.
	Impacts of blasting activity during project construction which generally destabilize the land mass and leads to landslides, damage to properties and drying up of natural springs and cause noise population will be studies. Proper record shall be maintained of the baseline information in the post project period.	Covered in Section 4.7.1.4 of Chapter-4.
	Positive and negative impacts likely to be accrued due to the project are listed.	Covered in various Sections of Chapter-4.
8	**Environmental Management Plans:**	
	1. Catchment Area Treatment (CAT) Plan should be prepared micro-watershed wise. Identification of free draining/ directly draining catchment based upon Remote Sensing and Geographical Information System (GIS) methodology and Sediment Yield Index (SYI) method of AISLUS, Deptt. of Agriculture, Govt. of India coupled with ground survey. Areas or watersheds falling under 'very severe' and 'severe' erosion categories should be provided and required to be treated. Both biological as well as engineering measures should be proposed in consultation with State Forest Department for areas requiring treatment. Year-wise schedule of work and monetary allocation should be provided. Mitigation measures to check shifting cultivation in the catchment area with provision for alternative and better agricultural practices should be included.	Covered in Section 7.2 of Chapter-7
	2. Compensatory Afforestation shall be prepared by the State Forest Department in lieu of the forest land proposed to be diverted for construction of the project as per the Forest (Conservation) Act, 1980. Choice of plants for afforestation should include native and RET species, if any. This will be a part of the forest clearance proposal.	Covered in Section 4.9.1.2 of Chapter-4.
	3. Biodiversity and Wildlife	Covered in Section 4.9.1.2 (B) and

S. No.	TOR Point	Compliance
	Conservation and Management Plan for the conservation and preservation of rare, endangered or endemic floral/faunal species or some National Park/Sanctuary/ Biosphere Reserve or other protected area is going. To get affected directly or indirectly by construction of the project, then suitable conservation measures should be prepared in consultation with the State Forest Department and with the physical and financial details. Suitable conservation techniques (in-situ/ex-situ) will be proposed under the plan and the areas where such conservation is proposed will be marked on a project layout map.	Wildlife Protection Plan is covered in Section 4.10.1.2 (A) of Chapter-4
	4. Fisheries Conservation and Management Plan - a specific fisheries management measures should be prepared for river and reservoir. If the construction of fish ladder/ fish-way etc. is not feasible then measures for reservoir fisheries will be proposed. The plan will detail out the number of hatcheries, nurseries, rearing ponds etc. proposed under the plan with proper drawings. If any migratory fish species is getting affected then the migratory routes, time/season of upstream and downstream migration, spawning grounds etc. will be discussed in details.	Covered in Section 4.12 of Chapter-4
	5. Resettlement and Rehabilitation Plan needed to be prepared on the basis of findings of the socio-economic survey coupled with the outcome of public consultation held. The R&R package shall be prepared after consultation with the representatives of the project affected families and the State Government. Detailed budgetary estimates are to be provided. Resettlements site should be identified. The plan will also incorporate community development strategies. R&R Plan is to be formulated as per	Covered in Section 7.3 of Chapter-7.

S. No.	TOR Point	Compliance
	new Act, 2013 which came into force w.e.t 1.1.2014. Plan will also incorporate community development strategies. Project Proponent will perform skill mapping for the services required 'for construction, operation & maintenance of the project based on the estimated workforce. In order to employ local population, the eligible persons amongst the local population should be trained to acquire skills required during the investigation, construction, operation & maintenance of the project and such an empowerment project for local populations should be part of and included in R&R Plan. Suitable Provisions for health care services should be incorporated in R&R Plan	
	6. Green Belt Development Plan along the periphery of the reservoir, approach roads around the colonies and other project components, local plant species must be suggested with physical and financial details. A layout map showing the proposed sites for developing the green belt should be prepared.	Covered in Section 10.6 of Chapter-10.
	7. Reservoir Rim Treatment Plan for stabilization of land slide/land slip zones, if any, around the reservoir periphery is to be prepared based on detailed survey of geology of the reservoir rim area. Suitable engineering and biological measures for treatment of identified slip zones to be suggested with physical and financial schedule. Layout map showing the landslide/landslip zones shall be prepared and appended in the chapter.	No need of Reservoir Rim Treatment
	8. Muck Disposal Plan suitable sites for dumping of excavated materials should be identified in consultation with State Pollution Control Board and State Forest Department. All muck disposal sites should be minimum 30 m away from the HFL of river. The quantity of muck	Covered in Section 4.2.1.3 of Chapter-4.

S. No.	TOR Point	Compliance
	to be generated and the quantity of muck proposed to be utilized shall be calculated in consultation with the project authorities. Details of each dumping site viz. area, capacity, total quantity of muck that can be dumped etc. should be worked out and discussed in the plan. Plan for rehabilitation of muck disposal sites should also be given. The• L-section/cross section of muck disposal sites and approach roads should be given. The plan shall have physical and financial details of the measures proposed. Layout map showing the dumping sites vis-a-vis other project components will be prepared and appended in the chapter.	
	9. Restoration Plan for Quarry Sites and landscaping of colony areas, working areas, roads etc. Details of the coarse/fine aggregate/clay etc. required for construction of the project and the rock/clay quarries/river shoal sites identified for the project should be discussed along-with the Engineering and Biological measures proposed for their restoration with physical and financial details. Layout map showing quarry sites vis-a-vis other project components, should be prepared.	Since no quarry site is envisaged for this project, the muck generated from excavation will be used for all purposed for Project construction. Thus, Restoration Plan for Quarry Sites has not been suggested.
	10. Study of Design Earthquake Parameters: A site specific study of earthquake parameters should be done. Results of the site specific earthquake design parameters should be approved by National Committee of Seismic Design Parameters, Central Water Commission (NCSDP}, New Delhi.	Sillahalla Pumped Storage Project area falls under seismic zone-II as per Seismic Zonation Map of India, which is enclosed as Figure-3.8 in Chapter-3.
	11. Dam Break Analysis and Disaster Management Plan The outputs of dam break model should be illustrated with appropriate graphs and maps clearly bringing out the impact of Dam Break scenario. To identify inundation areas, population and structures likely to be affected due to	Covered in Section 10.5 of Chapter-10

S. No.	TOR Point	Compliance
	catastrophic floods in the event of dam failure. DMP will be prepared with the help of Dam Break Analysis. Maximum water level that would be attained at various points on the downstream in case of dam break will be marked on a detailed contour map of the downstream area, to show the extent of inundation. The action plan will include Emergency Action and Management plan including measures like preventive action notification, warning procedure and action plan for co-ordination with various authorities.	
	12. Water, Air and Noise Management Plans to be implemented during construction and post-construction periods.	Covered in Sections 4.3, 4.7 and 4.8 respectively of Chapter-4
	13. Public Health Delivery Plan including the provisions of drinking water supply for local population shall be in the EIA/EMP Report. Status of the existing medical facilities in the project area shall be discussed. Possibilities of strengthening of existing medical facilities, construction of new medical infrastructure etc. will be explored after assessing the need of the labour force and local populace.	Covered in Section 4.13 of Chapter-4.
	14. Labour Management Plan for their Health and Safety	Covered in Sections 10.9 to 10.14 of Chapter-10.
	15. Sanitation and Solid waste management plan for domestic waste from colonies and labour camps etc.	Covered in Sections 4.2.1.6 and 4.3.1.1 of Chapter-4.
	16. Local Area Development Plan to be formulated in consultation with the Revenue Officials and Village Pancahayats. Appropriate schemes shall be prepared under EMP for the Local Area Development Plan with sufficient financial provisions.	Covered in Section 7.4 of Chapter-7.
	17. Environmental safeguards during construction activities including Road Construction.	Covered in Section 4.2.1.4 of Chapter-4.
	18. Energy Conservation Measures for the work force during construction with physical and financial details. Alternatives will be proposed for the labour force so that the exploitation of	Covered in Section 10.2 of Chapter-10.

S. No.	TOR Point	Compliance
	the natural resource (wood) for the domestic and commercial use is curbed.	
	19. Environmental Monitoring Programme to monitor the migratory measures implemented at the project site is required will be prepared. Provision for Environment Management Cell should be made. The plan will spell out the aspects required to be monitored, monitoring indicators/parameters with respect to each aspect and the agency responsible for the monitoring of that particular aspect throughout the project implementation.	Covered in various sections of Chapter-6.
	20. A summary of Cost Estimates for all the plans, cost for implementing all the Environmental Management Plans.	Covered in Section 10.18 of Chapter-10.

Annexure-II

Annexure-II: Compliance of Additional ToR issued by MoEF&CC for Sillahalla PSHEP Stage-I

S. No.	Additional ToR MoEF&CC	Compliance
1.	Land acquired for the project shall be suitably compensated in accordance with the law of the land with the prevailing guidelines. Private land shall be acquired as per provisions of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013, if any.	Compensation has been provided as per the guidelines of Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013
2.	The project involves diversion of 123.3 ha of forestland. Forest clearance shall be obtained as per the prevailing norms of Forest (Conservation) Act, 1980.	As per LPS, detailed break up of land has been firmed up. Accordingly 8.912 ha of forest land falls under project area. On the approval of LPS the forest clearance will be obtained.
3.	Application to obtain prior approval of Central Government under the Forest (Conservation) Act, 1980 for diversion of forest land required should be submitted as soon as the actual extent of forest land required for the project is known, and in any case, within six months of issuance of this letter.	Please refer compliance for Additional ToR point no (2).
4.	Fund allocation for Corporate Environment Responsibility (CER) shall be made as per Ministry's O.M. No. 22-65/2017-IA.III dated 1st May, 2018 for various activities therein. The details of fund allocation and activities for CER shall be incorporated in EIA/EMP report.	As per Revised notification of CER OM No. 22-65/2017-IA.III dated 30.09.2020, it was mentioned that concerns raised during public hearing shall be addressed. However, LADP has been recommended for proposed project.
5.	Mukurthi National Park and the Mudumalai-mukurthi Tiger corridor are present the distance of 3.49 Km and 4.18 Km, respectively from the project boundary. Therefore, NBWL clearance shall be obtained, if the project site is	Mukurthi National Park and the Mudumalai-mukurthi Tiger corridor are present at a distance of appox. 10 Km and appox.17 Km, respectively from the project boundary.

S. No.	Additional ToR MoEF&CC	Compliance
	falling inside the notified ESZ (Ministry OM dated 08th August, 2019).	However, as per the draft notification, Sillahalla does not falls under ESZ.
6.	A detailed Map regarding distance of the project boundary from the nearest wildlife, sanctuary, duly authenticated by the Chief Wildlife Warden shall be submitted with EIA/EMP report.	The map showing the distance of Mukurthi National Park and the Mudumalai-mukurthi Tiger from Sillahalla project site is enclosed as Annexure-I for kind perusal. After TNGECL observation the same will be submitted to office of Chief Wildlife Warden for authentication.
7.	Impact of the proposed project on the nearest Wildlife sanctuary shall be studied and proper conservation plan/mitigation measures shall be included in EIA/EMP report.	Shall be included in final CEIA/EMP study report after public hearing.
8.	Conservation plan for the Scheduled I species, if any, in the project study area shall be prepared and submitted to the Competent Authority for approval.	Shall be included in final CEIA/EMP study report after public hearing.
9.	Pre-DPR Chapters viz., Hydrology and Layout Map and Power Potential Studies duly approved by CWC/CEA shall be submitted.	Noted
10.	Environmental Cost benefit analysis shall be done.	Shall be included once Forest application is submitted
11.	Environment matrix during construction/operational phase needs to be submitted.	Shall be included in final CEIA/EMP study report after public hearing.
12.	Environmental Management Plan with budget breakup (Capital as well as recurring) shall be submitted.	Shall be included in final CEIA/EMP study report after public hearing.
13.	Secondary data may also be collected on flora, fauna, aquatic life, etc. from the local sources of the area and may also form part of the modified EIA/EMP report.	Complied
14.	Once the draft Western Ghat Eco-sensitive (WGE) Area Notification is approved by the Competent Authority, necessary	Western Ghat Eco-sensitive (WGE) is in Draft Stage.

S. No.	Additional ToR MoEF&CC	Compliance
	conservation measures shall be taken up in the area that is failing within WGE area in consultation with the Ministry by duly incorporating all the environmental parameters.	
15.	As the Western Ghat ESA Notification is not yet finalized, application for prior clearance from the Standing Committee of the National Board of Wildlife shall be submitted.	Western Ghat Eco-sensitive (WGE) is in Draft Stage.
16.	A cumulative study which assess the impact of each project on the flow pattern of the rivers and forest and biodiversity loss.	-
17.	The consultant engaged for preparation of EIA/EMP report has to be registered with Quality Council of India (QCI/NABET) under the scheme of Accreditation & Registration of MoEF &CC. this is a pre-requisite.	WAPCOS is a NABET accredited organization
18.	Consultant shall include a “Certificate” in EIA/EMP report regarding portion of EIA/EMP prepared by them and data provided by other organization(s)/laboratories including status of approval of such laboratories. Declaration by the Consultant that information submitted in the EIA/EMP is factually correct and shall be submitted along with EIA/EMP reports.	Shall be included in final CEIA/EMP study report after public hearing.
19.	An undertaking as part of the EIA report from Project proponent, owning the contents (information and data) of the EIA report with the declaration about the contents of the EIA report pertaining to a project have not been copied from other EIA reports.	Shall be included in final CEIA/EMP study report after public hearing.
20.	Consolidated EIA/EMP report is to be submitted as per the generic structure (Appendix III & IIIA) given in the EIA	EIA Report has been prepared as per Generic Format only.

S. No.	Additional ToR MoEF&CC	Compliance
	Notification, 2006.	
21.	The draft EIA/EMP report prepared as per the Generic Structure (Appendix III of EIA Notification, 2006) incorporating information as per the Standard ToR, should be submitted to the State Pollution Control Board concerned for conducting Public Consultation, district wise, as per the provisions stipulated in EIA Notification, 2006. Public Hearing, which is part of Public Consultation, shall be held district wise at the site or in its close proximity as prescribed in Appendix (IV) of EIA Notification, 2006. The draft EIA/EMP report is to be submitted to SPCB sufficient before the expiry of the ToR validity so that necessary amendments in EIA/EMP can be undertaken based on public hearing and the same is to be submitted to MoEF&CC before expiry of validity.	Noted
22.	All the tasks including conducting public hearing shall be done as per the provisions for EIA Notification, 2006 and as amended from time to time. Public hearing issues raised and compliance of the same shall be incorporated in the EIA/EMP report in the relevant chapter. Final EIA/EMP report should be submitted to the Ministry for Environmental Clearance only after incorporating these issues, before the expiry of validity of ToR.	Shall be included in final CEIA/EMP study report after public hearing.
23.	As per Ministry's Notification 17.02.2020, the ToR will remain valid for a period of 5 years from the date of issue of this letter for submission of EIA/EMP report along with public consultation. The ToR will stand lapsed after completion of 5 years in case final EIA/EMP is not submitted.	Noted
24.	Baseline data and public consultation shall not be older than 3 years, at the time of	Noted

S. No.	Additional ToR MoEF&CC	Compliance
	submission of the proposal, for grant of Environmental Clearance.	
25.	In case of any change in the scope of the project such as capacity enhancement, change in submergence, etc. fresh scoping clearance has to be obtained.	Noted
26.	Details of the name and number of posts to be engaged by the project proponent for implementation and monitoring of environmental parameters be specified in the EIA report.	Incorporated in Chapter 10.
27.	The EIA/EMP report must contain an Index details of compliance of all ToR conditions. The Index will comprise of page No. etc., vide which compliance of a specific ToR is available. It may be noted that without this index, EIA/EMP report will not be accepted.	Noted
28.	The PP should complete all tasks as per the provisions of EIA Notifications, 2006 and as amended time to time) and submit the application for final clearance within the stipulated time.	Noted
29.	Point wise reply to the representations (enclosed) received by them from the Ecologist, Scientist, NGOs of Nilgiris on the proposed project shall be submitted.	Provided as Annexure III

Annexure-III

Annexure-III: Reply to representations received by them from the Ecologist, Scientist, NGOs of Nilgiris on the proposed project

S.No.	Representation	Reply
1.	An estimated 10,000 people will be directly affected with the new dams being constructed with the submergence of more than 315 ha.	The submergence area of land for Upper and lower reservoir are 135 ha and 35 ha respectively. The type of land under submergence are Forest land, private land, Govt land, etc. No villages/buildings/ structures will get submerged. The water conductor system and power house are located under ground. Hence, eviction of people in the project area does not arise.
	Kundah and Sillahalla Pumped Storage Hydro Electric Projects are being pushed through without the mandatory environmental assessment and public hearing which is illegal.	For Kundah Pumped Storage Hydro Electric Project, public hearing was conducted on 12.04.2007 prior to obtaining Environmental Clearance during 2007. In the case of Sillahalla PSHEP, on issue of ToR, Environmental Impact Assessment study is being carried out. Public Hearing will also be conducted and submitted to EAC while applying for final Environmental Clearance.
2.	Due to construction of two additional dams, there will be further reduction of water entering the river, which will affect the downstream wild life.	This project is pumped storage project. The total capacity of new dams proposed is only 1375 Mcft (Pondage at FRL - 27.836 + 11.127 = 38.963 Mm^3). The reservoirs are to be filled up once during the monsoon season and thereafter the water will be recycled between the upper and lower reservoir. (i.e.) The water will be let out from upper reservoir to lower reservoir during generation mode. The same water will be pumped back to the upper reservoir from the lower reservoir during pumping mode. After one time filling the water received from the catchment area will be let into the river course only. However, minimum Environmental Flows will be maintained downstream of the reservoirs. The contention that there will be further reduction of water entering the river is not correct.

S.No.	Representation	Reply
3.	Diversion of water from catchments and changing the course of water flow will escalate the ecological and hydrological impacts in the 1000 hectare of forests downstream.	The annual yield of Sillahalla river is 1127.47 Mcft (31.92Mm^3). The requirement of water for pumped storage operation is 230Mcft (6.51Mm^3), which is 20.4% of annual yield. This quantum is a onetime requirement. Hence, the contention that the ecological and hydrological impacts in 1000 hectare will be escalated with reduced water flow is not correct.
4.	Extreme weather events – Like floods in 2019 & landslides. Large infrastructure projects are not to be taken up.	The Centre line of dams, the alignment of water conductor system and power house location will be finalised after carrying out detailed explorations, drift etc. and in consultation with GSI.
5.	Loss of wetlands and endemic plant species due to construction of dams and reservoirs.	The plantation in the submergence area of Upper & lower reservoirs are mostly wattle, tea plantations, Eucalyptus, etc. During EIA study the type of species available in the area are collected and conservative measures are proposed as may be required.
6.	Sillahalla stream is polluted due to water from carrot cleaning machines as well as sewage from Udagamandalam Town & other villages.	To control the silt entering the reservoirs, detailed catchment area treatment plan will, be implemented in the catchment area of Upper and Lower Reservoirs. Udagamadalam town is located 16 km d/s of Sillahalla Dam site. Hence, the question of entering sewage from Udhagamandalam Town does not arise. However all precautionary measures will be undertaken to protect the people from health hazard as per the guidelines of Public Health Department.
7.	Further arguments against the need for PSHEP: i) Latest technology battery back up cost will be lower. ii) Pumped storage would be net consumer of power. iii) Kadamparai PSHE Station is not being operated in pumped storage mode. iv) No pumped storage are required for Tamil Nadu.	Worldwide pumped storage is a proven and affordable technology for energy storage. Battery backup for large capacity of 1000MW will not be economical. As the renewable energy addition of solar and wind are increasing day by day, to store the infirm power and to convert the same into high value peak power pumped storage plants are required. Kadamparai pumped Storage PH is operated with pumping mode during day time to integrate Renewable Energy mainly Solar and

S.No.	Representation	Reply
		utilised in generator mode in peak hours when the solar power is zero. During wind season, whenever wind generation is more and frequency is high, the Kadamparai power house is being operated on pump mode with the cheapest cost. More pumped storage projects are required in Tamil Nadu to: ➢ Accommodate large scale RE power. ➢ Meet the peak load at the cheapest cost. ➢ Facilitate real time grid operation with safety and security. ➢ Meet any sudden short fall in RE generation. ➢ Meet the Hydro renewable Purchase Obligation (HPO). ➢ Ensure continuous power supply to the consumers with the optimum price.

Consultant :

WAPCOS LIMITED

(A Government of India Undertaking)
(Ministry of JAL SHAKTI)
76-C, Institutional Area, Sector – 18,
Gurugram – 120015, Haryana (INDIA)
Email id: dam@wapcos.co.in