WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED

(A Government of West Bengal Enterprise)

VOLUME- I: EIA REPORT

TURGA PUMPED STORAGE PROJECT

(Previously known as Purulia Pumped Storage Extension Project on Turga Nala)

(4 X 250 MW)

APRIL 2016

CONTENTS

CHAPTER-7 FLORAL ASPECTS

CHAPTER-8 FAUNAL ASPECTS

CHAPTER-9 AQUATIC ECOLOGY

CHAPTER-10 PREDICTION OF IMPACTS

LIST OF FIGURES

CHAPTER-1

INTRODUCTION

1.1 INTRODUCTION

The Turga Pumped Storage Project on Turganala is located in Purulia district of West Bengal. This is one of the four Pumped Storage Schemes initially identified by erstwhileWBSEB (now known as WBSEDCL). The Turga Pumped Storage Scheme envisages utilization of the waters of the river Turga in Ayodhya hills for peak power generation on a Pumped storage type development. The coordinates of Upper Dam site are 23°12’47”N and 86°04’20”E. Likewise, coordinates of the lower Dam site are 23°11’49’’N and 86°04’13”E. The project site is approachable by a jeepable road taking off from Balarampur – Baghmundi state highway. The nearest rail head is located at Barabhum and nearest airport is located at Ranchi. The project location map is enclosedas Figure-1.1.

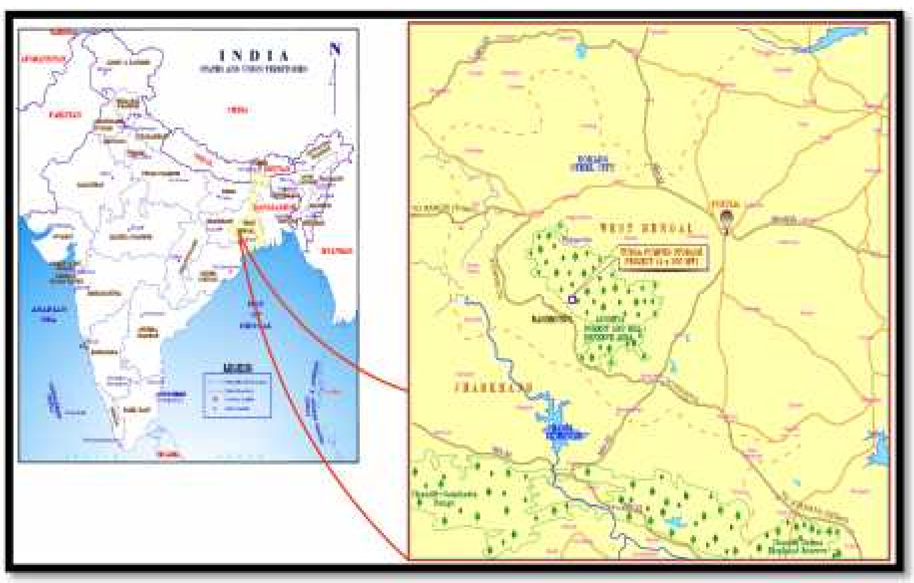


Figure-1.1 Project Location Map

1.2 PROJECT PROFILE

The Turga Pumped Storage Project envisages utilization of hydro potentiality of Ajodhya Plateau, an extension of Chhota Nagpur Plateau. The project envisages the construction of Upper Dam (C.A. 8.29 Sq. Km) across TurgaNala, a tributary of Subarnarekha river and a water conductor system with an underground Power House on the downstream of Upper Dam and a Lower Dam having intermediate catchment of 4.37 sq. km (total C.A. 12.66 sq. km).

The Project is a Close Loop type Pumped Storage Scheme. It comprises two reservoirs at two different levels (the difference of water levels of the reservoirs will represent the effective “head” of the Project) and water conductor system will connect the two reservoir through an underground power house. During peak hours power will be generated by depleting the water reserve of the upper reservoir which will pass through the waterway and the generator and turbines installed at the power house and will be stored in the Lower Reservoir. During off peak hours the excess power from thermal stations will be fed back to pump the water from Lower Reservoir to Upper reservoir through power house where generators and turbines will then act as motors and pumps respectively. The same cycle of operation will be repeated during peak and lean period.

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

1.3 NEED FOR THE PROJECT

According to 18th Electric Power Survey of India (“18th EPS”) and 12th & 13th National Electricity Plan (NEP), CEA estimates continuous large growth of required energy demand and peak load. Also, both in West Bengal State and all India, Compound Annual Growth Rate (CAGR) of peak load outweighs energy demand. These estimates indicate that actual difference between peak and off-peak load is widening. The importance and necessity of peak generating hydro power station to absorb the demand fluctuation, are increasing more than before. While conventional hydropower does have ability to accommodate such needs, each unit is relatively small and their generation depends on rainfalls and weather which are uncontrollable to human. On the other hand, Pumped Storage units have larger capacity and their operations are not interfered by uncontrollable natural factors. Therefore, it is obvious that implementation of Turga Pumped Storage Project will be beneficial to not only West Bengal, but also to Eastern Region

1.4 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The principal Environmental Regulatory Agency in India is the Ministry of Environment, Forests and Climate Change (MoEF&CC), and formulates environmental policies and accords environmental clearance for the projects. The State Pollution Control Board (SPCB) accords Consent to Establish and Operate for the project activity.

As per MoEF EIA Notification, dated 14th September 2006 (and amendments thereafter), under Activity 1(c) - River Valley projects; if, the capacity of power generation for any HEP will more than 50 MW, the project falls under Category A. Such projects mandatorily require a Comprehensive EIA study to be undertaken and Environmental Clearance to be obtained from MoEF&CC before the start of any construction activity.

The Turga Pumped Storage project falls under category "A" listed for Environment Clearance by MoEF as the proposed hydroelectric power generation capacity is 1000 MW.The Pre-Feasibility Report, Form-I including Terms of Reference (TOR) for the EIA study were submitted to MoEF&CC for approval by Expert Appraisal Committee for River Valley & Hydroelectric Projects of MoEF&CC, GoI.

The Environmental Clearance for pre-construction activitiesalong with approved TOR for CEIA Study was accorded by MoEF vide letter no J-12011/13/2013-IA-I, dated 04 November 2013. A copy of the same is enclosed as Annexure I.

1.5 OBJECTIVES OF THE EIA STUDY

The main objective of the study is to prepare the Environmental Impact Assessment Report and formulation of Environmental Management Plan for obtaining Environmental Clearance from the regulatory agencies. The study has been conducted to carry out Comprehensive Environmental Impact Assessment based on three season data covering the following:

- Assessment of the existing status of water, land, biological, climatic, socio-economic, health and cultural components of the environment.
- Identification of potential impact on various environmental components due to activities envisaged during pre-construction, construction and operational phases of the proposed Turga Pumped Storage Project.
- Prediction of significant impacts on the major environmental components using appropriate mathematical/simulation models wherever necessary.
- Preparation of environmental impact statement based on the identification, prediction and evaluation of impacts.

- Formulation of Environmental Management Plan (EMP) outlining preventive and curative strategies for minimizing adverse impacts during various phases of the project implementation along with the cost estimates for implementation of EMP.

1.6 CUMULATIVE IMAPCTS

There are no projects other than Turga Pumped Storage Project in Turga Basin. Hence, Cumulative Impact Assessment Study is not required.

1.7 OUTLINE OF THE REPORT

The document for the Comprehensive EIA study for the proposed Turga Pumped Storage Project has been presented in four volumes. The details are given as below:

- Volume-I presents the Environmental Impact Assessment (EIA) Study
- Volume-II covers the Social Impact Assessment (SIA) Study
- Volume-III outlines the Environmental Management Plan (EMP) Report.
- Volume-IV covers Public Hearing Proceeding Report

The present document (Volume-I) outlines the findings of the EIA study for the proposed Turga Pumped StorageProject.

The contents of the document are organized as follows:

Chapter-1 The Chapter gives an overview of the need for the project. The policy, legal and administrative framework for environmental clearance has been summarized. The objectives of the EIA study too have been presented in this Chapter.

Chapter-2 gives a brief description of the proposed Turga Pumped StorageProject.

Chapter-3 outlines the methodology adopted for conducting the Comprehensive EIA study for the proposed Turga Pumped StorageProject.

Chapter-4 summarizes the construction methodology proposed to be adopted for the proposed Turga Pumped Storage Project.

Chapter-5 covers the hydrological aspects of the proposed Turga Pumped Storage Project.

Chapter-6 covers the environmental baseline conditions covering physical aspects of environment. The baseline study involved both field work and review of existing documents, which is necessary for identification of data which may already have been collected for other purposes.

Chapter-7presents the information pertaining to floral aspects of environment. The study is based on collection of data from primary and various secondary data sources. As a part of the Comprehensive EIA study, detailed floral survey for was conducted for three seasons. The findings of the survey were analyzed and ecological characteristics of the study area have been described in this Chapter.

Chapter-8 outlines the faunal characteristics of the study area. The study is based on the findings of the primary and secondary data collection. The conservation status of various faunal species too have been presented in this chapter.

Chapter-9 delineates the details of aquatic ecological aspects of the Study Area. The information on fisheries in the project area too has been presented in this chapter.

Chapter-10 describes the anticipated positive and negative impacts as a result of the construction and operation of the proposed Turga Pumped Storage Project on physico-chemical and ecological aspects of environment. Prediction 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. But 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.

CHAPTER-2

PROJECT DESCRIPTION

2.1 INTRODUCTION

The Turga Pumped Storage Project is the second Pumped Storage scheme being taken-up by WBSEDCL amongst the four schemes identified in the Ajodhya Hills. The first project named Purulia Pumped Storage Project (4X225 MW) is already in operation since 2007.

The Turga Pumped Storage Project envisages utilization of hydro power potential of Ajodhya Plateau. The project envisages the construction of upper dam across Turga Nala for Upper Reservoir, a tributary of Subarnarekha river and a water conductor system with an underground Power House on the downstream of Upper dam and Lower Main and Saddle Dams for the lower Reservoir. The existing reservoir of Turga Irrigation Dam of I&W Directorate of Government of West Bengal has a storage capacity 1.973 Mcum between MWL 274.93 m and Dead storage level 262.74 m. At present, this scheme provides irrigation to irrigate 708 ha area. The total requirement of crop (Kharif & Rabi) is 458.238 ha.m. General layout of the Project is shown in Figure-2.1.

The present proposal is to increase the gross storage capacity to 18 MCM (Pondage at FRL) by constructing the Lower Main Dam just downstream of the existing Irrigation Dam and a Right Saddle Dam. The upper reservoir will have the gross storage capacity 21.6 MCM (Pondage at FRL). During peak hour, power will be generated by releasing the water from Upper Reservoir through the Water Conductor System to the Lower Reservoir. The water will be pumped back from Lower Reservoir to Upper Reservoir through the same Water Conductor System during off peak period. Accessibility of the site is enclosed as Figure-2.2. The quarry and dumping sites are shown in Figure-2.3

2.2 ALTERNATIVE STUDIES CARRIED OUT FOR VARIOUS MAJOR COMPONENTS OF THE PROJECT AND FINAL CHOICE

Optimum dam axis and dam type are selected based on geology and topography of the alternative sites. The Lower dam axis has been chosen as it offers the requisite storage possibilities. While choosing Upper dam axis besides geology and topography the length/head ratio was also one of the reasons.

The alignment of waterway is also very important aspect as it has impacts on the other project components such as power house, switchyard etc. Hence it has been chosen after necessary topographical and geological study of both banks of Turga nala. The course of Turga nala from upper dam to lower dam takes almost right angle turn near lower dam towards right bank in Westerly direction. As such only right bank offers the shortest length of Water conductor System. Power house site and orientation has been chosen based on the required rock cover and geology as per GSI recommendations.

Detailed reasons for layout selection are given in the following sections.

2.2.1 Lower Dam & Spillway

Lay out of the Lower Dam Axis has been considered straight in the East-West direction extending from Westerly point, N: 2565682.66m E: 403975.74m, at the Right Bank to Easterly point N: 2565619.01m, E: 404843.41m at the Left Bank.

From power potential study it was observed that to meet up the five (5) hourly peak generations of 1000 MW, nearly 14.2 MCM Live Storage is required. Accordingly, topography of the Turga nala upstream of the existing Turga Irrigation Dam was examined to find the suitable storage site. It is observed that the most suitable location for Lower Dam Axis which can provide the required Live Storage is the existing Turga Irrigation Dam Axis. Upstream of this location has suitable flat shape for adequate reservoir capacity. At other locations on further upstream of this axis location Turga nala flows in a very narrow valley and as such the topography of the nala does not offer any storage possibilities. Hence all the previous studies also chose the same site for Lower Dam Axis. Accordingly, considering the topography and geology of the existing Turga Irrigation Dam site is selected for proposed Lower Dam.

The Spillway for Lower Dam is Located near the right abutment on the original course of Turga nala. Considering the small design flood of 428 m^3/s, an un-gated ogee overflow Spillway has been considered.

Lay out of the Lower Saddle Dam Axis has been considered straight in the North -South direction extending from Southern point, N: 2565805.86m E: 403828.53m, at the Right Bank hillock of Turga nala to Northern point N: 2566349.70m, E: 403828.41 m near TRT outfall.

The saddle dam is required as the FRL of the Lower reservoir is 316.50 m where as at the saddle dam location the average bed level is EL 270m only. Hence this opening needs to be closed to create the lower reservoir.

An alternative of abutting the northern end of the saddle dam further d/s of the present saddle dam axis was also considered, primarily to increase the pondage of Lower reservoir and reducing the dam height. However, due to vicinity of private land (Palash garden) just d/s, the option was not considered and present saddle dam axis was chosen. The Rockfill with Clay core type has been chosen for the Lower Saddle Dam on cost consideration over Concrete dam because the main Lower dam is a concrete type dam which may increase the project cost further.

2.2.2 Upper Dam and Spillway

Lay out of the Upper Dam Axis has been considered straight in the East-West direction extending from Westerly point, N: 2567391.17m E: 404332.56m, at the Right Bank to Easterly point N: 2567415.10m, E: 405064.83m at the Left Bank.

As explained above the Lower Main Dam Axis was finalized first at the same location of the existing Irrigation Dam based on the topography. For finalizing the location of the Upper Dam Axis the following three alternative dam axes were studied. The various alternatives examined for this project are shown in Figure-2.4

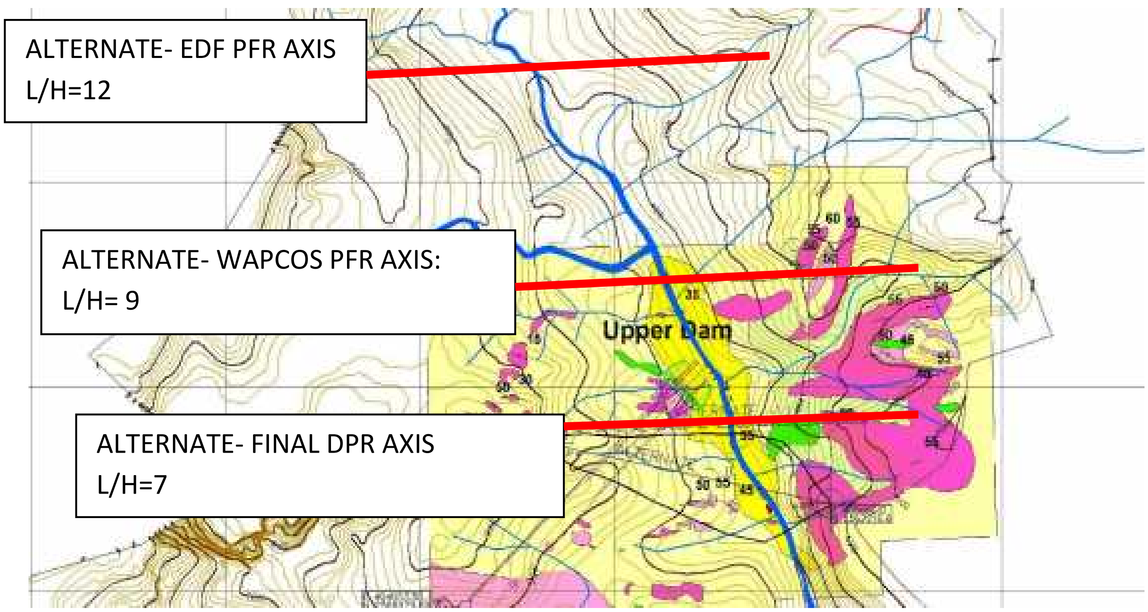


Figure-2.4: Layout showing alternatives for Upper Dam axis

The EDF PFR axis was the farthest from the Lower dam with Length/Head ratio is about 12 which is prohibitive for any Pumped Storage Project. Hence this alternative was not preferred in the present studies. The WAPCOS PFR axis was in the d/s of the EDF axis with slightly better L/H ratio of 9. However, this is still considered on higher side. The third alternative considered about 500m d/s of WAPCOS PFR axis , during the first visit of the Interdisciplinary team of experts in December 2012 with L/H=7.

Subsequently, GSI carried out the mapping and prepared the report on the third alternative location. Later on, GSI suggested that dam axis at right bank may be kept same but the left bank location may be further shifted by another 50-60m d/s to avoid deep nalas (from striking the dam body) on left bank. On examination it was felt that the right bank location of the third alternative location is same and is suitable. The left bank at the first location at which the GSI report has been prepared may not be suitable as a Nala is present there. About 50-60m d/s location in the Left Bank appears to be better alternative.

After consideration of all geological features and site topography GSI, Engineering Geology Division, Eastern Region agreed to shift the left abutment of the 3rd Alternative Location to about 50-60 m downstream to avoid the Nala crossing from striking the dam body. The Spillway for Upper Dam is Located near the left abutment on the original course of Turga nala. Considering the small design flood of 280 m^3/s, an un-gated ogee overflow Spillway has been considered.

2.2.3 Waterway & Powerhouse

The waterway is arranged at the right bank of the Turga nala in order to avoid the waterway to pass below the Turga nala. In order to avoid surge tank in both the HRT and TRT, the Powerhouse is placed almost at the halfway of the waterway to restrict the length of Headrace and Tailrace tunnel.

As for the hydraulic design of the intake and outlet, they are designed as per the guidelines originated in research by Central Research Institute of Electric Power Industry in Japan. The existing PPSP, which is successfully running since 2007 was designed in the similar manner as because the characteristics of Pumped Storage Power Plant are not clearly stipulated in any Indian Standard Code.

As for the Headrace and Penstock, the entire length is lined by steel liner to bear rise of internal water pressure and to prevent bedrock around the Headrace, whose thickness is relatively thin, from being fractured in case of sudden shut-off of power generation without surge chamber, and consequently, it is avoidable that water leaking from the waterway spouts out of the ground.

As for the Tailrace, the entire length is lined by reinforced concrete even though the Draft Tunnel from the end of the Draft Tube Liner to the junction of the branches is steel-lined.

The Powerhouse is horizontally set in the area as recommended by GSI from the geological viewpoint, The cavern is disposed in accordance with the GSI’s advice and to be placed in the direction in consideration of prospective initial ground stress.

On the other hand, as for the vertical arrangement, the Powerhouse is arranged in conformity with the GSI's counsel that rock cover on the powerhouse cavern is over twice of the height of the cavern plus some allowance.

The shape of the powerhouse cavern is designed as bullet type with slightly enlarged at the upper part as is the case with PPSP, and dimension of the cavern comes to 25.0 m in width, 53.0 m in height (For 4 nos. of Fixed Speed Machine) and 160.0 m in length as a result of design for electro-mechanical equipment. As per recommendations of GSI 26 m-wide cavern is feasible providing that proper supporting system is placed judging from the geological condition. Although geological survey in the drift is in progress geological condition of the bedrock at the Powerhouse cavern location is considerably good judging from results of boring and is expected to be practicable to construct such cavern.

2.2.4 Switchyard

The Switchyard is placed aboveground at the southeast of the Underground Powerhouse location in light of shortening of transmission line between the Switchyard and proposed new PPSP 400 kV substation where electricity produced by Turga Pumped Storage Project is planned to be transmitted. For that reason the new substation is planned to be constructed near PPSP's township which is located at the southeast of the Powerhouse.

Concerning method of insulation, Gas Insulated Switchgear (GIS) is adopted, and GIS is housed in the GIS Building in the Switchyard as is the case with PPSP. In addition to the GIS Building, the Switchyard Building housing diesel generator, receiving power cubicle, etc., are also arranged in the Switchyard.

The selected project layout is enclosed as Map-2.1.

2.3 SALIENT FEATURES

The salient features of Turga Pumped Storage Project are given in Table-2.1.

Table-2.1: Salient Features of Turga Pumped Storage Scheme

1. LOCATION	
Country **State** **District**	India West Bengal Purulia
River	Turga Nala a tributary of Subarnarekha River
Dam Axis (Upper)	Left Bank Latitude $23^0$12' 47.2" & Longitude 86^0 04' 19.9" E 405064.831 , N 2567415.095(UTM) Right Bank Latitude $23^0$12' 46.2" & Longitude 86^0 03'54.16" E 404332.556 , N 2567391.165(UTM)
Dam Axis (Lower)	Left Bank Latitude $23^0$11' 48.8'' & Longitude 86^0 04' 12.5" E 404843.406 , N 2565619.006(UTM) Right Bank Latitude $23^0$11' 50.7'' & Longitude 86^0 03' 41.9"

	E 403973.742 , N 2565682.666(UTM)
Access to the Project	
Road	i) Kolkata to Chandil along NH 33 via Jamshedpur 380km ii) Chandil to Balrampur along NH 32 30km iii) Balrampur to Patherdhi along State-Highway 30km iv) Patherdhi to Project Site (Upper dam) 10km **Total 450 km**
Airport	Ranchi
Railhead (with unloading facilities)	Barabhum Railway Station (30km from project site) on the Howrah Purulia Broad Gauge Line of South **Eastern railway** 335km from Howrah via Adra 320 km from Howrah via Tatanagar
Port	Haldia, Kolkata
2. PROJECT	
Type	Pumped Storage Project (Closed Loop Type)
Power	1,000 MW
Installed Capacity	4 X 250 MW
Peak Operating duration	5 hours daily
3. HYDROLOGY	
Catchment Area	
Upper Dam	8.29 km^2
Lower Dam	12.66 km^2
Average Annual Rainfall in Basin	1334 mm
Average annual Run-off	
Upper Reservoir	4.51 Mm^3
Lower Reservoir	6.88 Mm^3
75% Dependable Run-off	
Upper Reservoir	3.68 Mm^3
Lower Reservoir	5.63 Mm^3
90% Dependable Run-off	
Upper Reservoir	2.93 Mm^3
Lower Reservoir	4.47 Mm^3
Maximum Design Flood (PMF)	
Upper Reservoir	280 m^3/s
Lower Reservoir	428 m^3/s
Annual Average Sediment Load	1045m^3 /Km^2/yr

4.0 CIVIL STRUCTURE	
4.1 UPPER RESERVOIR	
FRL	464.00 m
MDDL	441.40 m (With irrigation Storage depleted) 444.40 m(For Pumped storage Generation)
Pondage at FRL	21.6 Mm^3
Pondage at MDDL(at 441.40m) Pondage at MDDL(at 444.44m)	5.9 Mm^3 7.4 Mm^3
Live Pondage	14.2 Mm^3
4.2 LOWER RESERVOIR	
FRL	316.5 m
MDDL	280.4 m
Pondage at FRL	18 Mm^3
Pondage at MDDL	3.8 Mm^3
Live Pondage	14.2 Mm^3
4.3 UPPER DAM	
Type	Rock fill with **Central impervious core**
Top of Dam	EL 467.5 m
Accepted Foundation Elevation	EL 404 m
Length of Dam at top	732 m
Max. Height of Dam	63.5m
Top width of dam	10.00 m
4.4 SPILLWAY ARRANGEMENT	
Type	Over Flow Ogee Type on Left Bank(Concrete)
Crest Elevation	EL 464.0m at FRL
MWL	EL 466m
Design Flood	280 m^3 /s
No. of Bays	4 Bays , 13m wide each
No. of Piers	3 Piers, 2 m wide each
Waterway	58 m
4.5 DIVERSION CUM BOTTOM OUTLET ARRANGEMENTS	
Type	Tunnel on left bank
Diversion Flood	109 m^3/s
Length & Diameter	691m , 4m (Concrete Lined)

Invert Level of DT at Inlet	EL 410.0m
Invert Level of DT at Outlet	EL 408.0m
Bottom Outlet	
Length & Diameter	Same as Diversion Tunnel will act as Bottom Outlet
Invert of Bottom Outlet at Inlet	EL 423.5m
Invert of Bottom Outlet at Outlet	EL 408.0m
Deletion Time	27 hrs(Approx.)
4. 6 MAIN LOWER DAM	
Type	Concrete Gravity
Top of Dam	EL 320m
Foundation Elevation	EL 256 m
Length of Dam at top	872 m
Max. Height of Dam	64 m
No. of OF blocks	4 nos, 18m wide each
No. NoF Blocks	40 nos, 20m wide each
Top width of dam	10.00 m
4.7 LOWER SADDLE DAM	
Type	Rock fill with central impervious core
Top of Dam	EL 320.0 m
Foundation Elevation	EL 270 m
Length of Dam at top	595 m
Max. Height of Dam	50.0 m (from Bed level)
Top width of dam	10.00 m
4.8 SPILLWAY ARRANGEMENT	
Type	Over Flow Ogee Type
Crest Elevation	EL 316.5 m at FRL
MWL	EL 318.53m
Design Flood	428 m3 /s
No. of Bays	5 Bays , 15m wide each
No. of Piers	4 Piers, 3 m wide each
Total Waterway	87 m
4.9 DEPLETION SLUICE	
Location	In Block No. 38
Size	1.5m(W) X 2.0(H)
Crest Elevation	EL 270m
Gate Chamber	7.7m(L)X 6m(W)X 5m(H)

Depletion Time	97 hrs.
4.10 DIVERSION ARRANGEMENT	
Coffer Dam with overflow spillway	Rockfill with earthen Core
Bed Level	EL265m
FRL/MWL	EL280m/283.5m
Diversion Flood	167 m^3/s
Height of Coffer Dam	20m
Spillway Crest	EL 280m
Spillway crest Length	35m
4.11 Power Intake	
Type H x W x No. x Line	Horizontal Type with anti-vortex lubbers 12.0m x 13.0m x 3 nos x 2 lines
4.12 Headrace Tunnel (Intake Tunnel)	
D x L x line	D 9.0 m x L 618.11 m x 2 lines
4.13 Penstock (Steel Lining)	
D x L x line After Bifurcation	D 9.0 m x L 224.37m x 2 lines D 6.4 m- D 4.4 m x L 73.73 m x 4 lines
4.14 Tailrace Tunnel	
Tailrace Tunnel No1 Tailrace Tunnel No2	D 7.0 m x L 126.90 m x 1 line D 7.0 m x L 114.40 m x 1 line D 10.0 m x L 419.14 m x 1 line D 7.0 m x L 102.90 m x 1 line D 7.0 m x L 89.40 m x 1 line D 10.0 m x L 402.77 m x 1 line
4.15 Tailrace Outlet	
Type H x W x No. x Line	Horizontal Type with anti-vortex lubbers 12.0m x 13.0m x 3 nos x 2 lines
4.16 Powerhouse	
-Type -Four Fixed Speed Pump/Turbine units -One Variable Speed Pump/Turbine unit + Three Fixed Speed Pump/Turbine units	Type; Underground Bullet shape L 160.00m x B 25.00 m x H 53.00 m L 160.00 x B 25.00 m x H 55.00 m
4.17 Transformer Room	Type;
Type L x B x H	Underground Bullet shape L 139.17 m x B 16.00m x H 16.00m

4.18 Switch Yard	
Type W x B	Type; Open air Type W 165 m x B 50 m at EL 340 .00 m
5.0 Hydro-mechanical Equipment	
5.1 Intake Equipment	
Intake Trashrack Intake Maintenance Gate Intake Gate	3 sets x 2 lines, W 13.0m x H 12.0m Vertical lift fixed wheel type steel gate 2 sets W 7.0m x H 9.0m Vertical lift fixed wheel type steel gate2 sets W 7.0m x H 9.0m
5.2 Steel Penstock	
- Type of penstock - Type, number of bifurcation - Inside diameter Before bifurcation After bifurcation - Total length	Embedded type welded steel penstock Internal reinforced type bifurcation 2sets 9.0 m (main pipe) 6.4~4.4 m (branch pipe) 975.7 m/lane (824.2 m : main pipe) (75.7 m/75.7 m: branch pipe to unit No.1(3), No.2(4))
5.3 Steel Liner of Tailrace Tunnel	
- Number of lane - Type of steel liner - Type, number of junction - Inside diameter Before junction After junction - Total length	4 lanes Embedded type welded steel liner Internal reinforced type junction 2 sets 7.0 m (branch pipe) 10.0 m (main pipe) 213.8 m (No.1), 164.4 m (No.2)
5.4 Draft Equipment	
- Quantity - Type of gate - Clear span - Clear height	4 sets High pressure slide type steel gate (Bonneted gate) with transition pipe 5.60 m 5.60 m
5.5 Tailrace Equipment	
Tailrace Trashrack Tailrace Gate	3 sets x 2 lines, W 13.0m x H 12.0m Vertical lift slide type steel gate 2 sets W 8.00 m x H 10.00 m
5.6 Bottom Outlet Equipment of Lower Dam	

Bulkhead Gate Auxiliary Gate Main Gate	Slide Type Steel Gate (Stoplog) 1 set W2.49m x H3.34m High Pressure Slide Type Steel Gate 1 set W 1.50m x H 2.00m High Pressure Slide Type Steel Gate 1 set W 1.50m x H 2.00m
5.7 Bottom Outlet Equipment of Upper Dam	
Trashrack Stoplog Auxiliary Gate Main Gate	Vertical Fixed Type Steel Trashrack 1 set W 4.0 m x H 4.0 m Slide Type Steel Gate 1 set W 4.0 m x H 4.0 m High Pressure Slide Type Steel Gate 1 set W 1.45m x H 1.80m Jet Flow Gate 1 set W 1.80m x H 1.80m
6.0 Electromechanical Equipment	
6.1 Pump Turbine	
Type	Francis type, vertical shaft reversible pump-turbine
Number of unit	Four (4) units
Effective head at normal static head	146.4 m
Maximum Turbine Output at normal effective head	255,500kW , 280,600kW (10% Overload)
Maximum Pump Input	285,000 kW
Maximum Turbine Discharge	197.0 m^3/s
Maximum Pump Discharge	196.7 m^3/s
Revolving Speed	187.5 rpm
6.2 Generator-Motor	
Type	Three (3) phase, alternating current synchronous, generator-motor, vertical shaft, rotating field, enclosed housing, rim-duct air-cooled and semi-umbrella type
Number of unit	Four (4) units
Rated Capacity	Generator; 306MVA Motor (output); 255 MW
Power Factor	Generator; 0.90 (lagging) Motor; 0.95 (leading)
Rated Voltage	18.0kV

Rated Current	2,574A
Rated Frequency	50 Hz
Rated Revolving Speed	187.5 rpm
Over Load Capacity	110 % rated capacity
6.3 Main Power Transformer	
Type	Indoor, oil-immersed, 3 single phase transformers with on-load tap changer (OLTC) for pumping operation
Number of unit	4 units
Rated Capacity	330 MVA
Rated Voltage	Primary; 18 kV Secondary; 400 kV adjustable range of the secondary voltage: -5% to +10%(3kV/tap)
Connection	Primary: Delta Secondary: Wye
Neutral Grounding System for Secondary Winding	Solidly Grounded
Basic Impulse Insulation Level (BIL)	Primary: 95 kV Secondary: 1,425 kV Neutral Secondary: 38 kV r.m.s(power frequency)
6.4 Generator-Motor Circuit Breaker	
Type	Indoor, Metal-enclose, SF6 gas blast and single pressure type
Number of Unit	Four (4) units
Rated Voltage	24 kV
Rated Normal Current	11,000 A
Rated Short Circuit Breaking Current	80 kA
6.5 Gas Insulated Switchgear	
6.5.1 Circuit Breaker	
Type	400 kV Gas Insulated Switchgear (GIS)
Number of Feeder	Nine (9) feeders including two (2) feeders for future expansion of transmission lines
Rated Voltage	420 kV
Rated Normal Current	2,000 A
Rated Short Time (2 sec) withstand Current	50 kA
Rated Lighting Impulse withstand Voltage	1,425 kV

Appropriate compensation measures as per ownership status has been suggested as a part of the Environmental Management Plan.

2.5 ACCESS ROADS

The project site is located on the west of Purulia district in the state of West Bengal. Access road networks to Purulia are available from all the major cities in the state. Materials required for project construction such as steel and cement have to be transported from the point of source to the site. Similarly construction equipment and machinery are also to be brought to the construction site.

The roads/railway routes that could be used for the above purposes are described in the following sections.

Regarding embankment materials, geotechnical investigation on the prospective borrow areas carried out by CSMRS have confirmed the availability of required quantity and suitable quality within short distance in the project area. On the other hand, natural fine & coarse aggregates required for concrete will be made available from the Quarry areas, located in the close vicinity of the Project Area.

i) Roads to the project

The project area is situated at a distance of 450 km from Kolkata. The road from Kolkata to the Project site comprises of four segments presented in Table-2.3.

Table-2.3: Segments of road network from Kolkata to Project Site

S.No.	Stretch	Length (km)
1.	Kolkata to Chandil along NH 33 via Jamshedpur (also called the Bombay road)	380
2.	Chandil to Balarampur along NH 32	30
3.	Balarampur to Pathardih along a Highway	30
4.	Pathardih to Project site (upper dam) Along village roads.	10
	Total	**450**

The project can also be approached from Kolkata by an alternate route via Bishnupur, Bankura, Purulia and Balarampur. The distance along this route is 405 km. The other route via. Jamshedpur and Chandil, though longer is considered more suitable for transportation of equipment and materials, as it is along a national highway for major portion of its length.

From Purulia, the district headquarter town, the project site is about 70km away, 30 km from Purulia to Balarampur along NH 32 plus 40 km from Balarampur to site via. Pathardih. The index map showing the access by rail and road is enclosed as Map-2.2.

ii) Roads in the Project Area

A total of about 13 km of new roads are to be constructed.

2.6 RAIL HEAD

The nearest railway station is Barabhum on the Howrah-Purulia broad gauge line of the South Eastern Railway via Tatanagar. Railway distance for this route is 320 km via Tata nagar & 335 km via Adra.

The railway siding for unloading heavy machineries and equipment is available at Barabhum.

From the railway station, the project is approachable by an all weather black-topped Balrampur-Bagmundi State Highway upto village Pathardih. Distance from Barabhum (Railway Station) to Pathardih is 30 km.

2.7 PORT FACILITIES

The services of two ports can be availed by the project at Kolkata and Haldia. Though Haldia port is nearer, the maximum handling capacity there is restricted to 50 M.T. only Kolkata Port has capacity of handling packages of any size upto 200 M.T. at its Netaji Subash dock.

For the purpose of transporting pump-turbines, generator motors and main transformer from any part of the country to the project site, both rail and road link is available.

Board gauge railway track from Howrah (Kolkata) via Kharagpur – Bishnupur – Adra – Purulia upto Barabhum and another route via Jamshedpur and Chandil upto Barabhum is also available. Both the routes are under South Eastern Railway and the distance from Kolkata to Barabhum is 335 km. The project area can be reached by road via National Highway No. 6 uptoBoharagora, through NH-31 upto Chandil and by NH-32 to Balarampur (Barabhum). The distance from Kolkata to Balarampur by road is around 410 kms. The National High ways are of class 70 R as per IRC (Indian Road Congress) Standard and are capable to carry 70 Tons throughout the country. IRC standard further specified that upto 100 ton can be transported by trailors with multiple wheels. The existing available road from Balarampur to Bagmundi (26km) is of District Board Specification and conforms to State Highway Standard. The balance road stretch of road (approx 1 km) needs to be strengthened.

The largest consignment in the project will be the runner (Dimension tentatively: 6.7 m x 6.7 m x 6.0 m). The existing National Highway and State Highway can accommodate transportation of the consignment easily. However, the balance road of approx. 1 km stretch needs to be strengthened as per Code.

2.8 CONSTRUCTION MATERIAL REQUIREMENT

The estimated requirements of construction material for the project are listed in Table-2.4. The quantum of construction material available in various quarries is given in Table-2.5.

Table-2.4: Quantities of Construction Material Required

S. No.	Structure	Core Material (Lac m^3)	Filter Material (Lac m^3)	Rockfill Material (Lac m^3)	Fine Aggregate (Lac m^3)	Coarse Aggregate (Lac m^3)
1	Upper Dam	5.50	2.23	28.80	0.21	0.42
2	Lower Dam	-	-	-	3.78	7.55
3	Lower Saddle Dam	2.90	1.40	14.97	-	-
4	Power House and T.H.	-	-	-	0.25	0.50
5	Waterway	-	-	-	0.36	0.72
	Total	**8.4**	**3.63**	**43.77**	**4.60**	**9.19**

Table-2.5: Quantities of Construction Material Available

S. No.	Description	Name of Quarry	Quantity (lakh m^3)
1	Clay	• Jilingtadh (UCA-1) • Hathinada (UCA-3,4&5) • Purana tarpania (UCA-7,8&9)	1.37 5.85 2.27
		• Kudna (LCA-1) • Turga Lower Reservoir (UCA-3,4&5) • Gosaidih (LCA-4&5) • Drift Area & Bagmundi BA (LCA-2)	1.49 0.18 0.73 1.03
2	Rockfill & Filter	• Kudna • Dulgubera	220 10
3	Coarse Aggregate & Fine Aggregate	• Turga • Dulgubera • Malti • Kudna • Hadhadinala	22 10 50 220 75

The location of quarry/borrow areas are shown in the Map-2.3.

2.9 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 of project areas, workshop and colony etc.

The maximum power demand due to the construction activities can be estimated taking total capacity of electrical driven equipment and lighting, which are supposed to work within the target time into consideration.

The maximum power demand also depends on the time length of construction activities and actual conditions at site such as production method of concrete aggregate, number of working adits, etc. From the experience gained from existing Purulia Pumped Storage Project it is estimated that maximum power demand will be limited to 9 MW during the entire construction period.

The construction power for Turga Pumped Storage Project 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 2nd 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.

2.10 POWER SUPPLY FACILITIES

The construction power for Turga Pumped Storage Project will be available from the existing 132/33/11 KV Sub Station at PPSP Township which receives Power from Purulia 132 KV grid Sub – Station. From the existing 22 MVA, 132/33 KV Power Transformer of the existing Sub-Station, power is fed to 2 X 7.5 MVA, 33/11 KV Power transformers. Both of the transformers are lightly loaded. Construction Power for Turga PSP will be taken from this Sub-Station through the 11 KV feeders already existing at site. Only 7 nos. 11/0.415 KV transformers having capacities of 1 MVA to 500 KVA would be installed with all necessary protection and metering arrangement at various construction sites.

2.11 TELECOMMUNICATION FACILITIES

2.11.1 During Construction

To ensure efficient execution at various works, all sites of the project should have adequate and reliable telecommunication network. One electronic private automatic exchange with a capacity of 50 lines is already existing at PPSP Site. The existing facility can be utilized during construction. This internal telephone system is being maintained by the PPSP, project authority. The DoPT and other Private Companies have installed Cell Phone Towers. The Construction area is covered by Cell Phone network. Telecommunication links between various project sites and outside places will be done through cellular network.

Additionally, a wireless VHF system is proposed for linking the Turga Pumped Storage Project site with the Project office and to the headquarters of WBSEDCL at Kolkata.

Internet facility is available at the PPSP Site Office and existing PPSP Township provided by the DoPT and other Private Companies. The facility will be extended for Turga Pumped Storage Project also.

2.11.2 After Completion of the Project

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

2.12 PROJECT COLONIES/ BUILDINGS

It is proposed to utilize about 75% of the Infrastructure of the existing project colony of Purulia Pumped Storage Project. Bagmundi is about 3 km from the lower dam site. As some facilities / services such as Police Station, Secondary School, Post Office, Market and Primary Health Centre with 30 beds for indoor patients, Land & Revenue Office and Block Development Office are available at this place.

Public Sector banking facility with its branches at PPSP Administrative Building and Baghmundi are available. ATM facility is also available at the Baghmundi Branch.

The details of various offices & buildings to be developed during construction phase are given in Table-2.6.

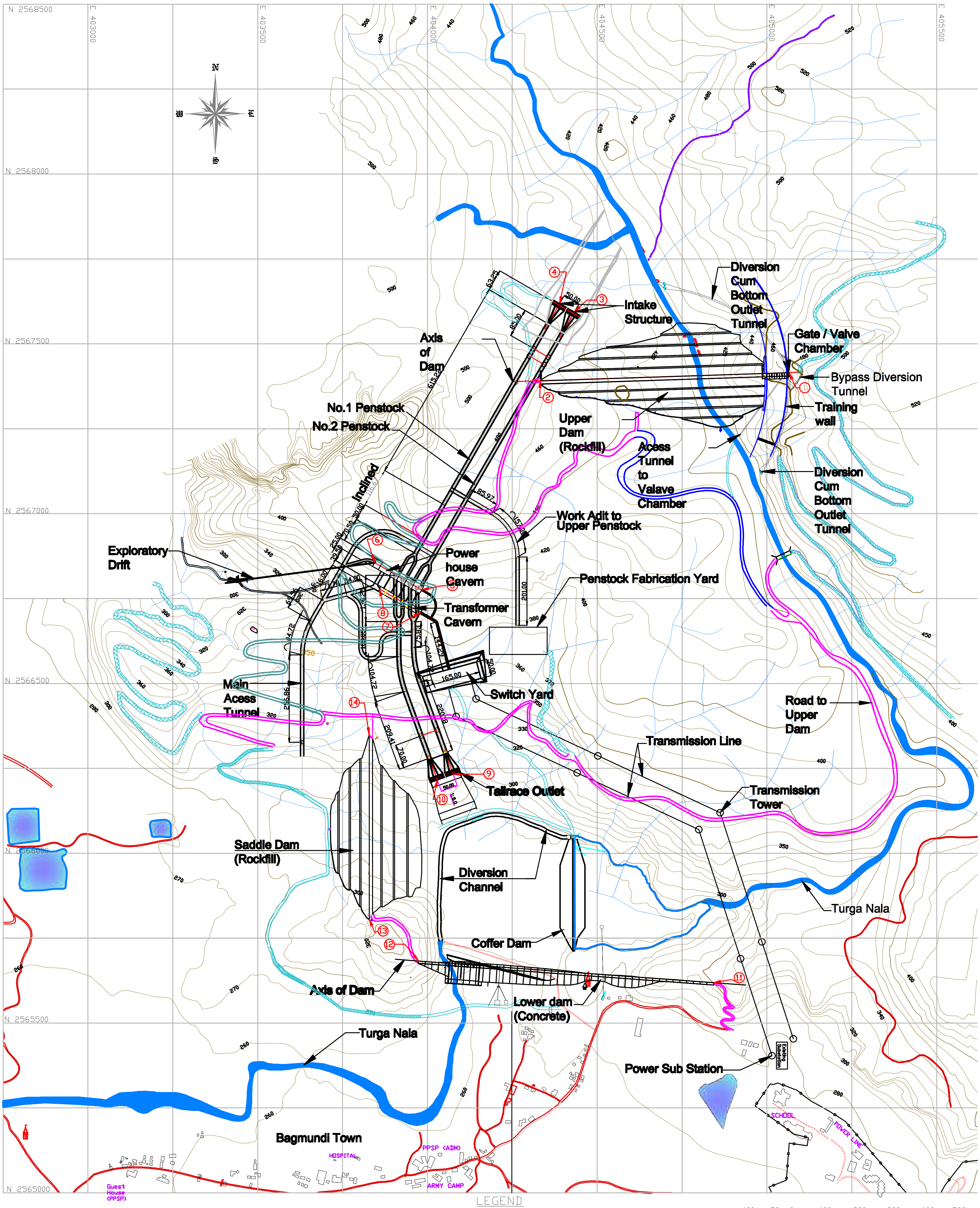
Table-2.6: Details of various offices & buildings to be developed during construction phase

S. No.	Buildings	Area (m^2)
1	Permanent Office Building	1000
2	Temporary Office Building	1000
3	Temporary Site Offices	1500
4	Workshops, Stores, Casuals , Material etc.	3000
5	Permanent Residential Building	4000
6	Temporary Residential Building	6000
	Total	**16500**

Colonies for labor will be developed by the contractors at Project site for which a specific clause will be stipulated in the contract documents.

2.13 WORKSHOPS

The Project works are planned to be let out on contract. The earth moving and other equipment for the works is to be procured and maintained by contractors. The project will have at its disposal only small and minimum equipment required for support services,



POINT	EASTING	NORTHING	COMPONENT	POINT	EASTING	NORTHING	COMPONENT
1	405064.831	2567415.095	UPPER DAM	9	404075.983	2566232.530	TAILRACE OUTLET
2	404332.556	2567391.165		10	404028.999	2566215.429	
3	404432.830	2567593.854	INTAKE	11	404843.406	2565619.006	LOWER DAM
4	404389.528	2567618.854		12	403973.742	2565682.666	
5	403983.108	2566775.713	POWER HOUSE	13	403828.534	2565805.865	SADDLE DAM
6	403844.544	2566855.713		14	403828.408	2566349.700	
7	403979.234	2566708.668	TRANS-FORMER ROOM				
8	403858.711	2566778.251					

LEGEND

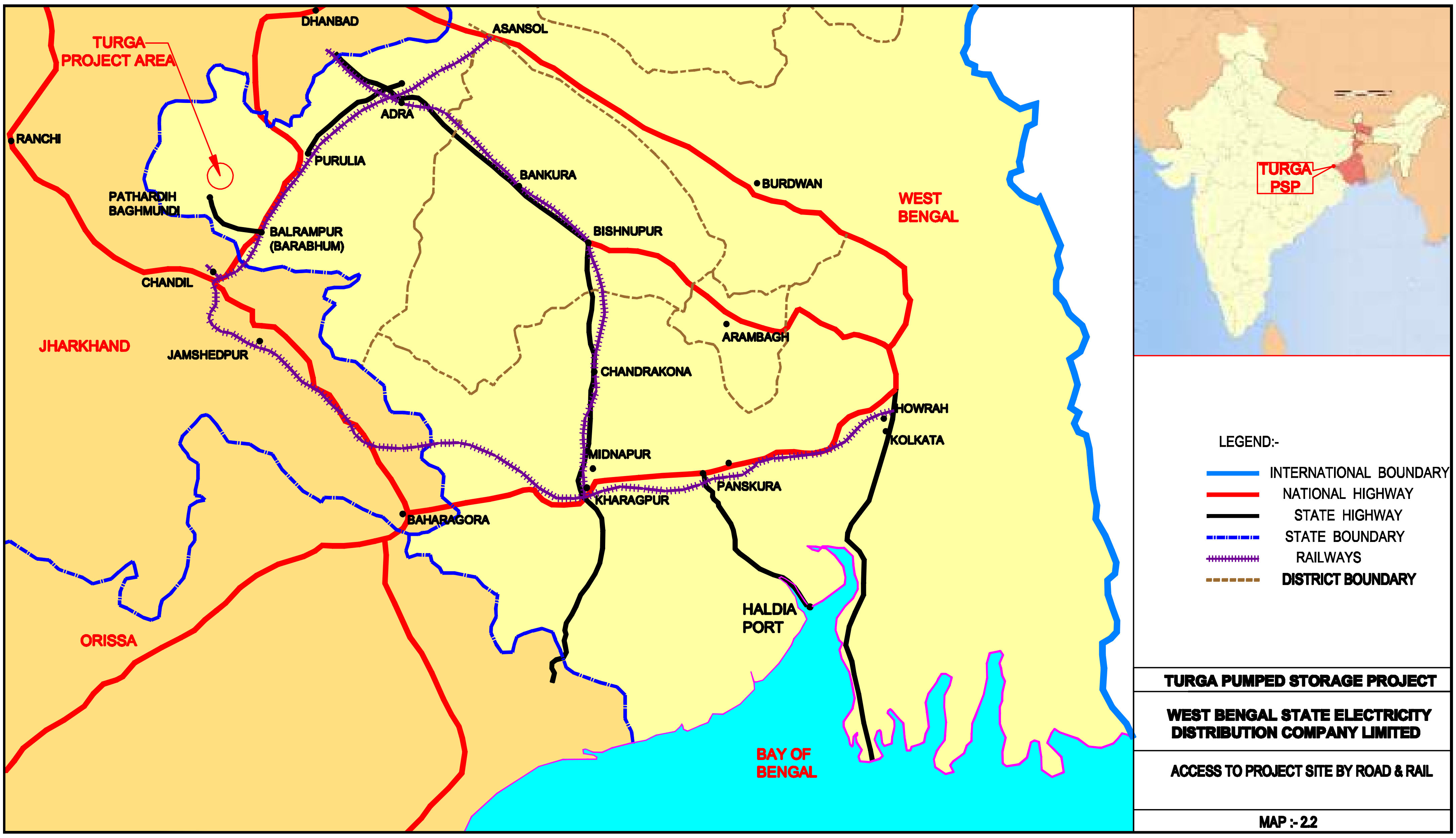
HOUSE	
TEMPLE	
RIVER/NALA	
POND (Existing)	
TEMPORARY ROAD	
MAJOR CONTOUR	
EXISTING ROAD	
PERMANENT ROAD	
ROAD ALT 1	

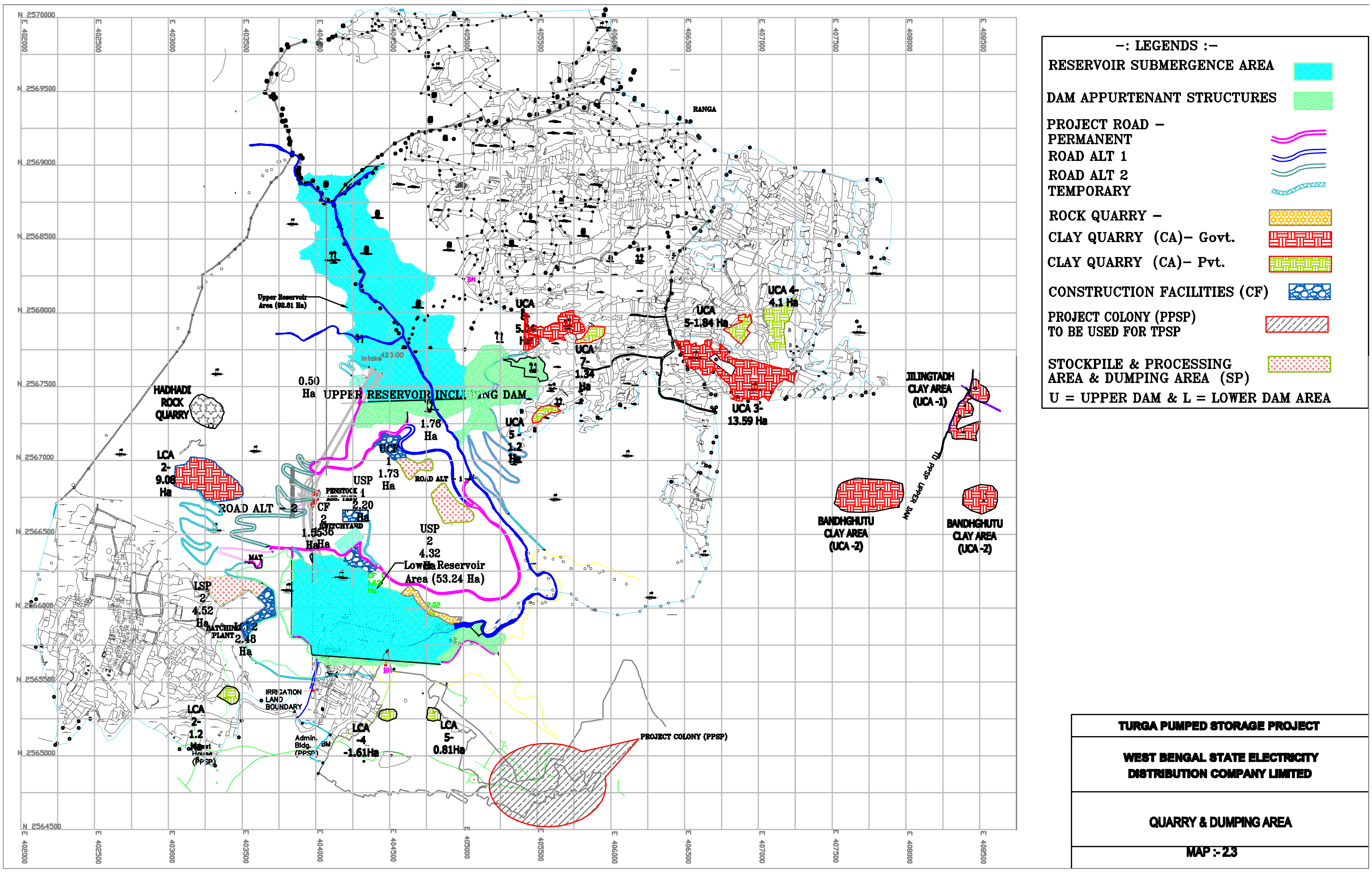
TURGA PUMPED STORAGE PROJECT

WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED

GENERAL LAYOUT PLAN
OF THE PROJECT

MAP - 2.1


TURGA PROJECT AREA
DHANBAD
ASANSOL
RANCHI
ADRA
PURULIA
BANKURA
BURDWAN
WEST BENGAL
PATHARDIH BAGHMUNDI
BALRAMPUR (BARABHUM)
BISHNUPUR
CHANDIL
ARAMBAGH
JHARKHAND
JAMSHEDPUR
CHANDRAKONA
HOWRAH
KOLKATA
MIDNAPUR
PANSKURA
KHARAGPUR
BAHARAGORA
HALDIA PORT
ORISSA
BAY OF BENGAL
TURGA PSP
LEGEND:-
INTERNATIONAL BOUNDARY
NATIONAL HIGHWAY
STATE HIGHWAY
STATE BOUNDARY
RAILWAYS
DISTRICT BOUNDARY
TURGA PUMPED STORAGE PROJECT
WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED
ACCESS TO PROJECT SITE BY ROAD & RAIL
MAP :- 2.2


-: LEGENDS :-
RESERVOIR SUBMERGENCE AREA
DAM APPURTENANT STRUCTURES
PROJECT ROAD -
PERMANENT
ROAD ALT 1
ROAD ALT 2
TEMPORARY
ROCK QUARRY -
CLAY QUARRY (CA)- Govt.
CLAY QUARRY (CA)- Pvt.
CONSTRUCTION FACILITIES (CF)
PROJECT COLONY (PPSP)
TO BE USED FOR TPSP
STOCKPILE & PROCESSING
AREA & DUMPING AREA (SP)
U = UPPER DAM & L = LOWER DAM AREA
TURGA PUMPED STORAGE PROJECT
WEST BENGAL STATE ELECTRICITY
DISTRIBUTION COMPANY LIMITED
QUARRY & DUMPING AREA
MAP :- 2.3
UPPER RESERVOIR INCLUDING DAM
Upper Reservoir Area (92.81 Ha)
Lower Reservoir Area (53.24 Ha)
HADHADI ROCK QUARRY
JILINGTADH CLAY AREA (UCA -1)
BANDHGHUTU CLAY AREA (UCA -2)
UCA 3- 13.59 Ha
UCA 4- 4.1 Ha
UCA 5-1.84 Ha
LCA 2- 9.08 Ha
ROAD ALT - 2
USP 1 2.20 Ha
USP 2 4.32 Ha
LSP 2 4.52 Ha
PROJECT COLONY (PPSP)
IRRIGATION LAND BOUNDARY
RANGA

CHAPTER-3

METHODOLOGY ADOPTED FOR THE EIA STUDY

3.1 INTRODUCTION

The present chapter outlines the methodology adopted for preparation of Environmental Impact Assessment and the Environmental Management Plan for the proposed Turga Pumped Storage project. Standard methodologies of Environment Impact Assessment have been followed for conducting the study. A brief description of the methodology adopted for conducting the CEIA study for the proposed Turga Pumped Storage project is outlined in the present chapter.

3.2 STUDY AREA

The study area considered for the CEIA study is given as below:

- Submergence area of Upper and Lower Reservoir
- Area within 10 km of the periphery of the submergence area of Upper and Lower Reservoir
- Area to be acquired for locating the various project appurtenances
- Area within 10 km of various project appurtenances
- Catchment area intercepted at the upper and lower dam sites

The study area is enclosed as Figure-3.1.

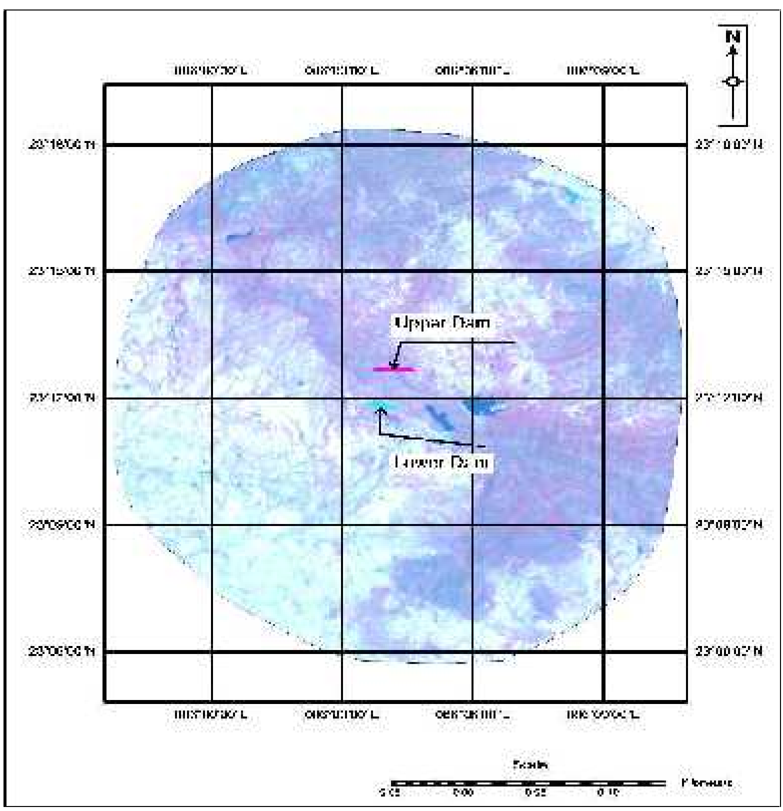


Figure-3.1: Satellite imagery of the Study Area for Turga Pumped Storage project

3.3 DATA COLLECTION

3.3.1 Physico-Chemical Aspects

Primary surveys have been conducted for three seasons namely pre-monsoon (summer), monsoon and winter. The data has been collected for flora, fauna, forest types and ecological parameters, geological and soil features. During these surveys data and information was collected on physico-chemical, biological and socio-economic aspects of the study area. In addition, detailed surveys and studies were also conducted for understanding bio-diversity in the study area.

As a part of the EIA study, field studies has been conducted for primary data collection for three seasons. The details of seasons covered as a part of the study are given in **Table-3.1**.

Table-3.1: Details of field studies conducted as a part of CEIA study for Turga Pumped Storage Project

Season	Months
Winter	December 2013 – January 2014
Summer	April 2014
Monsoon	August-September 2014

Geology

The regional geology around the project area highlighting geology, stratigraphy etc. have been covered in the EIA Report, as per the available information in the Detailed Project Report (DPR) of the project.

Hydrology

Hydrological data for river Turga as available in the Detailed Project Report was collected and has been suitably incorporated in the Comprehensive EIA study.

Seismicity

The information on seismicity of project has been covered in the EIA Report, as per the available information in the Detailed Project Report (DPR) of the project.

Landuse pattern

Landuse pattern of the study area as well as the catchment area was carried out by standard methods of analysis of remotely sensed data and followed by ground truth collection and interpretation of satellite data. For this purpose digital satellite data was procured from National Remote Sensing Agency, Hyderabad, IRS-P6 LISS-IV. The data was processed through ERDAS software package.

Soils

The soil quality was monitored at various locations in the catchment area of upper and Lower Reservoir. The monitoring was conducted for three seasons as detailed in **Table-3.1**.

Water Quality

The existing data on water quality has been collected to evaluate river water quality on upstream and downstream of the project site. The water quality was monitored for various seasons as listed in **Table-3.1.**

Ambient Air Quality

The ambient air quality was monitored at three locations in the study area. Monitoring was conducted for three seasons as listed in **Table-3.1.** The frequency of monitoring for each season was twice a week for four consecutive weeks. The parameters monitored were Suspended Particulate Matter less than 10 microns (PM_{10}), Sulphur-dioxide (SO_2) and Nitrogen-dioxide (NO_2).

Ambient Noise Level

As a part of the EIA study, noise level was monitored at various locations in the study area. Monitoring was conducted for various seasons as listed in **Table-3.1**. At each station, hourly noise level was monitored during day time. Further day time equivalent noise level too was estimated and compared with the applicable standards.

3.3.2 Ecological Aspects

Terrestrial Ecology

Flora

Data on forest type, dominant tree species, economically important species in the study area has been collected from the forest department. The relevant data on bio-diversity, economically important species, medicinal plants, rare and endangered species in the study area have been collected from other secondary sources including published papers, etc.

Field studies were conducted for three seasons to collect data on various aspects in the study area. The sampling sites were selected based on topography and floristic composition. The various aspects studied were floral density, frequency and abundance of species of trees, shrubs and herbs. Plants of economical and medicinal use and endangered species were also identified as a part of the study.

Fauna

The faunal assessment has been done on the basis of secondary data collected from different government offices like forest department, wildlife department, fisheries department etc.

The presence of wildlife was also confirmed from the local inhabitants depending on the animal sightings and the frequency of their visits in the study area. In addition, review of secondary data was another source of information for studying the fauna of the area. Besides, sightings of faunal population during ecological survey and then field studies were also recorded as a part of the data collection exercise.

Aquatic Ecology and Fisheries

Water samples from river Turga were collected as a part of field studies. The density and diversity of periphyton and phytoplanktons, species diversity index and primary productivity etc. were studied. The field studies were conducted for various seasons as listed in **Table-3.1.**

The secondary data pertaining to fisheries in river Turga was collected through literature review.

Fishing was done at various sites in the project area including river stretch between Upper and Lower dam sites to ascertain the dispersal pattern of fish species. Based on the findings of the field studies, an inventory of the fish species was prepared.

3.3.3 Socio-economic Aspects

Demography

The demographic and socio-economic characteristics of the submergence area as well as the study area have been studied through available secondary sources. The information on demographic profile, caste profile, literacy level and occupational profile was collected as a part of the study.

3.4 SUMMARY OF DATA COLLECTION

The summary of the data collected from various sources is outlined in **Table-3.2.**

Table-3.2: Summary of data collected for the Comprehensive EIA study

Aspect	Mode of Data collection	Parameters monitored	Frequency	Source(s)
Meteorology	Secondary	Temperature, humidity, rainfall	-	India Meteorological Department (IMD)
Water Resources	Secondary	Flow, Design hydrograph and design flood hydrograph	-	Detailed Project Report (DPR)
Water Quality	Primary	Physico-chemical and biological parameters	Three seasons	Field studies for winter, summer, and monsoon seasons

Aspect	Mode of Data collection	Parameters monitored	Frequency	Source(s)
Ambient air quality	Primary	PM_{10}, SO_2, NO_2	Three seasons	Field studies for winter, summer, and monsoon seasons
Noise	Primary	Hourly noise and equivalent noise level	Three seasons	Field studies for winter, summer, and monsoon seasons
Landuse	Primary and secondary	Landuse pattern	-	NRSA and Ground truth Studies
Geology	Secondary	Geological characteristics of the study area	-	Detailed Project Report (DPR)
Soils	Primary	Physico-chemical parameters	Three seasons	Field studies for winter, summer, and monsoon seasons
Terrestrial Ecology	Primary and secondary	Floral and faunal diversity	Three seasons	Field studies for winter, summer, and monsoon seasons
Aquatic Ecology	Primary and Secondary	Presence and abundance of various species	Three seasons	Field studies for winter, summer, and monsoon seasons
Socio-economic aspects	secondary	Demographic and socio-economic aspects	-	Available secondary data.

3.5 IMPACT PREDICTION

Prediction is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur because of implementation of the project. An attempt was generally made to forecast future environmental conditions quantitatively to the extent possible. But for certain parameters, which cannot be quantified, general 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. Impact of project activities has been predicted using mathematical models and overlay technique (super-imposition of activity on environmental parameter). For intangible impacts qualitative assessment has been done.

The environmental impacts predicted are listed as below:

Air

- Changes in ambient levels and ground level concentrations due to total emissions from point, line and area sources
- Effects on soils, material, vegetation, and human health
- Impact of emissions DG sets used for construction power if any, on air environment.

Noise

- Changes in ambient levels due to noise generated from equipment, blasting operations and movement of vehicles
- Effect on fauna and human health

Water

- Changes in quality
- Sedimentation of reservoir
- Impact on fish fauna
- Impact of sewage disposal
- Impacts on hydrologic regime.
- Impacts on water quality.
- Impacts due to sewage generation from labour camps

Land

- Changes in land use and drainage pattern
- Changes in land quality including effects of waste disposal
- Riverbank and their stability
- Impact due to submergence

Ecological Aspects

- Deforestation and shrinkage of animal habitat
- Impact on fauna and flora (including aquatic species if any) due to decreased flow of water
- Impact on rare and endangered species, endemic species, and migratory path/route of animals, if any
- Impact on breeding and nesting grounds, if any
- Impact on animal distribution, migration routes (if any), habitat fragmentation and destruction due to barrage building activity
- Effect on riverine fisheries including migratory fish species

- Impacts due to acquisition of forest land
- Impacts due to increase in terrestrial and aquatic ecology due to increased human interferences during project construction and operation phases

Socio-economic Aspects

- Impact on the local community including demographic changes
- Impact on economic status
- Impact on human health
- Impact due to increased traffic
- Impact on Holy Places and Tourism
- Loss of land
- Displacement of population due to acquisition of private and community properties
- Increase in incidence of water-related diseases including water-borne and vector-borne diseases
- Increase in air pollution and noise level during project construction phase

Other Aspects

- Downstream impact on water, land & human environment due to drying up of the river in the stretch between dam site and powerhouse site.

3.6 ENVIRONMENTAL MANAGEMENT PLAN AND COST ESTIMATES

Based on the environmental baseline conditions and project inputs, the impacts were identified and a set of measures have been suggested as a part of Environmental Management Plan (EMP) for their amelioration. The management measures have been suggested for the following aspects:

- Creation of Green Belt Plan around the Periphery of the Reservoir
- Compensatory Afforestation plan, Biodiversity Conservation and Wild life Management Plan
- Reservoir Fisheries Development for conservation/management of fishes.
- Muck Disposal Plan Suitable sites for dumping of excavated material have been identified with adequate engineering and biological measures.
- Energy Conservation Measures
- Dam Break Analysis and Disaster Management Plan
- Restoration and landscaping of working Areas: reclamation of borrow pits (quarry sites), muck disposal and construction areas.
- Public Health Delivery System including the provisions for drinking water facility for the

local community.

- Sanitation & Solid Waste Management Plan for domestic waste from colonies & labour camps, etc.
- Water, Air & soil Quality & Noise Environment Management during construction and post-construction periods.
- Forest Protection Plan
- Environmental Awareness Plan.
- Environmental Flows for resistance of aquatic ecology and water quality in the river.

The expenditure required for implementation of these management measures has also been estimated as a part of the EMP study.

3.7 CATCHMENT AREA TREATMENT PLAN

As a part of the CEIA study, a catchment area treatment plan for the catchment area intercepted at the upper and lower dam sites has been formulated. Various sub-watersheds have been categorized into different erosion categories, as per Silt Yield Index (SYI) method. For high and very high erosion categories, a catchment area treatment plan comprising of engineering and biological measures has been formulated.

3.8 DAM BREAK ANALYSIS

A dam break analysis has been conducted to simulate hypothetical failure of dam including preparation of inundation maps. A Disaster Management Plan (DMP) including the cost estimates has been prepared for dealing with emergency situation. It includes emergency preparedness plan, surveillance plan, evacuation plan etc including communication system.

3.9 LOCAL AREA DEVELOPMENT PLAN

As a part of the CEIA, a Local Area Development Plan (LADP) has been formulated for implementation in study area villages. An amount of 0.5% of the project cost has been earmarked for implementation of Local Area Development Plan. The key features of the Local Area Development Plan includes upgradation of infrastructure facilities in schools of various Study Area villages, scholarship to students, construction of community toilets as a part of Swatch Bharat Abhiyan, upgradation of infrastructure in various PHCs and other infrastructure in the Study Area.

3.10 ENVIRONMENTAL MONITORING PROGRAMME

It is necessary to continue monitoring of certain parameters to verify the adequacy of various measures outlined in the Environmental Management Plan (EMP) and to assess the implementation of mitigative measures. An Environmental Monitoring Programme for monitoring of critical parameters has been suggested for implementation during project construction and operation phases. The cost required for implementation of the Environmental Monitoring Programme has also been indicated as a part of the Report.

3.11 COST ESTIMATES

The Cost Estimate covering following aspects have been prepared for the following aspects:

- Environment Management Plan
- Environment Monitoring Programme
- Catchment Area Treatment Plan
- Disaster Management Plan
- Local Area Development Plan
- Other compensation, mitigation and management measures.

CHAPTER- 4

CONSTRUCTION METHODOLOGY

4.1 GENERAL

This chapter describes the construction methodology, schedules and equipment planning for construction of the Turga Pumped Storage Project. Mechanized construction through the Contractor(s) is planned for all major components of the project so as to achieve consistent quality and planned progress. The present methodology and the equipment planning is intended for the purpose of the Project Estimates / Project costs and also in evaluating the reasonableness of the participating bidders' construction techniques and equipment planning within overall construction schedules and the Project cost estimate.

4.2 PROJECT CONSTRUCTION TIME

The project is planned in two phases.

i) Pre construction phase

The pre-construction phase which includes land acquisition, model testing etc. This phase will also include bid engineering both for LCB work & ICB work. The pre-construction phase will also cover construction of project road from lower dam to upper dam and construction of main Access Tunnel covered under LCB works. After getting concurrence & clearance of the project, this phase will commence from 1st month of the project implementation period and continued upto 14th months of the implementation period. During the fag end of the Pre-construction stage i.e. in the 13th month of the implementation period, the Main Civil works will start (two months of overlapping).

ii) Construction Phase

The main project work (ICB work) Construction is planned to commence from 13th month and planned to be finished by 75 month. It is also proposed that construction of (i) Diversion tunnel, Upper Dam & Appurtenant Structures, (ii) Lower Dam & Saddle Dam, (iii) Water Conductor System and (iv) Power House Complex System are proposed to start simultaneously such that construction of all the major components are completed within the scheduled time frame.

4.3 KEY MATERIAL PLANNING

4.3.1 Project Component wise Major Quantities

The estimated quantities of major item of works that are likely to be involved for construction of various project components are given in Table-4.1.

Table-4.1: Estimated Quantities of Major Item of Works

S. No	Name of Component	Estimated Quantity				
		Common Excavation (m^3)	Rock Excavation (m^3)	Fill Materials (m^3)	Concrete (m^3)	Reinforcement (t)
1	Diversion Tunnel cum Bottom Outlet	-	55000	-	3216	63
2	Upper Dam	93400	304850	3866472	49210	-
3	Coffer Dams	47530	7130	452223	-	-
4	Lower dam	309775	132760	-	848979	240
5	Saddle Dam	75680	88060	2061669	-	-
6	Power Intake	411700	256990	-	35280	2719
7	Headrace Tunnel	-	172880	-	54380	-
8	Power House	-	174490	-	50410	4029
9	Transformer Room	-	41660	-	9290	660
10	Tailrace Tunnel	-	112870	-	31050	914

4.3.2 Source of Key Construction Materials

The sources of key construction materials like impervious clay core, rock fill shell and rip rap materials available in and around the Project site are listed in Table-4.2.

Table-4.2: Sources of Key Construction Materials

S. No.	Description	Name of Quarry	**Quantity** (lakh m^3)
1	Clay	• Jilingtadh • Hathinada • Purana tarpania	1.37 5.85 2.27
		• Kudna • Turga Lower Reservoir	1.49 0.18

S. No.	Description	Name of Quarry	Quantity (lakh m^3)
		• Gosaidih • Drift Area & Bagmundi BA	0.73 1.03
2	Rockfill & Filter	• Kudna • Dulgubera	220 10
3	Coarse Aggregate & Fine Aggregate	• Turga • Dulgubera • Malti • Kudna • Hadhadinala	22 10 50 220 75

4.4 PROGRAM FOR CONSTRUCTION

4.4.1 Pre-Construction Activities

Pre-Construction activities in general would include various activities as listed in Table-4.3.

Table-4.3: List of various pre-construction activities

1	Land Acquisition
2	Pre-Construction Survey & Investigation
3	Model Testing
4	Infrastructure Project Road from Lower Dam to Upper Dam alongwith Drainage and requisite Cross drainage works
5	Protection works for uphill and Downhill
6	Construction Power Arrangement From existing Grid incldg S/S
7	Railway Siding at Barabhum
8	Detailed Desigsn & Drawings (Tender drawings & Detailing during construction)
9	Tender Engineering covering Pre-qualification for ICB,Document Preparation for Main Civil works /Hydro-Mechanical/ Eelectrical Works including working Facilities
10	Preparation of Tender documents (CIVIL / HYDRO-MECHANICAL/ ELECTRICAL)
11	Prequalification of Bidder(s)/ Shortlisting of bidder(s) (UNDER ICB)
12	Tender Processing including evaluation & Award of Main Project works covering Civil/ Hydro-Mechanical/ Electrical Works

All these activities are assumed to be completed during first year. Development of all full scale infrastructure facilities may not be required much as most of the facilities are existing in the Purulia Project Area and the same are expected to be made available to be utilized in Turga PSP. However, these structures may need some modifications and / or repairs. Similarly, existing roads may also need some repairs and / or development for transportation of materials vis-à-vis heavy equipment to site. Further, new roads connecting to Upper Dam may likely to be developed. Construction power may be obtained from the existing grid, but a new sub-station need to be developed. In consideration of such availability, development of infrastructure facilities including appointment of vendors could be completed within first year.

4.3.2 Main Civil Works (Open)

(a) River Diversion Works

River Diversion works will comprise of (i) upstream Diversion Tunnel cum bottom outlet, 4.0 m dia concrete lined x 730 m long. Before taking up construction of the Upper Dam, construction of the diversion tunnel is anticipated to be completed within 12.

Considering an average progress of 130m/ month, total time required to complete the tunnel including construction of the end portals with ramps, inlet and outlet structures and concreting, is estimated to be 12 months. The sequence of construction methodology and operations shall be based upon the following :

- Excavation of the Diversion tunnel is proposed to be carried out by Full Face Drill & Blast Method with 3-shift working of the diversion tunnel
- Driving of Heading according to the class of Rocks (3.5m for Class I, 3.0m for Class II, 2.5m for Class II and 2m or less for Class IV type Rocks).
- Drilling of blast holes with 2-Boom Jumbo Drill and loading of blasted muck with 2.0 cum capacity Loader with side dump bucket, assisted with 180hp Dozer for ripping and transport of muck in 22t capacity Rear End Dumpers
- Shotcrete with 10 m^3 capacity wet Shotcrete Machine with robot arm
- Rock bolting with fully mechanized Rock Bolting Rig, wherever required
- Transportation of concrete in 6 cum capacity Transit Mixers
- Concreting from 15 cum/ hr. capacity Concrete Pumps
- Travelling steel Form, 10m long for concreting
- Piling / Stacking of mucks at disposal yard with 180HP Dozer

(b) Construction of Upper Dam

Construction of 63.5 m high Upper Dam (Earth & Rockfil) will involve about 0.40 Mm^3 foundation excavation, 22147 m drilling & grouting and about 3.87 Mm^3 embankment fill as detailed in Table-4.4.

Table-4.4: Estimated Quantities in Upper Dam Construction

Foundation Excavation	**Bank Volume[m^3]**	**Foundation Treatment**	**Length (m)**
Common Excavation	93400	Consolidation Grouting	3370
Rock Excavation	304850	Curtain Grouting	188840
Total Quantity	**398250**	**Total**	**22147**
Impervious Core	551220		
Sand Filter	91740		
Coarse Filter	223194		
Rockshell Material	2880740		
Rip Rap	119580		
Total Quantity	**3866474**		

The sequence of operations for the main dam is proposed as under :

(i) Rock Excavation after Common Excavation

(ii) Drilling for Consolidation Grouting and Curtain Grouting after excavation of the COT

(iii) Placement of Fill material from both banks following construction of curtain grouting

Though the work of diversion tunnel and coffer dam will still be in progress the construction of the Upper Dam can be taken up from the 19th month i.e excavation of foundation from banks. The work of excavation of soils and rocks in 14 months thereafter, foundation treatment which includes consolidation grouting and curtain grouting is proposed to be completed in another 15 months by the end of 35th month. Thereafter, placement of fill materials which include impervious core and filter materials, rockshell materials and riprap shall be carried out in 40 months, from both banks. Following sequence of operations are proposed for construction of the Upper Dam:

- Excavation and loading of soft materials with 2.0 cum capacity Hydraulic Excavators and Ripping with 180hp Dozer and transportation with 22t RE

Dumpers

- Drilling of 38 mm dia holes @ 1.5m c/c with heavy duty Jack Hammers in the slopes and that in accessible areas with Crawler / Wagon Drills with 76mm bits and hole patterns with spacing of 2.75m c/c for rock excavation
- Loading of blasted rocks with 2.0 cum capacity Wheel Loaders and transportation of excavated rock materials in 18 t capacity Rear End Dumpers and 180hp Dozer for pushing blasted rocks
- Drilling of Grout holes with Rotary Drills and grouting with Grout Pumps
- Loading of Fill materials at stockpiled sites with 3.5 cum capacity Wheel Loaders and transportation with 32t capacity RE Dumpers
- 180 HP Dozer at stockpiled sites
- 320hp Dozer at Embankment for rough spreading of fill materials
- Motor Grader, 145 hp
- Compaction with Vibratory Compactor, 10t capacity with smooth drum
- Compaction with Vibratory Compactor, 10t capacity, with pad foot drum
- Water Tanker,28000 l capacity for Moisture control

(c) Construction of Upper Dam Spillway

Upper Dam Spillway, which will be in the left flank of the Upper Dam, with crest elevation at El 464.0m at FRL, is an Over flow Ogee type spillway having four bays, each of 13.0m wide. Estimated Quantities of various works likely to be involved in Construction of Upper Dam Spillway is given in Table-4.5.

Table-4.5 : Estimated Quantities of various Works Items in Spillways(Upper Dam)

Foundation Excavation	**Bank Volume[m^3]**	**Foundation Treatment**	**Length (m)**
Common Excavation	1350	Consolidation Grouting	2195
Rock Excavation	5008	Curtain Grouting	3805
Total Quantity	**6358**	**Total**	**6000**
Concrete	**49210**		

Foundation excavation of the spillway is proposed to be completed in 33rd month itself and thereafter foundation treatment in next 1 month. Concreting is proposed to be completed in 6 months. The sequence of construction methodology and operations for the spillway construction are proposed as described below:

- Excavation and loading of soft materials with 0.75 cum capacity Hydraulic Excavators and Ripping with 180hp Dozer and transportation with 12t RE Dumpers.
- Drilling of 38mm dia holes @ 1.5m c/c with heavy duty Jack Hammers for rock excavation
- Loading of blasted rocks with 2.0 cum capacity Wheel Loaders assisted with 180hp Dozer and transportation in 18t RE dumpers
- Drilling holes for consolidation and curtain grouting with Rotary Drills
- Placing of concrete with Tower Cranes and Concrete Pumps, 38 cum / hr capacity
- Concrete transportation in Transit Mixtures of 8.0cum capacity
- Needle Compactor for compactor of concrete
- Water Tanker, 8000l

4.4.2 Construction of Lower Dam and Appurtenant Structures

(a) Diversion of River Water

Diversion of river water for the Lower Dam comprises of (i) upstream coffer dam involving 3,48,000 cum materials and a 730 m diversion channel. Construction of the coffer dam and the diversion channel is proposed to be completed during 13th month to 23rd month.

(b) Construction of the Lower Dam

The Lower Dam is a concrete gravity dam,64m high and consists of 44 Blocks inclusive of the spillway section which will have 5 bays ,each of 15m width within 36th – 40 th Blocks, having total spillway width of 72m towards the right bank. The Overflow section will also have a depletion sluice(1.5m Wx2.0m H) in Block No 38.Total length of the dam is 872m at the dam top at El 320m. The dam is proposed to be constructed with conventional concrete. Estimated Quantities of various works items likely to be involved in Lower Dam Construction are given in Table-4.6.

Table-4.6: Estimated Quantities in Lower Dam Construction

Foundation Excavation	Bank Volume[m^3]	Foundation Treatment	Length (m)
Common Excavation	309775	Consolidation Grouting	36000
Rock Excavation	132760	Curtain Grouting	37800
Total Quantity	**442535**	**Total**	**73800**
Concrete			
Non Overflow Section	658930		
Over flow Section	190050		
Total Quantity	**848980**		

Before completion of the coffer dam/ diversion Channel, excavation in the high banks of the Lower Dam on the left bank from left abutment upto right bank of the existing Turga Irrigation Dam is proposed to be completed. After Completion of the coffer dam / diversion, excavation of the dam foundation in the portion of the existing dam will be resumed and entire foundation excavation will be completed in 16 months during 14th month to 30th month. After foundation excavation, consolidation grouting is proposed to be carried out in 12 months, starting from 20th month to 32nd month. There after placement of concrete could be followed from 22nd month and continued raising the dam upto El 263 m so as to start with construction of the foundation gallery. On completion of the foundation gallery, curtain grouting could be continued from inside the foundation gallery so that raising of the dam could be continued without any interruption. Drainage holes may also be provided along with curtain grouting.

After construction of the foundation gallery at El 263m, construction of the dam body may be raised upto the Inspection gallery at El 283.0m as per drawings and as per specifications. On completion of the Inspection gallery, construction of the dam body (NOF) may be further raised to the dam crest by the end of 58th month of implementation. Overall concreting is proposed to be undertaken in 40 months.

Two batching and mixing plants, each 60 cum capacity or one B&M Plant of 100 cum/ hr capacity are proposed to cater to the concreting requirement of the dam. These plants are proposed to be established at suitable locations in the downstream of the dam. Arrangement for placing of concrete covering the entire dam area is proposed to be carried out with the help of three tower cranes with 50m boom length. Local pockets which will remain outside the periphery of tower crane will be taken care separately during placement.

The sequence of construction methodology and operations for the spillway construction shall be based upon the following :

- Excavation & loading of soft materials with 2.0 cum capacity Hydraulic Excavators and Ripping with 180hp Dozer and transportation with 18t RE Dumpers
- Drilling of 38mm dia holes @ 1.5m c/c with heavy duty Jack Hammers in the slopes and that in accessible areas with Crawler / Wagon Drills with 76mm bits and hole patterns with spacing of 2.75m c/c for rock excavation
- Loading of blasted rocks with 2.5 cum capacity Wheel Loaders assisted with 180hp Dozer and transportation of excavated rock materials in 22t capacity Rear End Dumpers
- Placing of concrete with Tower Cranes with 50m boom length and Concrete Pumps, 38 cum/hr
- Concrete transportation in Transit Mixtures of 8.0cum or buckets mounted on flat bed trucks
- Immersion Vibrator for compaction of concrete
- Batching & Mixing Plant of capacity of 2x 60 cum /hr or 1x100 cum/hr to be located preferably at near vicinity of the placement site. The rate of concreting shall be of the order of 95 cum/hr
- Aggregate crushing & screening plant (400TPH)for preparation of coarse and fine aggregates to feed batching and mixing plant through belt conveyor

(c) Construction of Lower Saddle Dam

Lower saddle Dam is an Earth & Rockfill dam, 50 high having crest length of 595m at El 320m.

Construction of the dam will involve about 1.64 Mm^3 excavation of soil & rock and 2.09 Mm^3 fill materials. Estimated Quantities of various works items likely to be involved in construction of Earth & Rockfill Saddle Dam is given in Table-4.7.

Table-4.7: Estimated Quantities in Saddle Dam Construction

Foundation Excavation	**Bank Volume[m^3]**	**Foundation Treatment**	**Length (m)**
Common Excavation	75680	Consolidation Grouting	2466
Rock Excavation	88060	Curtain Grouting	11250
Total Quantity	**163740**	**Total**	**13716**
Impervious Core	289170		
Sand Filter	82150		
Coarse Filter	139236		
Rockshell Material	1497615		
Rip Rap	81180		
Total Quantity	**2089351**		

On completion of foundation excavation of the Lower dam, the half of the set of equipment from lower dam may be diverted for excavation of the saddle dam foundation. Excavation in foundation which includes soil & rock excavation, is expected to be completed in 7months from 21st month to 27th month. After excavation of the bank slopes and stripping of the dam seat upto the rockline, excavation of the COT may be taken up. On excavation of the CoT upto the final grade for a certain reach, consolidation and curtain grouting may be started such that excavation of CoT and consolidation / curtain grouting would be followed simultaneously. Foundation treatment is proposed to be completed in 10 months during 23rd month 33rd month. After foundation treatment, placement of different fill materials may be taken up and continued till completion as per the drawings and specifications. Placement of embankment fill materials is intended to be completed in 28 months from 25th month to 53th month. The sequence of operations for construction of the saddle dam shall be based upon the following construction methods and equipment :

- Excavation & loading of soft materials with 2.0 cum capacity Hydraulic Excavators and Ripping with 180hp Dozer and transportation with 22t RE

Dumpers

- Drilling of 38mm dia holes @ 1.5m c/c with heavy duty Jack Hammers in the slopes and that in accessible areas with Crawler / Wagon Drills with 76mm bits and hole patterns with spacing of 2.75m c/c for rock excavation
- Loading of blasted rocks with 2.5 cum capacity Wheel Loaders and transportation of excavated rock materials in 28t capacity Rear End Dumpers
- 180hp Dozer for pushing blasted rocks
- Drilling of Grout holes with Rotary Drills and grouting with Grout Pumps, 38 cum/hr
- Loading of Fill materials at stockpiled sites with 3.5 cum capacity Wheel Loaders and transportation with 35t capacity RE Dumpers
- 180 HP Dozer at stockpiled sites
- 320hp Dozer at Embankment for rough spreading of fill materials
- Motor Grader, 145 hp
- Compaction with Vibratory Compactor, 10t capacity with smooth drum
- Compaction with Vibratory Compactor, 10t capacity, with pad foot drum
- Water Tanker, 28000 l capacity for Moisture control

4.5 UNDERGROUND WORKS

4.5.1 General

Underground works comprise mainly of (i) Power House system (25m(W)x53m (H)x160m(L) with adjoining Transformer cavern,[16m(W)X 16M (H) and 139.17 m (L)]; (ii) Water Conductor system and (ii) Switchyard System. The power house is to accommodate 4 units of 250 MW capacity and will have Transformer cavern duly connected with a busbar tunnel of about 46 m length. The water conductor system comprises of the Intake structure having Gate shafts (14.40 m dia x 45.6 m high), 2nos x 9.0 dia x 618 m long Water conductor/ Penstocks system each bifurcated to [9.0m dia x224.4m length x 2 lines and 9.0m dia x 73.7m length x4lines), to feed 4 Units of generating system. The Power House is connected to 4x bifurcated lines x 7.om diax108.5mlength (av) and thereafter confined to 2lines x 10.0m x 411.0m length, D-shaped Tailrace Tunnel to discharge the power house releases to the Lower dam.

Underground works comprising of water conductor system and the power house complex will involve several types of excavation like HRT / Access Tunnel & Work Adits, from horizontal to inclined whereas the gate shafts are vertical, and the power house complex will involve benching. It is planned to have 3.0m pull length for tunneling works whereas 1.5m depth of benching for power house and transformer cavern.

4.5.2 Construction of Water Conductor System

(a) Construction of Intake Structure and Gate Shafts

Since the road to intake is the first activity the work on intake can start from 15th month. Before taking up excavation of the Intake structure, construction of the portals and slope stabilization need to be carried out. Finished diameter of each the Gate Shaft is 12.40m and excavated diameter is 14.60m with height of about 46m. Quantities likely to be involved for construction of the Intake structure and the underground Gate Shaft as outlined in Table-4.8.

Table-4.8: Estimated Quantities for Intake Structure and Gate Shafts

Intake Structure	**Bank Volume[m^3]**	**Gate shafts**	**Length (m)**
Common Excavation	365580	Excavation	12560
Rock Excavation	243720	M20 & blockout concrete	6590
Total Quantity	**609300**		
Concrete	32850		

Excavation of the Gate Shaft may be carried out with the following sequence of operations :

(i) At first an appropriate sized chamber will be excavated for installation of the Raise Climber at bottom of the Gate shaft at about El 422.40 m with an access from the Intake point. The Pilot shaft of 2.5m dia shall be excavated upto ground level at about El 469 m , using Raise Climber from the bottom of the chamber

(ii) Widening of the Pilot shaft to full section will be done by Drill & Blast Method with benching of 1.5m deep and access from top over trolley travelling on rails and hauled by Winch at the top. The rails will continue to be extended as enlargement of the section will progress

(iv) Drilling blast holes with three Jack Hammers over the platform of the Raise Climber

(v) Charging holes by the Operators stationed over the platform

(v) Blasting after positioning of the Raise Climber into safe position at the bottom

(vii) Defuming by spraying mixture of air and water carried through mono rail of the climber

(viii) Removal of muck at bottom by deploying 3.0 cum capacity Side Dump Loader with 28t RE Dumpers through the Intake point ,

(ix) Rock supporting system will be installed concurrently as the excavation proceeds

(x) Lowering of the Steel liners from top by using the rails and subsequently concreting for filling around the ferrules.

4.5.3 Construction of Waterway [Headrace Tunnel]

(a) Construction of Adits

Prior to construction of the HRT, two Work Adits namely Adit to HRT near IP 2 and Adit to Lower Pestock need to be constructed. Excavation of these Work Adits can be started at the same time by Drill & Blast Method (Heading & Benching). With 8.0m deep Heading, followed with 1.7m(av.) deep Benching. With the average progress rate of tunneling @ 25m/month as calculated below, it is expected that construction of these Adits could be completed in 14 months starting from 16th month upto 27th month with the following cycle time of operations. Details of the Adits are given in Table-4.9.

Table-4.9 : Particulars of Work Adits for HRT

Particulars	Internal Dimensions (m)	Excavated Dimensions (m)	Length (m)
Adit to HRt near IP2	9.0 , circular	11.65	430 (1:95)
Adit to Lower Penstock	8.00 x 8.50, D-shaped, concrete lined	9.20 x 9.50[Lined]	333 (1:12)

(b) Construction of HRTs

Construction of both the HRTs is proposed to be undertaken simultaneously with the above progress rate and the following faces.

		Proposed Construction Time
(i)	Intake Point towards Gate Shaft : 80m	3 months [20-22]
(ii)	IP 2 towards Gate Shaft ; 533 X2	18 months [27-45]
(iii)	IP 2 towards IP3 (inclined) : 174X2m	25 months [32-57]
(iv)	IP 3 towards PH :73X4 m(with bifurcation)	12 months [26-38]

Excavation of the Adits and the HRT shall be based upon the following construction methods and equipment :

- Driving of Heading according to the class of Rocks (3.5m for Class I, 3.0m for Class II, 2.5m for Class II and 2m or less for Class IV type Rocks).
- Drilling of blast holes with 2-Boom Jumbo Drill with man–baskets[during Heading] and Wagon Drills for Benching
- Loading of blasted muck with 3.0 cum capacity Loader with side dump bucket , assisted with 320hp Dozer for ripping and transportation of muck in 28t capacity Rear End Dumpers
- Shotcrete with 15 cum capacity wet Shotcrete Machine with robot arm
- Rock bolting with fully mechanized Rock Bolting Rig, wherever required
- Transportation of concrete in 6 cum capacity Transit mixers
- Concreting from 20 cum/ hr. capacity Concrete Pumps
- Travelling steel Form, 10m long for concreting
- Piling / Stacking of mucks at disposal yard with 180HP Dozer

4.5.4 Construction of Access Tunnel, Power House Complex and Tailrace Tunnel

Power house complex comprises of Powerhouse cavern [25m (W)x 53m (H) x 160m (L)], Transformer Cavern [16m(W)x 16m(H)x 139.17m(L)], Access Tunnel and many other Adits as given in Table-4.10.

Table -4.10 : Particulars of Tunnels linked to Power House Complex

Name of Tunnel	Size & Shape	Length (m)
Main Access Tunnel[MAT]	8m x8.5m, D-shaped	430m
Exploratory Adit to the Crown of Powerhouse Cavern	8mx8.5m	120 m
Branch Tunnel to Service bay	8mx8.5m	**200m**
Work Adit to Tail Race Tunnel	8mx 8.5m, D-shaped	371m

Tail Race Tunnel	10m x 10m, D-shaped	541m
Ventilation Tunnel	3m x 3.5m, D-shaped	108m
Cable Tunnel	4.5m x 4.29m, D-shaped	140m

(a) Excavation of Adits

Excavation of the Adits shall be taken up as and when the portals are completed and will be carried out by Drill and Blast Method. Drilling will be done with 2-boom hydraulic jumbo drill using by full face method except the Tailrace Tunnel. Mucking will be done with a combination of side dump loader and RE dumpers. Suitable rock support, wherever necessary, will also be carried out as the excavation proceeds.

Main Access Tunnel (MAT) to Powerhouse Cavern shall be constructed first by Drill and Blast Method. Excavation of first 430m of this tunnel is proposed to be undertaken in 14 months during 5th month to 18th month. Thereafter branch tunnel of 200m to service bay level will be completed in 7 months. The branch to the top of crown of power house of 120m will be completed in 3 months during 19th month and finished by 22nd month. This adit will be extended inside the cavern to pass through the whole length of the powerhouse longitudinally to form a central passage.

After completion of the central passage, the entire width of the power house will be excavated in parts such that proper rock supports are left at places for the crown. At first, excavation will be completed in 2/3rd width along the crown along with providing rock supports of the crown with least initial deformations, before taking up remaining 1/3rd portion. Widening of the central passage to full width of the powerhouse roof to 25 m width will be carried out from the erection bay end. Roof supporting and concreting will be carried appropriately in stages as roof excavation proceeds. On completion of excavation and supporting of the crown of the powerhouse cavity upto EL 277.40 m , excavation of the powerhouse will be carried out by benching operations in stages. The blasted material during benching operation will be pushed to a tunnel at service bay level (extension of Main Access Tunnel) through glory holes. Thereafter, material will be disposed off through the main access tunnel. Concreting of side walls shall also be carried out in stages after excavation of the cavern. The excavation will start from 22nd month and complete in 55th month in 33 months. The concreting will start in 40th month and will be completed in 56th month.

(c) Construction of Transformer Cavern

Excavation of the Transformer cavern can be done through branch tunnel to transformer hall i.e part of MAT at El 290.0m. Firstly, pilot tunnel will be excavated from Main Access Tunnel at the Tailrace Tunnel side. Secondly, the cavern will be enlarged to be excavated to Powerhouse side and then, benched excavation will be done.

The construction methods and equipment for excavation of the Powerhouse and the Transformer Room with excavation of adits & tunnels shall be as follows :

- Driving the Main Access Tunnel to Powerhouse cavern by drill & blast method employing 2-boom Jumbo drill and 2.5 cum capacity side dump Loader with 18t RE Dumpers for mucking operations
- Driving the branch tunnel to the crown of Powerhouse with another set of the same type of equipment employed for the Main Access Tunnel
- Side wall slashing of branch tunnel to form crown of the Powerhouse with the same set of equipment
- Excavation of two benches of size 11.5m x 11.5m, in stages by employing crawler drill and jack hammers (two Sets) for drilling and 180 hp Wheel Dozer for pushing the muck through the glory holes
- Collection and disposal of muck from bottom of glory holes by using 2.5 cum capacity side dump Loader in combination with 18t capacity RE Dumpers

(d) Draft Tubes and Tailrace Tunnel System

The features of Draft Tubes and the Tailrace Tunnel System are given in Table-4.11.

Table-4.11: Features of Tailrace Tunnel System

Work Adit to Tail Race Tunnel (TRT)	8mx 8.5m, D-shaped	371 m
Tail Race Tunnel	10m x 10m, D-shaped	541 m
Gate Shafts	7.0m(W)X12.0m(L)x65m(H)	2 Nos

Excavation of the Tailrace system may be carried out as follows:

(i) From the entry face of the TRT Adit, which off-takes from the MAT towards the Draft Tube Tunnel

(ii) From the above entry face of TRT Adit towards Gate Shaft

(iii) From the Outlet Portal towards the Gate Shaft

After construction of the Adit that off-takes from the MAT , excavation of the manifold and the draft tube can be completed and the same time excavation of the TRT could also be continued from the same face. Further, excavation of the TRT may also be carried out from the Portal at the Outlet structure to reduce time and construction cost. Thereby, it is presumed that construction of the whole system can be completed in 29 months, spreading over April of Year 2 to April of Year 4 as detailed below :

- TRT Outlet Structure in 12 months from February ,Year 2 to January, Year 3
- Adit to TRT in 9 months from April, Year2 -Jan, Year 3
- Outlet gate Shafts in 10 months from may, Year3 to Feb,Year 4
- Tailrace Tunnel in 17months from Jan, Year 3 to May, Year 4

The Draft Tube Gate shaft is proposed to be excavated from the floor of the Transformer Cavern through benching operations similar to construction of HRT Gate shaft. Excavation of the Adit and the TRT ,etc shall be undertaken with the following construction methods and equipment :

- Driving of Heading according to the class of Rocks (3.5m for Class I, 3.0m for Class II, 2.5m for Class II and 2m or less for Class IV type Rocks).
- Drilling of blast holes with 2-Boom Jumbo Drill with man-baskets[during Heading] and Wagon Drills for Benching
- Loading of blasted muck with 3.0 cum capacity Loader with side dump bucket , assisted with 320hp Dozer for ripping and transportation of muck in 28t capacity Rear End Dumpers
- Shotcrete with 15 cum capacity wet Shotcrete Machine with robot arm
- Rock bolting with fully mechanized Rock Bolting Rig, wherever required
- Transportation of concrete in 6 cum capacity Transit mixers
- Concreting from 20 cum/ hr. capacity Concrete Pumps

- Travelling steel Form, 10m long for concreting
- Piling / Stacking of mucks at disposal yard with 180HP Dozer

4.6 CONSTRUCTION OF SWITCH YARD

Construction of Switch Yard is proposed to be undertaken in 12 months during May, Year 5 to Dec, Year 6

4.7 HYDRO-MECHANICAL WORKS

Installation of the Hydro-Mechanical[H-M]equipment will be carried out as soon as the associated civil works are in progress and / or completed as and when such requirements are called for H-M equipment ,relating to the following are proposed to installed / commissioned as per the schedules mentioned hereunder :

(i) D T Gates in 6 months
(ii) Upper & Lower Dam Outlet arrangement in 12 months
(iii) Intake Gates in 15 months
(iv) TRT Gates in 10 months

4.8 ELECTRO-MECHANICAL EQUIPMENT

Preparation of specification, processing of tenders, allotment of work and approval to suppliers drawings, etc is planned to be done during the year 2016-2017. Various activities related to supply, installation and testing is earmarked during the period of Sep, Year 2 to Dec, Year 5. Installation, Testing & Commissioning of the Electro-Mechanical Equipment are proposed to be undertaken as follows:

(i) EOT Cranes, 2sets in 3 months from Jul-Sep, Year 3
(ii) Pump Turbines, 4 sets in 30 months during Jul, Year 4 to Dec, Year 5
(iii) Generator Motor, 4 sets in 27 months during Oct, Year 4 to Dec, Year 5
(iv) Main Transformer, 4 sets in 15 months during Sep, Year 5 to Nov, 6
(v) Auxiliary & others , LS in 6 months during Jan-Jun, Year 6

CHAPTER-5

WATER RESOURCES

5.1 INTRODUCTION

The Turga Pumped Storage Project envisages utilization of hydro potentiality of Ajodhya Plateau. The project envisages the construction of upper dam across Turga Nala, a tributary of Subararekha river and a water conductor system with an underground Power House on the downstream of Upper Dam, a Lower Main Dam with ungated spillway and a lower saddle dam.

The existing reservoir of I &W Directorate of Government of West Bengal has a storage capacity 1.973 Mcum between MWL 274.93m and Dead storage level 262.74m. At present, this scheme provides irrigation over an area of 708 ha. The total requirement of crop (Kharif and Rabi) is 458.238 ha.m. The present proposal is to increase the gross storage capacity to 18 Mm^3 by shifting the axis and raising the height of lower dam. The gross storage capacity of the upper reservoir will be $21.6Mm^3$.

During peak hour, power will be generated by releasing the water from Upper Dam at the head available and water will be pumped back during off peak period. The catchment area Map of Lower Dam and upper dam is shown in Figure-5.1

Being a large Pumped Storage Project of 1000 MW on a small Nala (Turga Nala), the inflow series and rainfall data, plays a very vital role in project planning specially the impoundment schedule. The efficacy/ reliability of observed data play an important role in assessing the suitability of the project. However, such data must be consistent.

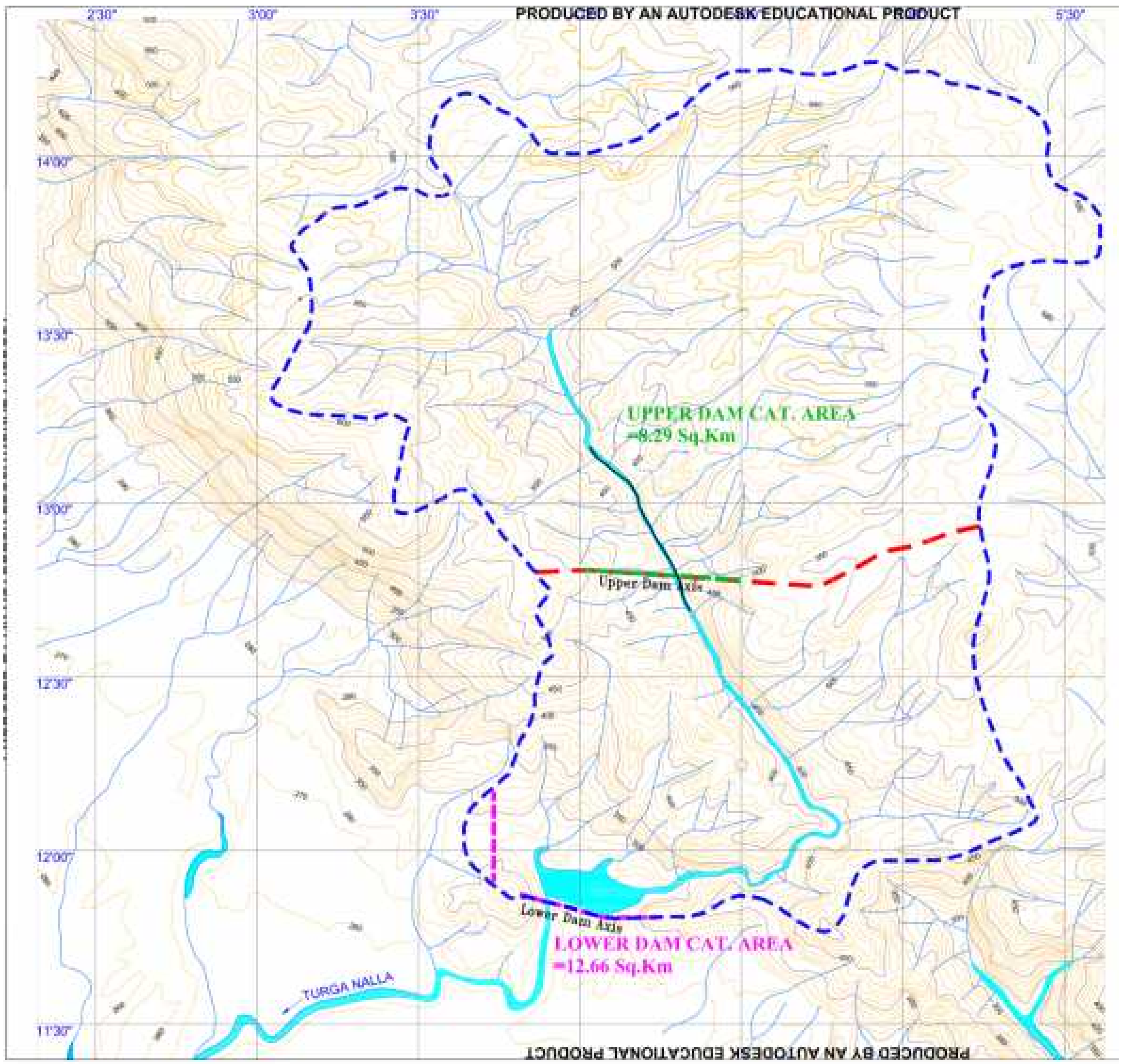


Figure-5.1: Catchment Area Intercepted at Upper and Lower Dam Sites

As a part of the Hydrological studies the following consistency checks were conducted:

- Rainfall Runoff correlation at Turga Lower Dam(1990-1997)- (Baghmundi site)
- Rainfall-Runoff correlation at Kistobazar Dam(1983-1989)
- Rainfall-Runoff correlation at Turga Lower Dam (1983-1997)
- Average-Monsoon Runoff Percentage to Average Monsoon Rainfall
- Statistical Checks at Baghmundi R.G. Station

5.2 DEVELOPMENT OF RUNOFF SERIES AT TURGA UPPER AND LOWER DAM

The discharge data available at two stations viz Kistobazar dam on Kistobazar Nala and Turga Lower Dam on Turga Nala have been clubbed to formulate discharge series for the period of 1983-1997. The discharge data was found to be consistent with the rainfall data except for the monsoon of 1984. The average monsoon runoff coefficient computed as 0.40. The month wise run off equation have been developed for the month season using the concurrent rainfall and discharge data from 1985-1997.

The rainfall runoff equations for Turga Upper and Lower Dams are given in Table-5.1.

Table-5.1: Rainfall-Runoff equation for Turga Upper and Lower Dam

Month	Regression Equation	R^2	R
June	Y= 0.264x – 27.43	0.81	0.9
July	Y= 0.432x -39.29	0.81	0.9
August	Y= 0.668x – 60.47	0.82	0.905
September	Y= 0.411x +38.75	0.83	0.911
October	Y= 0.178x + 0.10 x_{-1} +22.99	0.52	0.721

Where X- Rainfall (mm) of current month, X_1- Rainfall (mm) of previous month and Y- Runoff (mm)

The long-term rainfall data is available at Baghmundi rain gauge station, which falls near the catchment area of the project site for the period 1958-2012. The missing rainfall data for the period 1998-2000 have been filled up using the concurrent rainfall data of Ayodhya hill rain gauge station. The average annual rainfall at Baghmundi rain gauge station works out to 1334 mm.

Based on the above rainfall-runoff equations and Baghmundi having long term rainfall data the monsoon month flow series has been computed at Lower Turga Dam Location. The non-monsoon flow has been considered as 11% of the monsoon flows based on the rainfall data pattern at Baghmundi raingauge station. The inflow series at Turga upper dam location has been computed by transferring the Lower Dam series in catchment area proportion. The inflow series of upper and lower dams are appended as Annexures II and III respectively.

Based on annual inflow data enclosed as Annexure II and III, assessment of yield in various dependable years is shown in Table-5.2.

Table-5.2: Annul Inflow for 50%. 75% and 90% Dependable Year

Year	Annual Inflow (MCM)		Exceedance Probability
	Upper Dam	Lower Dam	
2011	6.58	10.04	1.79%
1967	6.34	9.68	3.57%
2012	6.22	9.50	5.36%
1995	6.21	9.48	7.14%
1997	6.11	9.33	8.93%
1985	6.05	9.23	10.71%
1990	5.98	9.14	12.50%
2007	5.82	8.90	14.29%
1999	5.74	8.76	16.07%
1971	5.73	8.74	17.86%
1964	5.52	8.43	19.64%
1984	5.45	8.33	21.43%
2008	5.45	8.32	23.21%
1994	5.36	8.18	25.00%
1970	5.35	8.17	26.79%
1974	5.14	7.84	28.57%
1986	5.05	7.71	30.36%
1987	4.97	7.60	32.14%
1968	4.96	7.57	33.93%
1958	4.88	7.45	35.71%
1992	4.88	7.45	37.50%
1996	4.85	7.40	39.29%
1963	4.77	7.28	41.07%
1978	4.75	7.25	42.86%
1989	4.71	7.19	44.64%
2009	4.65	7.11	46.43%
1961	4.60	7.02	48.21%
1973	4.60	7.02	50.00%
1981	4.53	6.92	51.79%
1960	4.50	6.88	53.57%
1962	4.50	6.86	55.36%
1959	4.44	6.78	57.14%
1983	4.32	6.60	58.93%
1991	4.31	6.58	60.71%
1965	4.27	6.52	62.50%
1993	4.19	6.41	64.29%
1980	4.16	6.35	66.07%
1998	4.00	6.10	67.86%
2002	3.91	5.97	69.64%
2001	3.85	5.88	71.43%
2006	3.70	5.66	73.21%
1972	3.68	5.63	75.00%
1988	3.64	5.56	76.79%
2004	3.63	5.54	78.57%
2003	3.42	5.23	80.36%
1977	3.22	4.92	82.14%
2005	3.06	4.67	83.93%
2000	3.05	4.65	85.71%
1969	2.95	4.51	87.50%
1982	2.94	4.49	89.29%
1975	2.92	4.45	91.07%
1979	2.74	4.18	92.86%
1966	2.59	3.96	94.64%
1976	2.29	3.50	96.43%
2010	2.29	3.50	98.21%

The average 75% and 90% dependable flows at the two dam site are given in Table-5.3.

Table-5.3: Average 75% and 90% dependable flows at Upper and Lower Dam Sites

Location	Catchment Area (Sq. Km)	90% dependable flow (Mcum)	75% dependable flow (Mcum)	50% dependable flow (Mcum)	Average annual Runoff (Mcum)
Lower Dam	12.66	4.47	5.63	7.02	6.88
Upper Dam	8.29	2.93	3.68	4.6	4.51

The power potential studies for the two dams have been carried out taking into account the irrigation and water supply requirements.

The monthwise water availability for 90% dependable year for Upper and Lower Reservoir of Turga Pumped Storage Project are given in Table-5.4.

Table-5.4: Water availability for 90% Dependable Year

Month	Upper Reservoir	Lower Reservoir
June	0.11	0.17
July	0.38	0.58
August	0.02	0.04
September	1.55	2.37
October	0.56	0.86
Total Monsoon (A)	**2.63**	**4.01**
Total Non-Monsoon (B)	**0.29**	**0.44**
Total Annual (A+B)	**2.92**	**4.45**

5.3 DESIGN FLOOD STUDIES

5.3.1 PMF for Lower and Upper Dam

The hydraulic head of both the dam are more than 30 meter. According to the criteria BIS 11223-1985 these dams are to be designed for Probable Maximum Flood condition.

Since the catchment area of the two dams (Lower Dam 12.66 sq. km& Upper Dam 8.29sq km.) is small and stream slope is steep, the design flood has been estimated by Rational formula approach. From the latest PMP atlas of Mahanadi and adjoining river basin, one day SPS depth has been taken as 565mm and one day PMP as 735mm. The Moisture Adjustment Factor 30% (MAF1.3) is considered after applying clock hour correction subject to maximum 50 mm, the 24 hour PMP value has been computed as 785mm and the same has been adopted to estimate the PMF for the Lower & Upper Dam. A loss rateof 1.5mm/hour and base flow 0.05 cumec/ sq. km have been considered as given in the Flood Estimation Report of CWC. The PMF of Lower and Upper Dam works out to 428 cumec and 280 cumec respectively which have been considered for the design. The details of PMF calculations are enclosed as Annexure-IV.

5.3.2 Diversion Flood

According to BIS 14815-2000, the diversion flood for concrete dams is to be higher of maximum observed non monsoon flow at the dam site and 25 year return period flow computed based on non-monsoon peaks. In the absence of observed non monsoon flood peaks nearby station, the 25 year return period flood has been estimated by Rational formula considering 25 year return period rainfall at the project site location as 24 cm as per Isopluival maps of Eastern India (Part-II) published by IMD. The 25 year return period flood of 167 cumec and 109 cumec have been computed for the Lower and Upper Dam, respectively.

5.4 SEDIMENTATION STUDIES

In the absence of sediment observed data at the site or nearby, the sediment rate 1045 cum/sq.km./year (1.045 mm/year) has been adopted based on the average sediment rate of Indo-Gangetic Plains. The New zero elevation for upper dam after feasible service time (i.e. 70 years) has been computed as 408.2m which is much Lowerthan the MDDL 448 m by Empirical area reduction method.

The sedimentation studies for Lower Turga Dam could not be carried out by empirical area reduction method due to incomplete reservoir elevation area-capacity of the reservoir which could not be obtained below FRL and the concerned values have been linearly interpolated between 255m to 274.625m. Since the size of the catchment is small, the new zero elevation after feasible service time(i.e. 70 years) has been computed by area increment method as 255.42m which is much below the MDDL. 280m.

5.5 IMPOUNDING SCHEDULE

RESERVOIR IMPOUNDING SCHEDULE AND MEASURES

Reservoir impounding schedule study is conducted for deciding the development schedule of the project.

The power plant would start its operation after the completion of impoundment for upper and lower reservoirs.

The calculation of the impounding period is made based on the monthly inflow data recommended in the hydrological study.

Following items below are about the filling calculation.

Features of Reservoirs

Upper Reservoir

Catchment Area	: 8.29 km^2
FRL	: EL. 464.0 m
MDDL (for pumped storage power plant (PSPP))	: EL. 444.4 m
Vg (Gross Storage Capacity including irrigation and other purpose)	: $21.560 \times 10^6 m^3$
Vi (Storage Capacity for Irrigation and other purposes)	: $1.5 \times 10^6 m^3$
Ve (Effective (Live) Storage Capacity for PSPP)	: $14.2 \times 10^6 m^3$
Vd (Dead Storage Capacity)	: $5.876 \times 10^6 m^3$

Lower Reservoir

Catchment Area (Intermediate)	: 12.66 km^2 (4.37 km^2)
FRL	: EL. 316.5 m
MDDL (for pumped storage power plant (PSPP))	: EL. 280.4 m
Vg (Gross Storage Capacity)	: $18 \times 10^6 m^3$
Ve (Effective (Live) Storage Capacity for PSPP)	: $14.2 \times 10^6 m^3$
Vd (Dead Storage Capacity)	: $3.8 \times 10^6 m^3$

Necessary storage capacity for generating one (1) unit

Required live storage capacity

Ve' =discharge (max) ×unit (1)×generation time (5 hours)

$$197 \times 1 \times 5 \times 60 \times 60 = 3.546 \times 10^6 \ m^3$$

The least necessary storage capacity

$$V(1) = Vd\ (upper) + Vd\ (lower) + Ve' = (5.876 + 3.773 + 3.546) \times 10^6 \ m^3$$

$$= 13.195 \times 10^6 \ m^3$$

Necessary storage capacity for generating four (4) units

Required live storage capacity

$$Ve' = 197 \times 4 \times 5 \times 60 \times 60 = 14.184 \times 10^6 \ m^3$$

The least necessary storage capacity

$$V(1) = Vd\ (upper) + Vd\ (lower) + Ve' = (5.876 + 3.773 + 14.184) \times 10^6 \ m^3$$

$$= 23.833 \times 10^6 \ m^3$$

Hydrological Data

Inflow before impounding

Monthly inflow series of upper and lower dams used for estimating the impounding schedule of the project are shown in Annexures-II and III are summarized in Table-5.5.

Table-5.5: Annual Inflow

	Upper Dam (MCM)	Lower Dam (MCM)	in mm
Annual Inflow	4.51	6.88	544

Rainfall

The monthly rainfall data at Baghmundi Raingauge Station from 1958 to 2012 is used for the reservoir impounding schedule.

Evapo-transpiration (E_{TA})

Evapo-transpiration from the project area can be calculated as outlined in Table-5.6. Same values of evapo-transpiration are used for upper and lower reservoir areas.

E_{TA} = Rainfall – Inflow (before impounding)

Table-5.6: Evapotranspiration

(Unit: mm)

	June	July	Aug.	Sep.	Oct.	Monsoon Total	Non Monsoon Total	Annual
Rainfall	232	330	308	259	73	1,202	137	1,339
Inflow	35	104	145	145	62	490	54	544
E_{TA}	197	226	163	114	11	712	83	795

Note: the above figures are average from 1958 to 2012

Evaporation from Reservoir

Evaporation from upper and lower reservoirs is given in Table-5.7. Same values of evaporation are used for upper and lower reservoirs.

Table-5.7: Evaporation from Reservoir

(Unit: mm)

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
70	80	140	180	210	170	110	120	100	90	70	50	1,390

The above figures are exactly same as those used for Purulia Pumped Storage Project (PPSP).

Reservoir storage capacity/area curves

The reservoir storage capacity/area curves for impounding schedule are shown in Figure-5.2 and Figure-5.3 respectively.

Evaporation volume from reservoir is assumed to be exactly proportional to submerged area, which of upper reservoir varies from 0.53 km^2 (at MDDL) to 0.93km^2 (at FRL) and that of lower reservoir varies from 0.28 km^2 (at MDDL) to 0.53 km^2 (at FRL) approximately.

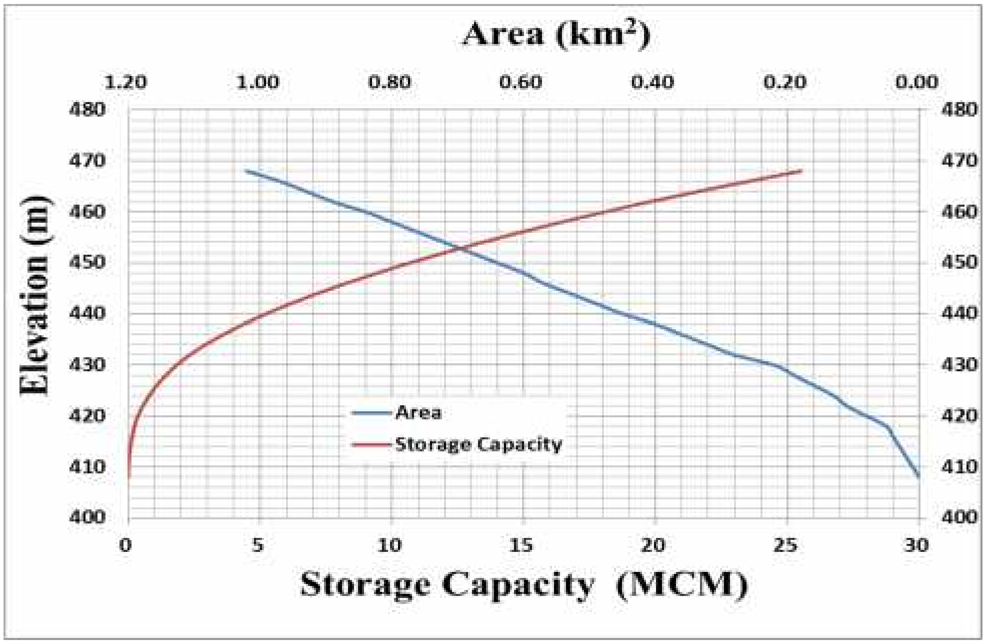


Figure-5.2: Upper Reservoir Storage Capacity / Area Curve

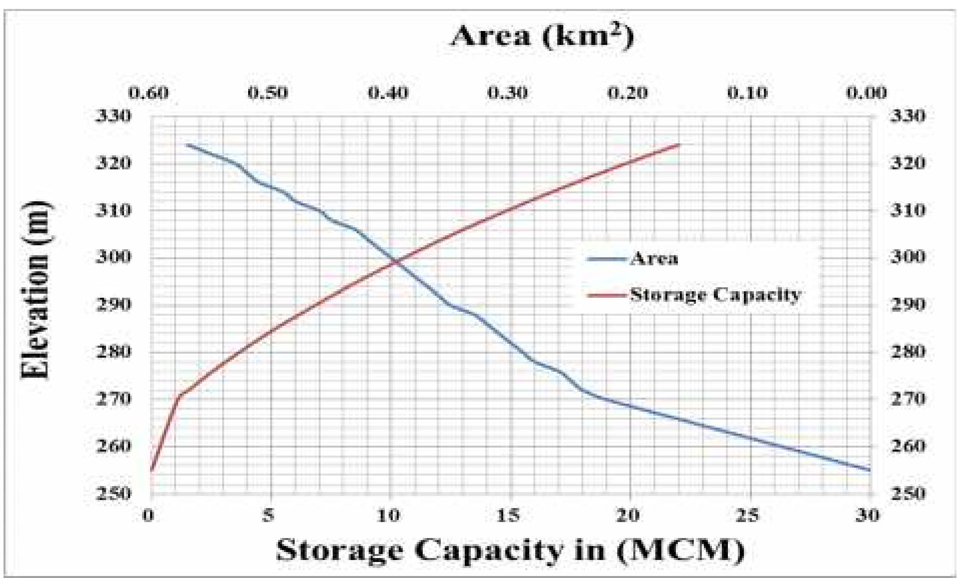


Figure-5.3:Lower Reservoir Storage Capacity / Area Curve

Inflow during impounding

Inflow to reservoir can be calculated as following. Since the volume of evaporation varies according to the area of reservoir, it is necessary to continue the calculation until obtaining convergent state.

$Q_2 = Q_1 \times (CA - A_R) + [R - (E - E_{TA})] \times A_R$

where.

Q_2 : Inflow during impounding (mm)

Q_1 : Inflow before impounding (natural inflow) (mm)

CA : Catchment area (km^2)

A_R : Reservoir area (km^2)

R : Rainfall (mm)

E : Evaporation from reservoir (mm)

E_{TA} : Evapotranspiration from river basin (catchment area) (mm)

Impounding Schedule

The required periods of reservoir impounding for commencement of the project are calculated under following conditions.

- Irrigation and other water demand required at the downstream of the lower reservoir would be supplied from other water resource during the reservoir impounding of the project.
- Irrigation and other water which must be kept at the upper reservoir would be stored after full (four (4) units) operation of the project

Following three (3) scenarios under difference hydrological conditions (average, wet and dry) are considered to estimate the required period for plant operation.

Average Year

By using monthly average inflows to both reservoirs from 1958 to 2012, the required period of reservoir impounding for one (1) unit operation and four (4) units operation were calculated.

The shortest period and the longest period for first unit operation are to start impounding from the beginning of the monsoon season (June), which takes seventeen (17) months, and from July or August or September or October, which takes twenty-four (24) months.

It can be said that two (2) monsoon seasons to two (2) years are necessary for one (1) unit operation if the average inflow data is used.

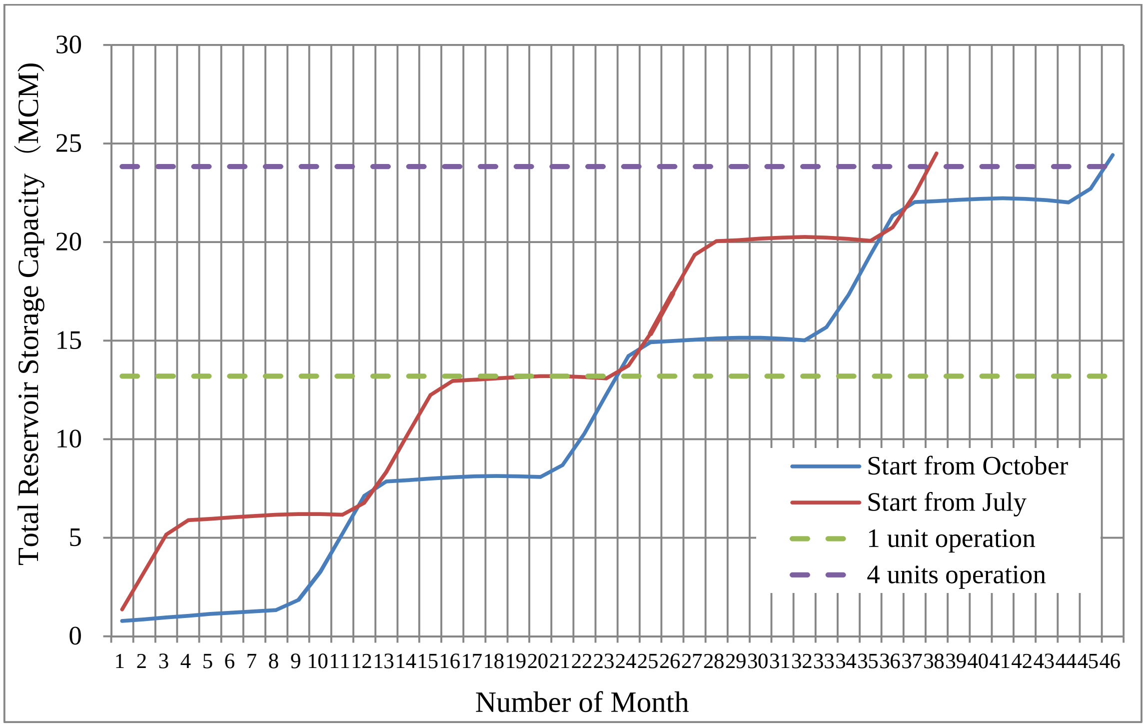


Figure-5.4:Impounding Schedule for Average Year

The shortest period and the longest period for four (4) units operation are to start impounding from July or August or September, which takes thirty-eight (38) months, and from October or November, which takes forty-six (46) months.

It can be said that three and half (3.5) monsoon seasons are necessary for four (4) units operation if the average inflow data is used.

Wet Year

By using monthly inflows to both reservoirs from 1958 to 2012, the shortest required period of reservoir impounding for one (1) unit operation and four (4) units operation were calculated.

The shortest periods for first unit operation and four (4) units operation are to start impounding from August 1995 to August 1996, which takes thirteen (13) months, and from August 1995 to September 1997, which takes twenty-six (26) months.

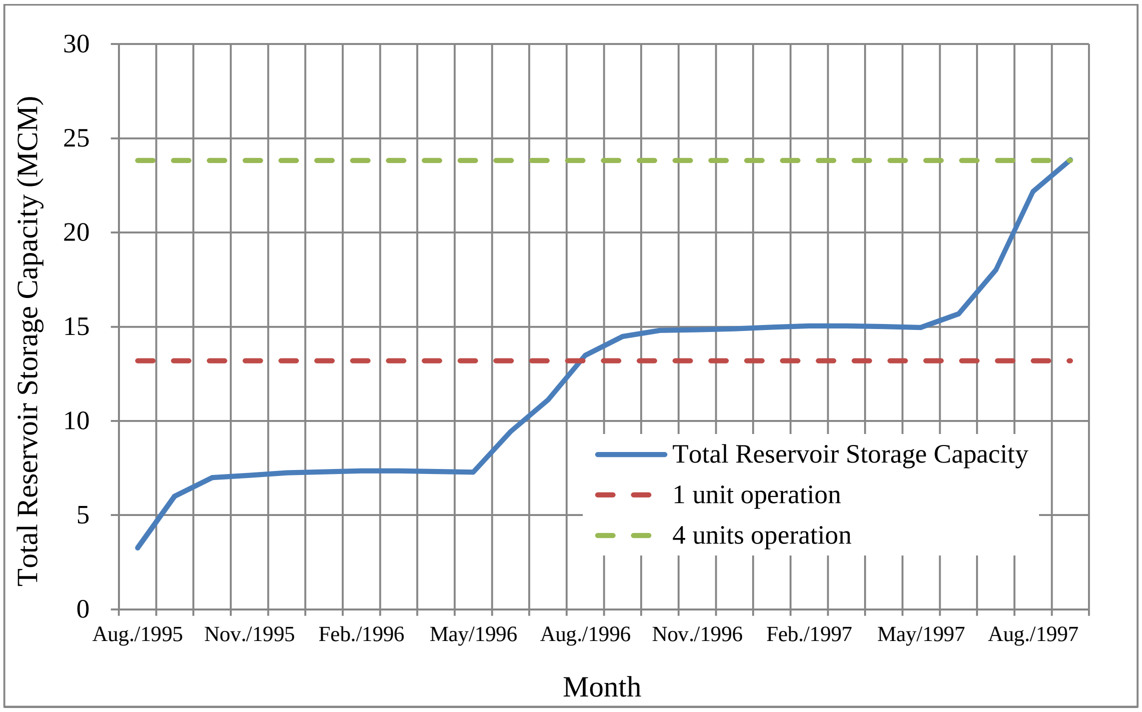


Figure-5.5 Impounding Schedule for Wet Years

It can be said that only one (1) year plus one (1) month are enough for one (1) unit operation if the reservoir impounding fortunately starts in the wettest year (the heaviest rainy monsoon year), and two (2) monsoon seasons plus two (2) months are enough for four (4) units operation if impounding fortunately starts at the beginning of successive three (3) wet years.

Dry Year

By using monthly inflows to both reservoirs from 1958 to 2012, the longest required periods of reservoir impounding for one (1) unit operation and four (4) units operation are calculated.

The longest period for first unit operation and four (4) units operation are to start impounding from August 1975 to July 1978, which takes thirty-six (36) months, and from August 1975 to July 1980, which takes sixty (60) months.

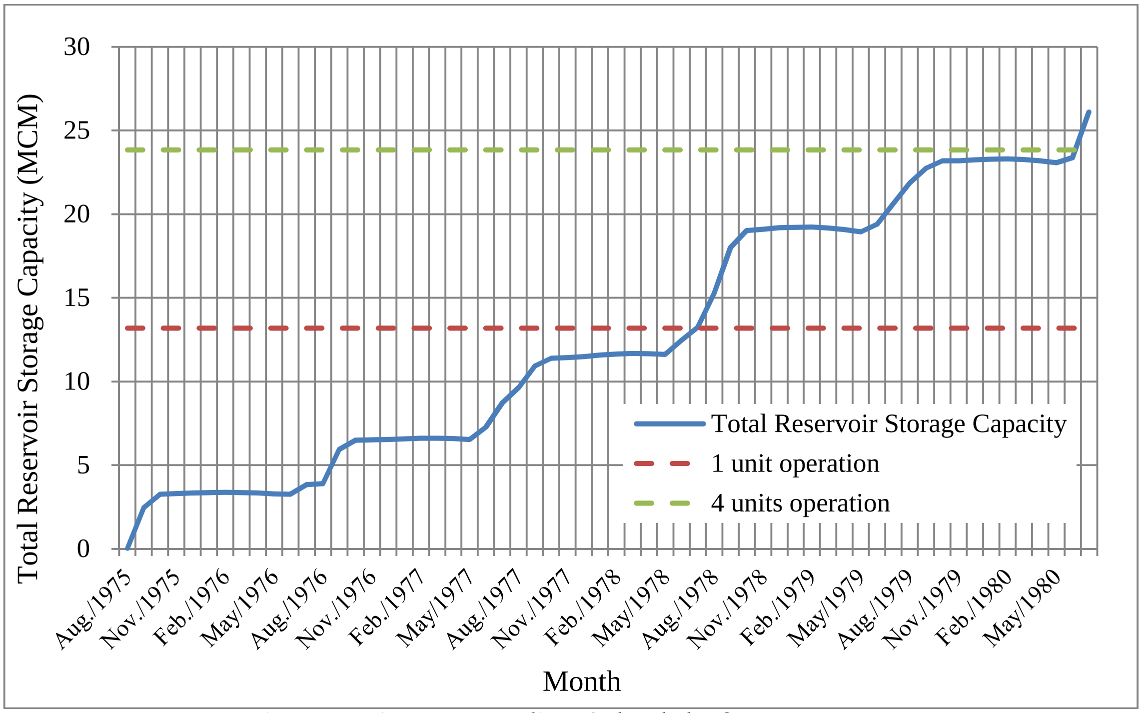


Figure-5.6: Impounding Schedule for Dry Years

It can be said that three (3) years are necessary for one (1) unit operation and five (5) years are necessary for four (4) units operation if impounding unfortunately starts at the beginning of successive dry years.

Consideration of Environmental Flow Release

In this study, the impounding schedule is estimated based on the condition that environmental flow can be supplied from other water resources and inflow to upper and low dams can be fully utilized for pumped storage project.

Here, the worst case, that other water resources are not available at all, is examined by estimating how the impounding period becomes longer than the original.

Environmental Flow

Minimum environmental flow release would be 20% of average of four months of lean period and 25% of flow during non-lean non-monsoon period corresponding to 90% dependable year. The cumulative flow releases including spillage during monsoon period should be 30% of the cumulative inflows during the monsoon period corresponding to 90% dependable year.

Since there is no lean period in this area, the environmental flows during monsoon period and non-monsoon period for the upper dam are 0.79 (2.63 × 30%) MCM and 0.07 (0.29 × 25%) MCM respectively, and those for the lower dam are 1.20 (4.01 × 30%) MCM and 0.11 (0.44 × 25%) MCM respectively.

Impounding Schedule for Average Year (considering environmental flow)

By using monthly average inflows to both reservoirs from 1958 to 2012, the required period of reservoir impounding for one (1) unit operation and four (4) units operation are calculated.

The shortest and the longest periods for first unit operation are to start impounding from August, which takes twenty-five (25) months meaning eight (8) months longer that the original, and from October, which takes thirty-four (34) months meaning ten (10) months longer than the original.

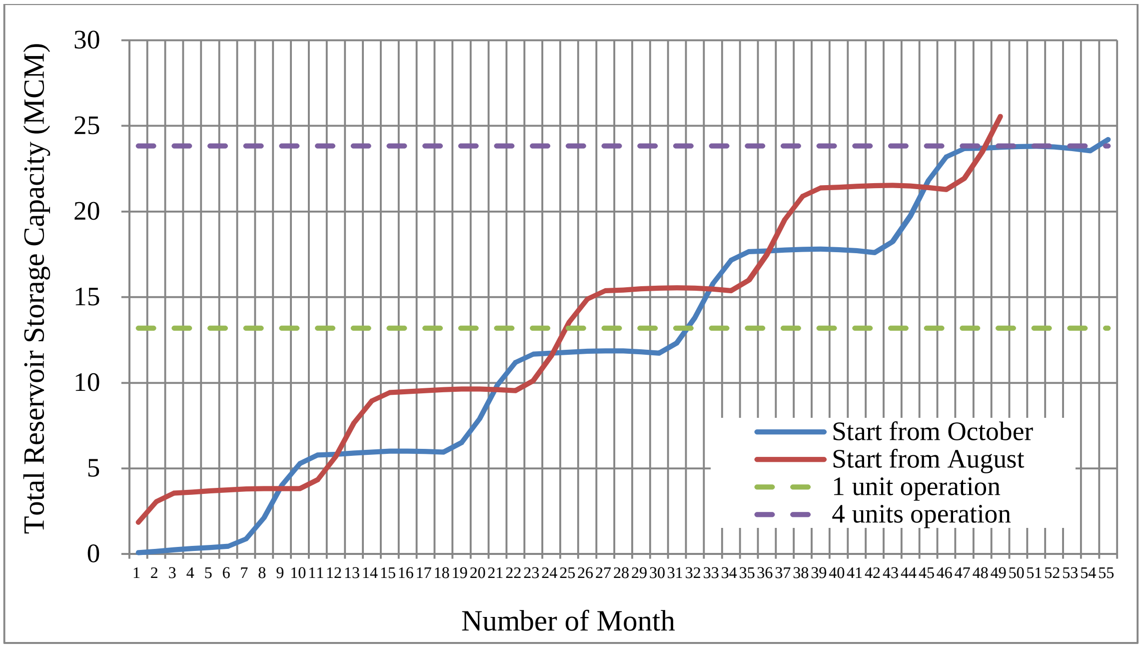


Figure-5.7Impounding Schedule for Average Year (with envirometal flow)

The shortest period and the longest period for four (4) units operation are to start impounding from July or August or September or October, which takes forty-nine (49) months meaning eleven (11) months longer than the original, and from December, which takes fifty-five (55) months meaning nine (9) months longer than the original.

Impounding Schedule for Wet Year

The required period of reservoir impounding for one (1) unit operation and four (4) units operation are calculated taking into account environmental flow release against the shortest periods of the original, which start from August 1995, without consideration of environmental flow release.

The start months for first unit operation and four (4) units operation change from thirteen (13) months later to twenty-three (23) months later, which means ten (10) months longer, and from twenty-six (26) months later to thirty-seven (37) months later, which means eleven (11) months longer.

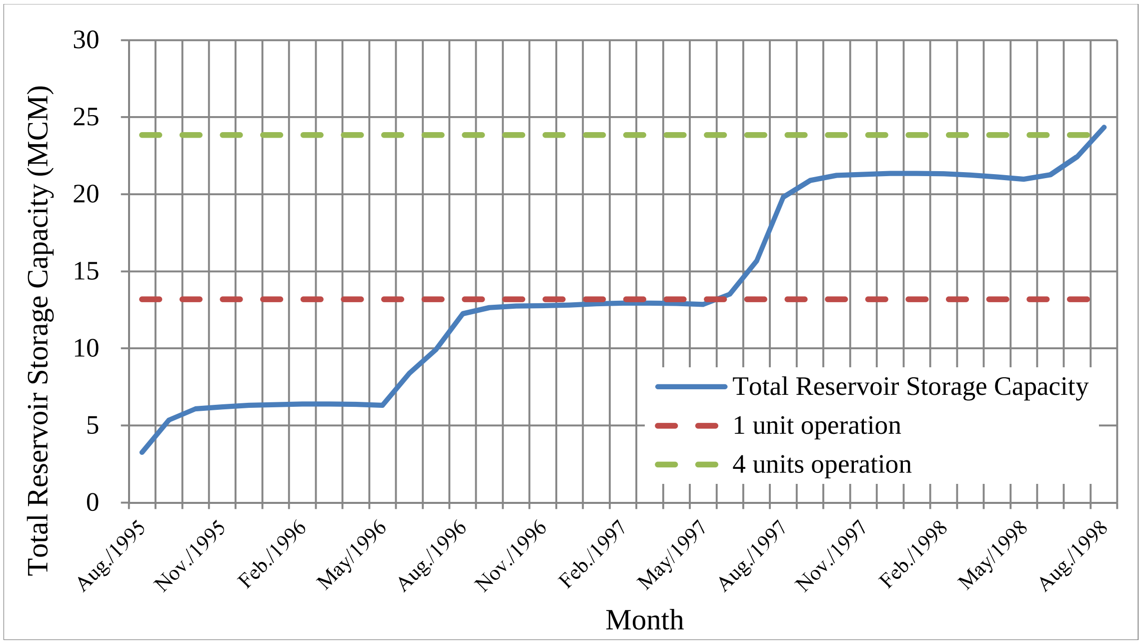


Figure-5.8Impounding Schedule for Wet Years (with environmental flow)

Recommendation

To shorten the reservoir impounding period for the plant operation, it is recommended to consider partial reservoir impounding during the construction works of the dams during the detailed study. As a matter of course, the related rules and regulations to partial impounding must be preserved.

It might be possible to start reservoir impounding during the construction works of embankment at the upper and lower dams under following conditions from technical aspect.

- Construction works of spillway portion of dam is completed
- Construction works of embankment portion reaches to a certain elevation, which can keep a certain overflow depth to discharge a flood
- Reservoir water elevation even during a certain flood would not be permitted to exceed the height of embankment at any time

CHAPTER-6

BASELINE STATUS –PHYSICO-CHEMICAL ASPECTS

6.1 GENERAL

Before start of any Environmental Impact Assessment study, it is necessary to assess the baseline levels of relevant parameters which are likely to be affected as a result of the construction and operation of the proposed Turga Pumped Storage project. A similar approach has been adopted for conducting the CEIA study for the proposed Turga Pumped Storage Project.

The baseline status has been divided into following three categories:

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

The baseline setting for physico-chemical aspects have been covered in this Chapter. The field studies have been conducted for three seasons as detailed in Table-6.1.

Table-6.1: Details of field studies conducted as a part of CEIA studies

Season	Months
Winter	December 2013 – January 2014
Summer	April 2014
Monsoon	August – September 2014

As a part of the study, detailed field studies on various aspects were conducted. Baseline status has been ascertained for the following aspects:

- Meteorology
- Geology
- Seismology
- Soils
- Landuse
- Ambient air quality
- Ambient Noise Levels
- Water Quality

The information presented in this Chapter has been collected by the Consultant through field studies, interaction with various government departments and collation of available literature with various institutions and organizations

6.2 METEOROLOGY

Meteorologically, the year can be divided into three distinct seasons. Winter season sets in from the month of November and continues upto February, followed by summer season from

March to June. The area receives rainfall under the influence of south-west monsoons from mid-June to September. The period from mid-September to October is the post-monsoon season or the retreating monsoon season.

Rainfall: As per approved CWC Hydrology Report the average annual rainfall at Baghmundi rain gauge station works out to 1334 mm which is very close to the annual average rainfall in the project area district i.e.1310.9 mm. Majority of the annual rainfall is received under the influence of south-west monsoons. The maximum rainfall is received in the months from July to September.On an average, there are 72 rainy days in a year. The monthwise rainfall received in the project area district is given in Figure-6.1.

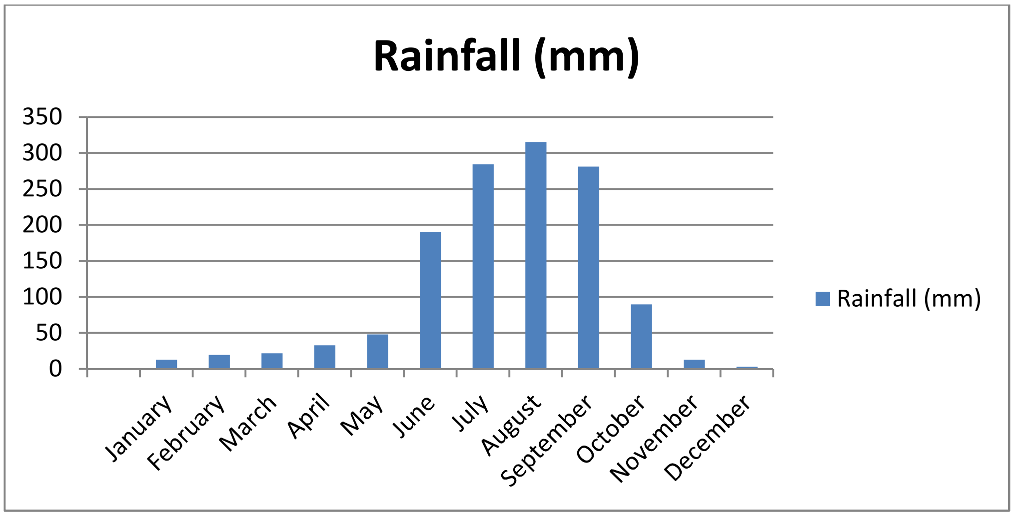


Figure-6.1: Monthwise Variation of Rainfall in Project Area District

Temperature: The temperature continuously increases from March up to the month of May, which is the hottest month of the year. The mean maximum and minimum monthly temperatures in the month of May are 39.6°C and 26.5°C respectively. With the onset of monsoons in mid-June, there is a drop in the temperature. January is the coldest month of the year, with the monthly mean of daily maximum and minimum temperatures being 25.3°C and 12.4°C respectively. The month-wise temperature variations in the project area district are shown in Figure-6.2.

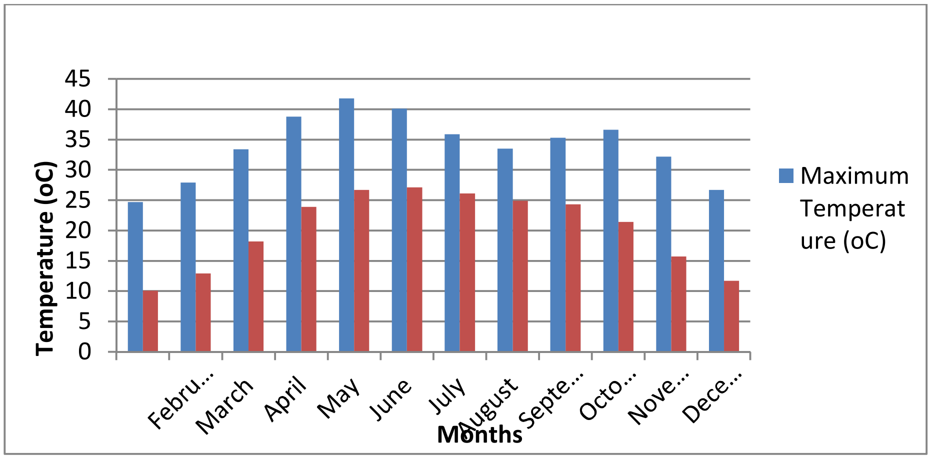


Figure-6.2: Monthwisevariations in Maximum and Minimum Temperatures in Project Area District

Humidity: The humidity in the air is generally low throughout the year except during the rainy season. The summer months are the driest with relative humidity being as low as 46% to 31% at 17:30 hrs. The month-wise variations in humidity in the project area district are depicted in Figure 6.3.

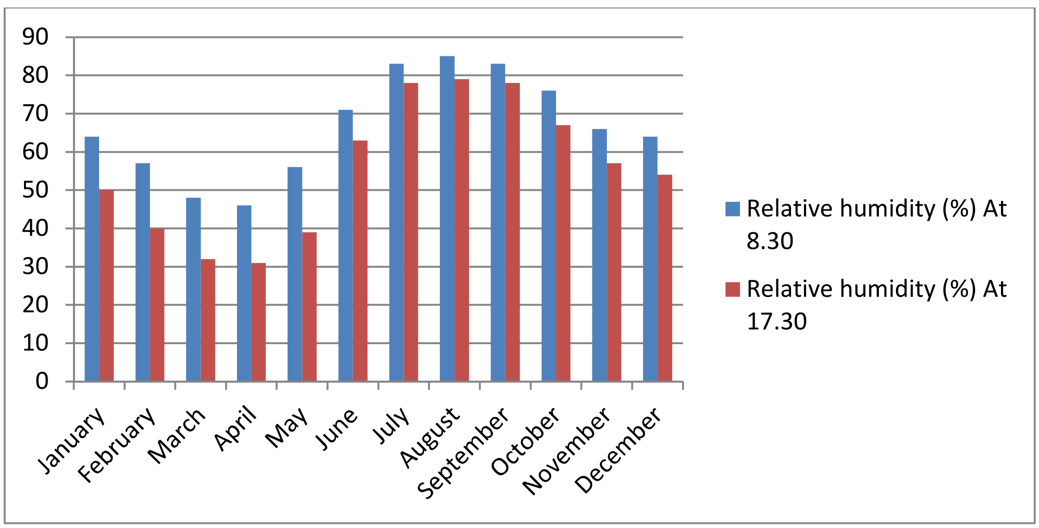


Figure-6.3.: Monthwisevariation in Humidity in Project Area District

The monthly data on various meteorological parameters and special weather phenomena in the project area district is summarized in Table-6.2.

Table-6.2: Average meteorological conditions in the project area district

Month	Temperature (°C)		Rainfall (mm)	No. of rainy days	Relative humidity (%)		Wind velocity (km/hr)
	Maximum	Minimum			At 8.30	At 17.30	
January	25.3	12.4	12.9	1.2	64	50	3.1
February	28.5	15.2	19.3	1.8	57	40	3.9
March	34.0	19.8	21.6	2.1	48	32	4.5
April	38.5	24.5	32.8	2.5	46	31	5.6

Month	Temperature (^oC)		Rainfall (mm)	No. of rainy days	Relative humidity (%)		Wind velocity (km/hr)
	Maximum	Minimum			At 8.30	At 17.30	
May	39.6	26.5	47.9	3.5	56	39	6.7
June	36.2	26.2	190.4	10.0	71	63	6.7
July	32.1	25.1	284.3	16.4	83	78	6.0
August	31.5	24.8	315.4	15.9	85	79	5.4
September	31.6	24.4	280.9	12.7	83	78	4.9
October	31.1	21.9	89.6	4.9	76	67	3.5
November	28.6	17.0	12.6	1.0	66	57	2.9
December	25.6	12.9	3.2	0.4	64	54	2.8
Average	**31.9**	**20.9**			**67**	**56**	**4.7**
Total			**1310.9**	**72.4**			

Source: IMD

6.3 GEOLOGY

6.3.1. Regional Geology

The Turga Project area located in Ajodhya Hills, lies in the tectonic regime of Chhotanagpur Gneissic Complex (CGC).This covering an area of 100,000 km^2forms the eastern extension of the Central Indian Tectonic Zone(CITZ).Chhotanagpur Complex (CGC) lies north of the E–W trending North Singhbhum Mobile Belt (NSMB); (Refer Figure-6.4).

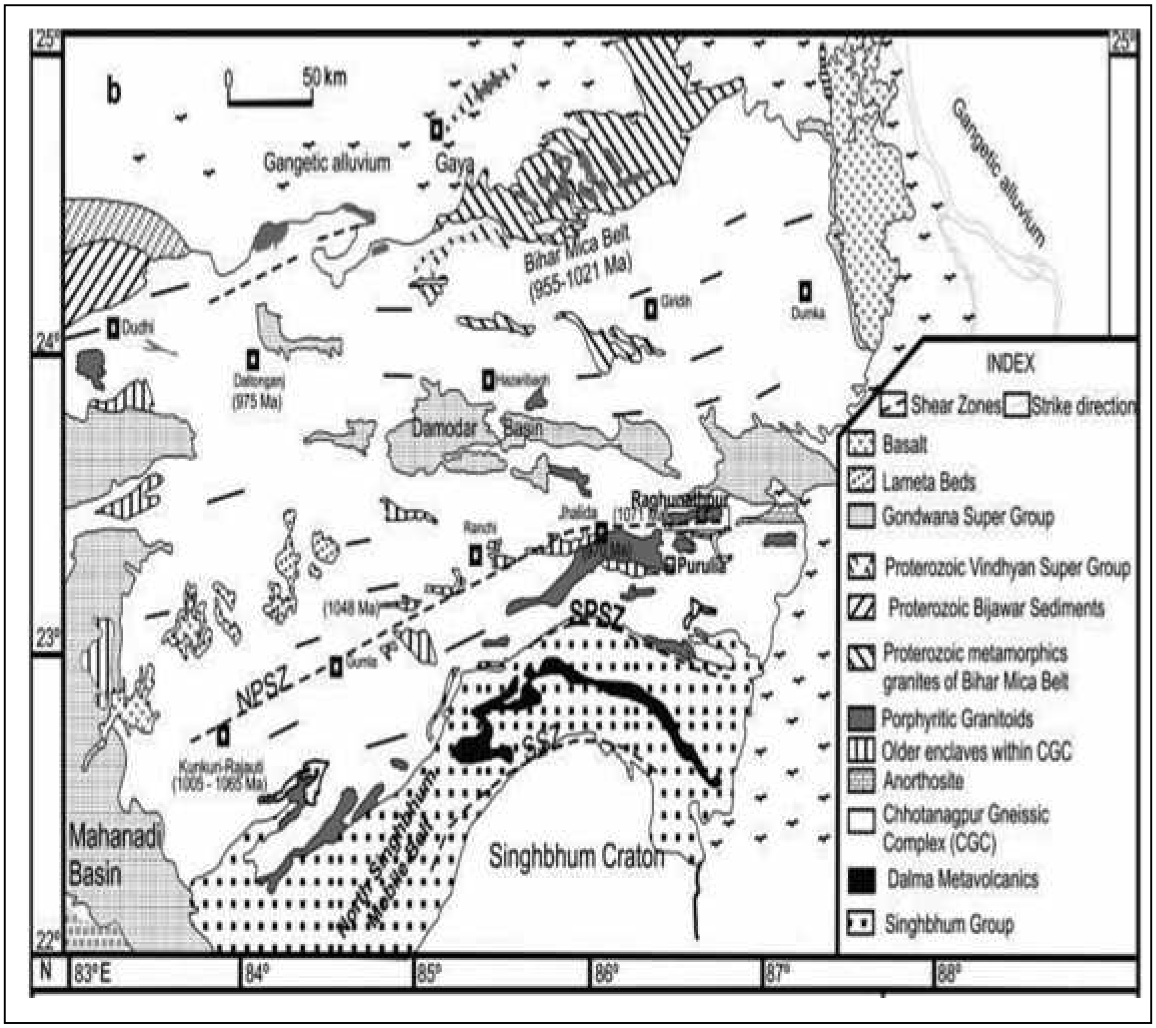


Figure-6.4: Geological map of the Chhotanagpur Gneissic Complex (CGC)(After Basu1993)

The boundary between the NSMB and the CGC is marked by the South Purulia Shear Zone (SPSZ;Basu, 1993). The northern and eastern frontier of the CGCiscovered by the Ganga-Brahmaputra alluvial deposits.In the west, the CGC is separated from the main Central Indian Tectonic Zone (CITZ) by younger Gondwana sediments. The structural trend of the CGC is approximately ENE–WSW to E–W and conform to the CITZ (Acharyya,2003). The Chhotanagpur Gneisses Complex is seemingly terminated towards east by GammoynaKhandaGhosh- Rajmahal Fault system (Refer Figure-6.5).

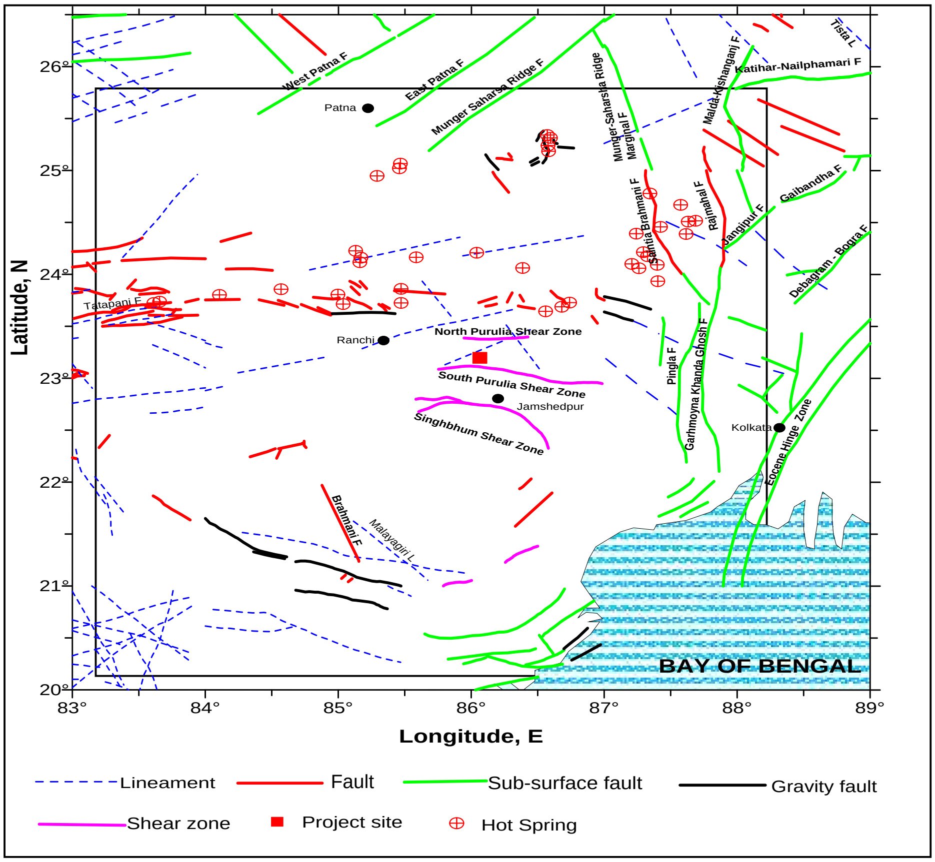


Figure-6.5: Major tectonic features Chhotanagpur and adjacent regimes (after GSI 2000)

The CGC is characterized by predominant granitoid gneisses and migmatites (Paleo- to Neo-Proterozoic) with older (Archean) enclaves of meta-pelitic gneisses, amphibolites, calc-granulites, quartzite's, charnockites, leptynites, and mafic granulites, and younger intrusives of granites, pegmatites, norites, anorthosites and alkaline rocks (Mahadevan, 2002).The study area constitutes mainly the crystalline rocks comprising quartzo-feldspathic gneiss and its migmatitic variants belonging to the Chhotanagpur Gneissic Complex which is equivalent to the Chaibasa Formation or Singhbhum Granite of Archean/Proterozoic age. It is younger than the Iron Ore Group of Rocks lying further south, separated by a WNW-ESE trending SPSZand northerly dipping shear zone, extending from south of Baghmundi to Khariduara in Purulia district, and then further eastward towards KhatrainBankura district. Granite gneisses of different petrological variations, migmatites, mica schist, phyllites, slates, epidiorites, amphibolites and quartzite's are the principal rocks exposed in the area (Refer Figure-6.6).

6.3.2 Geology & Geomorphology of Ajodhya Plateau area

The Project is located in Ajodhya Hills between South Purulia Shear zone (SPSZ) and North Purulia Shear Zone (NPSZ). The area has undergone three phases of tectonic deformations (Das, 1991). The deformation in the Phase-I has North-South principal compressive direction developing the isoclinal fold (F1) with E-W sub-horizontal axes and overturning towards south responsible for the development of S1 axial plane schistosity. The Phase-II has North-South to NE-SW compressive stress developing isoclinal, reclined to asymmetric inclined folds (F2) with easterly and westerly plunging axes responsible for the development of dominant S2 - crenulation/fracture cleavage. As compared to the above, Phase – III has East-West compression developing gentle to open cross folds (F3) with northerly plunging axes formed by folding of S2 foliation plane. In the project domain the prominent foliation trend swings from E-W to NW-SE with low to moderate dips towards North and NE (**Refer Figure-6.6**)

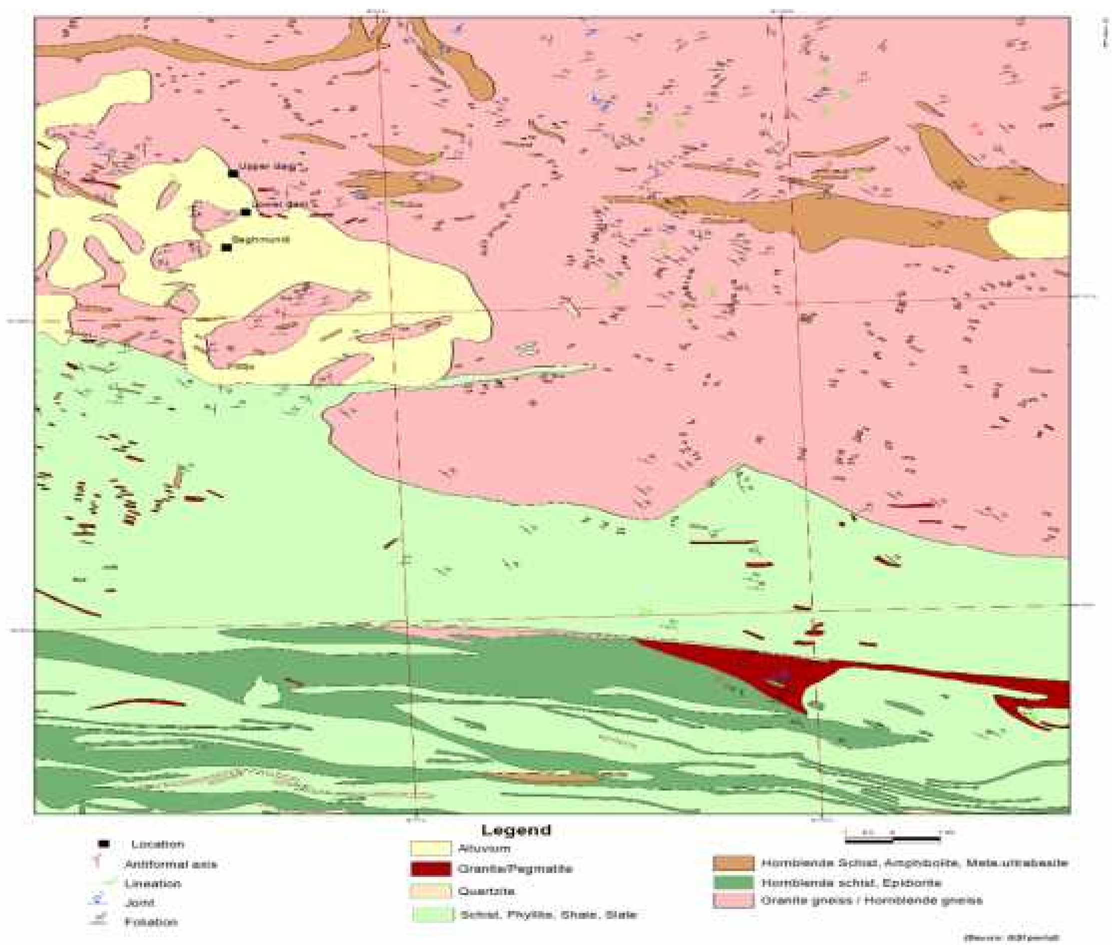


Figure-6.6: Regional Geological Map around the Turga Pumped Storage Project, Purulia district, West Bengal

The Ajodhya Hills lying in CGC forms a prominent plateau. The Plateau is traversed by NNW-SSE, E-W& NNE, SSW trending shear zones. The drainage system in the area is mostly structurally controlled with valleys trending along these structural elements. The Plateau is characterized by an extensive planation surface (EL>500m).Towards south and south west the plateau slopes steeply with flat low level plain (EL < 400m) at the foothill.

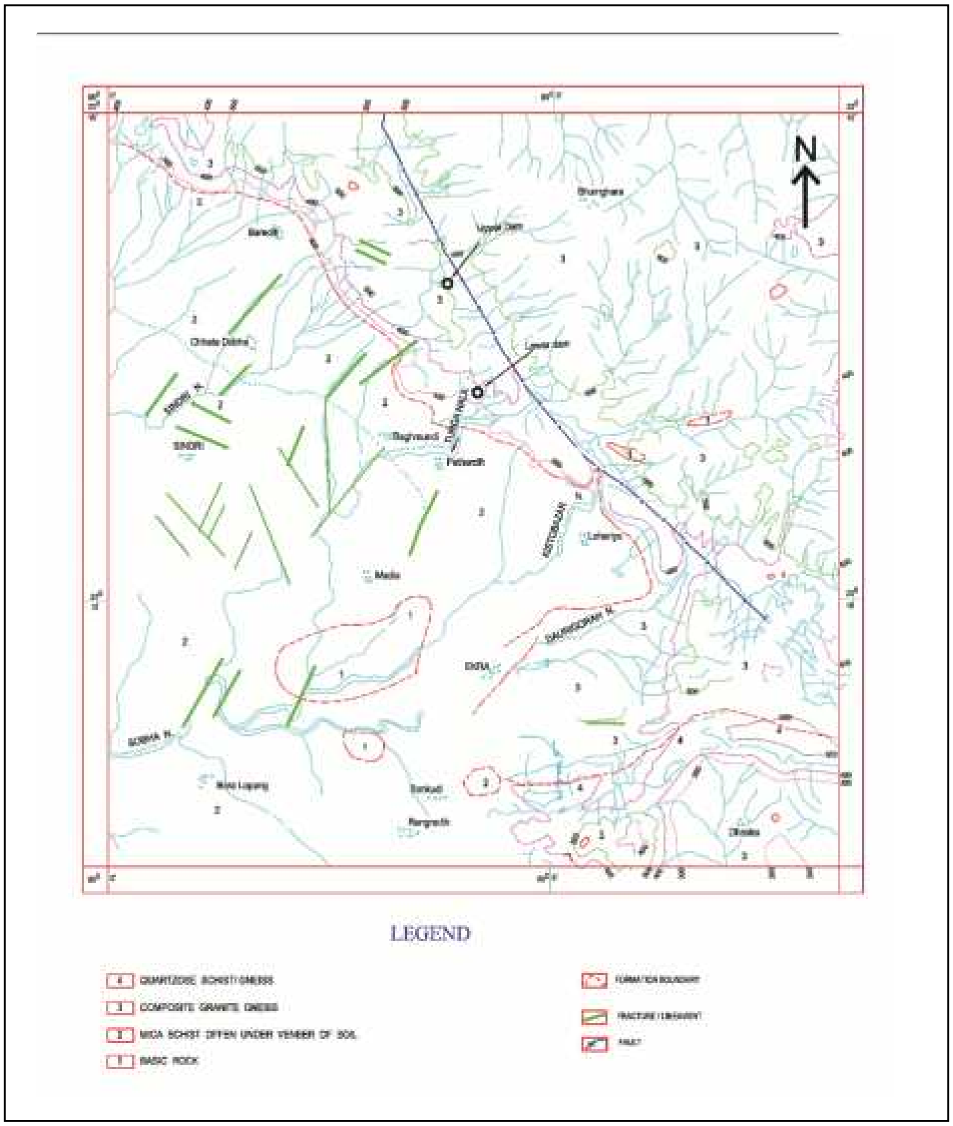


Figure-6.7: Photo Geological map of the area around Baghmundi, Purulia District and West Bengal (modified after Chakraborty,1998)

The Turga Pumped Storage Project is located near Bagmundi on the southern margin of the plateau. The drainage around the project area two seasonal rivulets namely Kistobazar and TurgaNala, is structurally controlled by NE-SW and E-W trending fracture/ lineaments /prominent master joints display dendritic to sub-rectangular pattern.

The TurgaNala originates from the Ajodhya Plateau near Lepsitar village and flows towards SE along a remarkably straight alignment for a distance (~ 4.0 km) and then abruptly turns towards WSW before entering the alluvial plains towards Baghmundi village. Within the hilly segment, this stream appears to follow a lineament. This prominent and conspicuous lineament has been inferred to be shear zone/fault within granite gneisses on the basis of photo signatures and indications of feather joints on either side of the zone (Chakraborty, 1988).

The proposed Upper Rock Fill Dam of Turga Pumped Storage Project is located across this linear segment of TurgaNala with moderate slopes cut in the plateau whereas the Lower Dam is across the lower reaches of TurgaNala transecting a structural hill. The Under Ground Power House (UGPH) and associated water conductor system is located in the main plateau domain. The geological map showing layout of the project is shown in Figure-6.8.

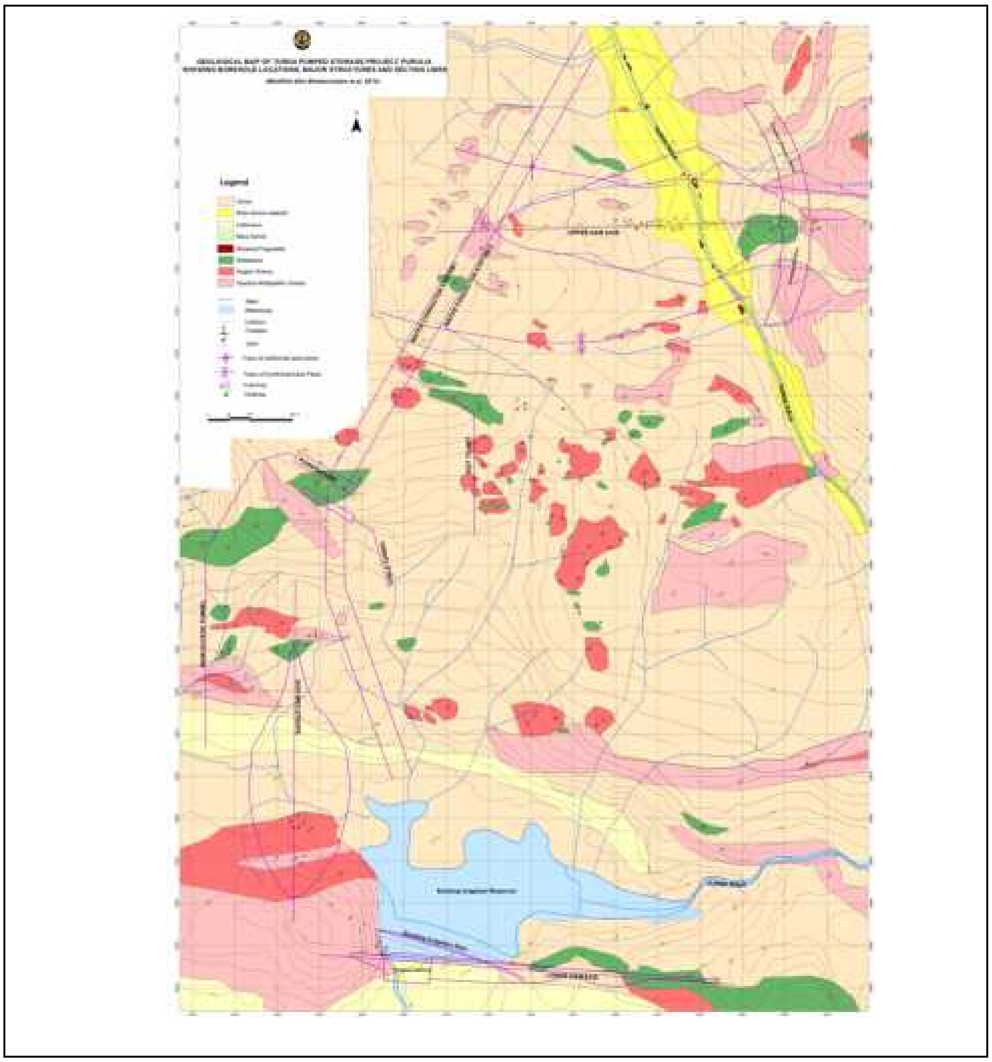


Figure-6.8: Geological map showing lay-out of the project

The project area consists dominantly of hard compact quartzo-feldspathic gneisses and its petrological variants and subordinate zones of meta-basic rocks (e.g., amphibolite gneiss).Three major litho-types of gneisses are: (i) augen gneiss with minor pegmatites, (ii) quartzo-feldspathic gneiss with minor mica- gneiss and (iii) quartz-biotite gneisses. The gneisses at many places show migmatitic structure with relict bands of amphibolite &schists, pegmatitic permeations and ptygmatic quartz veins.

Hard and competent quartzo-feldspathic gneiss exposed on the left abutment of the proposed upper dam alignment of Turga PSP. The bedrock also shows broad warping.

Along the Turga river bed in the upper dam area, isolated exposures of highly sheared and fractured quartzo-feldspathic gneissare also noted. The valley slopes are characterized by sporadic rock outcrops and colluvium/scree cover with thickness ranging between 1 m and 10 m. Locally, quartzo-feldspathic gneisses exposed along the Turganala bed are highly fractured, sheared and silicified.

Highly fractured /sheared quartzo-feldspathic gneiss exposed in TurgaNala bed.

At the lower dam site quartzo-feldspathic gneisses are exposed in the river section; a prominent meta-basic body occurs on the left abutment.The power house area exposes continuous sheet of gneisses on the southern limb of synform with large tract of meta-basics.

As discussed earlier, the Chhotanagpur Gneiss complex has undergone multiphase deformation with complex system of folding; in the project domain superposition of three generations of folds are discernible .The prominent foliation general trends in 80° and 120°sectorwith dips ranging between 30° and 55° towards North and Northeast. However due to the presence of large and open warps, low to moderate (30°-35°) dips towards SSE have also been observed. The plateau between lower and upper dams, exhibit abroad synformal warp. The fold axis of the warp plunges gently towards ESE (160°-170°). Examining various alternatives, Under Ground Power House (UGPH) has been located south of the hinge zone of the synformal warp.

In general, rocks are traversed by 3+ random sets of joints and yield mostly prismatic blocks; the exposed rock mass, in general, are attributed with GSI values of 70 to 85.

In the reservoir areas of both the proposed upper as well as lower dams and also the moderately steep hill slopes around the project area, no active landslides or signs of slope instability are noted.

6.4 SEISMICITY

As discusses earlier the Turga Pumped Storage Project Complex has undergone three phases of deformation and metamorphism during Proterozoic period. Subsequently the areas witnessed prolonged extensional tectonics generating half –grabenGondwana basins north of the Ajodhya Hills.

In the central portion, shear zones mark the boundaries of the major geological provinces. The Singhbhum Shear zone has an E-W trend in the central part, which takes a gradual south-easterly and south-westerly swing towards east and west respectively. In the west, it branches out and follows the northern and southern boundary of the Chakradharpur Granite Gneiss, which is considered to be tectonically emplaced basement element within an otherwise normal stratigraphic sequence. Another high strain zone, the south Purulia Shear zone (SPSZ), is present in the eastern part along the boundary between the Proterozoic Fold Belt of Northern Singhbhum and the Chhotanagpur Gneissic Complex(CGC). Further north, within the gneissic terrain of Chhotanagpur, development of another shear zone (North Purulia Shear zone NPSZ) is noted. Other major tectonic discontinuities include basin marginal faults of the Gondwana Basins, which run parallel to the regional structural grain. The epicenters of past earthquakes with major tectonic features in the region of Turga Pumped Storage Project domain is given in Figure-6.5.

The presence of several hot springs in association with mild seismicity (Refer Figure-6.5) within the Damodar Valley GondwanaGraben are indicative of further reactivation along these fault system. Recent studies by GSI reveal evidences of contemporary activity along the basin marginal fault of the Talchir Basin. Several transverse faults are also reported from this area, which are well documented within the Gondwana sequence. Some of these discontinuities, particularly the Brahmani Fault, which controls the Brahmani River Valley, have neo-tectonic signatures.

The project site lies in seismic Zone-III as per the zoning map of India (IS: 1893-2002, Part-1). The analysis of seismicity Turga Pumped Storage Project has been carried out by CWPRS, Pune. These studies has been performed followed the guidelines of NCSDP.

The data on past earthquakes (magnitude>4.8) around the project site is collated. These earthquake events have been correlated with tectonic features of the domain (Refer Figure-6.9). Proximal to the project two earthquakes 5.9m (Dated 3.5.1968 & 3.5.1969) have been recorded at an epicentral distance of 59km from the Project. These are found to be endemic to south PuruliaShearZone (SPZ, Refer Figure-6.9). Within a distance of 300 km, the largest earthquake of magnitude 6.0 had been recorded with epicenter at a distance of 217.1 km from the site on 4th June 1764.

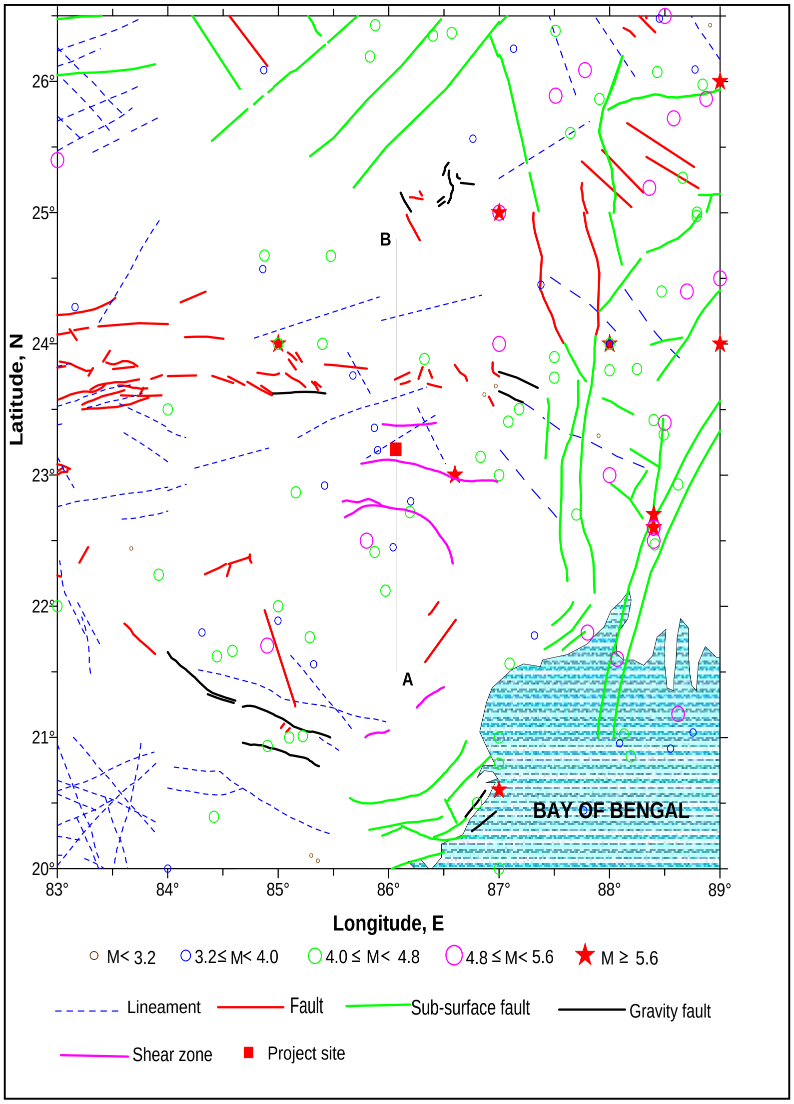


Figure-6.9: Epicenters of past earthquakes with major tectonic features in the region of Turga PSP domain

Based on the tectonics and past seismicity of the area the deterministic and probabilistic seismic analyses have been performed. Five numbers of area sources have been identified and analyzed for evolving design seismic parameters .For the deterministic estimate of the site-specific design ground motion for Turga project, the magnitude of the MCE is taken as 6.2 at an epicenter distance of 9.4 km from the site. The median response spectra of horizontal and vertical components for this MCE, with damping ratio of 5 % are taken as the deterministic target spectra. The DBE spectra are taken to be one standard deviation less than median value. The probabilistic estimates of the spectra are obtained for return periods of 2500 years and 475 years for MCE and DBE conditions respectively. The MCE and DBE levels of design accelerograms for horizontal and vertical components of motion are generated to be compatible with the recommended target spectra. The design accelerograms of horizontal and vertical components of motion are obtained separately using the respective target spectra and suitable phase differences. The values of the peak ground acceleration for horizontal and vertical components are found to be 0.176 g and 0.128 g for MCE; and 0.108 g and 0.075 g for DBE conditions respectively. Smoothed design response spectra are computed for damping ratios of 2%, 3%, 5%, 7%, 10% and 15% of critical from the MCE and DBE levels of design accelerograms.

6.5 SOILS

Soil is the product of geological, chemical and biological interactions. The soil in a region varies according to altitude and climate. As a part of field studies, soil samples from the catchment area were collected and analysed. The monitoring was conducted for three seasons namely winter,summer and monsoon seasons. The details of soil sample monitoring are given in Table-6.5. The locations of various sampling locations are given in Figure-6.10.

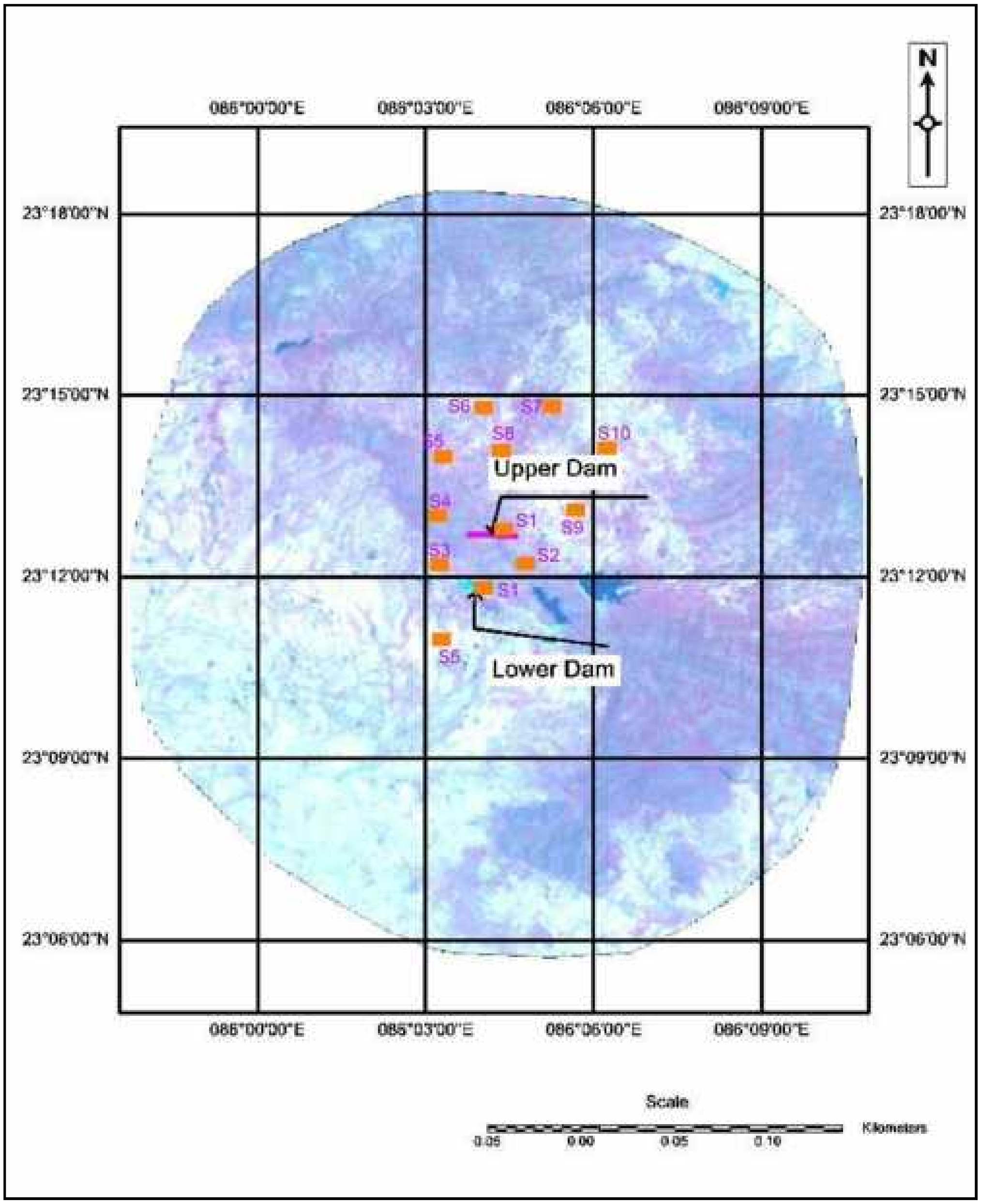


Figure-6.10: Soil sampling location map

Table-6.5:Soil quality in the catchment area

Parameters	Stations									
	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**
Winter Season										
pH	7.1	7.3	7.2	7.2	7.4	7.2	7.4	7.2	7.3	7.1
Electrical conductivity (milli mhos/cm)	0.15	0.20	0.16	0.17	0.18	0.20	0.17	0.18	0.15	0.20
Nitrogen, kg/ha	270	212	310	290	350	310	320	290	240	270
Phosphates, kg/ha	190	150	145	180	220	170	250	210	200	180
Potassium,kg/ha	10	15	12	12	18	20	17	15	15	12
Organic matter (%)	1.2	1.1	1.5	1.5	0.7	1.5	0.9	1.0	1.0	1.5

Parameters	**Stations**									
	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**
Summer Season										
pH	7.2	7.3	7.2	7.3	7.5	7.3	7.4	7.2	7.3	7.2
Electrical conductivity (milli mhos/cm)	0.16	0.22	0.17	0.18	0.20	0.24	0.19	0.19	0.16	0.22
Nitrogen, kg/ha	250	210	150	170	330	290	200	275	225	230
Phosphates, kg/ha	180	140	135	170	210	150	220	200	190	175
Potassium,kg/ha	9	12	14	11	15	20	15	12	12	10
Organic matter (%)	1.0	1.0	1.3	1.2	0.6	1.4	0.8	0.9	0.9	1.2
Monsoon season										
pH	7.1	7.2	7.1	7.0	7.2	7.2	7.4	7.2	7.3	7.1
Electrical conductivity (milli mhos/cm)	0.15	0.20	0.16	0.17	0.18	0.20	0.17	0.18	0.15	0.20
Nitrogen, kg/ha	270	212	310	290	350	310	320	290	240	270
Phosphates, kg/ha	180	150	145	180	220	170	250	210	200	180
Potassium,kg/ha	9	12	14	14	20	22	20	18	17	15
Organic matter (%)	1.0	1.0	1.4	1.5	0.8	1.4	0.8	1.0	1.0	1.2

The soils are in neutral range. The EC level are low. The EC levels indicate that the salt content in the soils is low. The level of various nutrients and organic matter indicates low to moderate soil productivity.

6.6 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. Resourcesat-2, LISS-III digital satellite data was procured from National Remote Sensing Agency (NRSA), Hyderabad. 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 FCC and classified images of the study area are shown in Figures-6.11 and 6.12 respectively. The land use pattern of the study area is outlined in Table-6.6.

Table-6.6:Landuse pattern of the study area based on satellite data

S.No.	**Category**	**Area(ha)**	**Area(%)**
1	River/ Water body	223	0.53
2	Vegetation	13189	31.13
3	Agricultural Land	12325	29.09
4	Barren Land/Rocky outcrops	10839	25.58

S.No.	Category	Area(ha)	Area(%)
5	Scrub	5708	13.47
6	Settlements	83	0.20
	Total	**42367**	**100.00**

The major landuse category of land in the study area is under vegetation as it accounts for 31.13% of the study area. The area under agricultural land accounts for about 29.09% of the total study area. Barren land/ Rocky outcrops occupy about 25.58% of the total study area. Settlements and water bodies account for about 0.2% and 0.53%, respectively of the study area respectively.

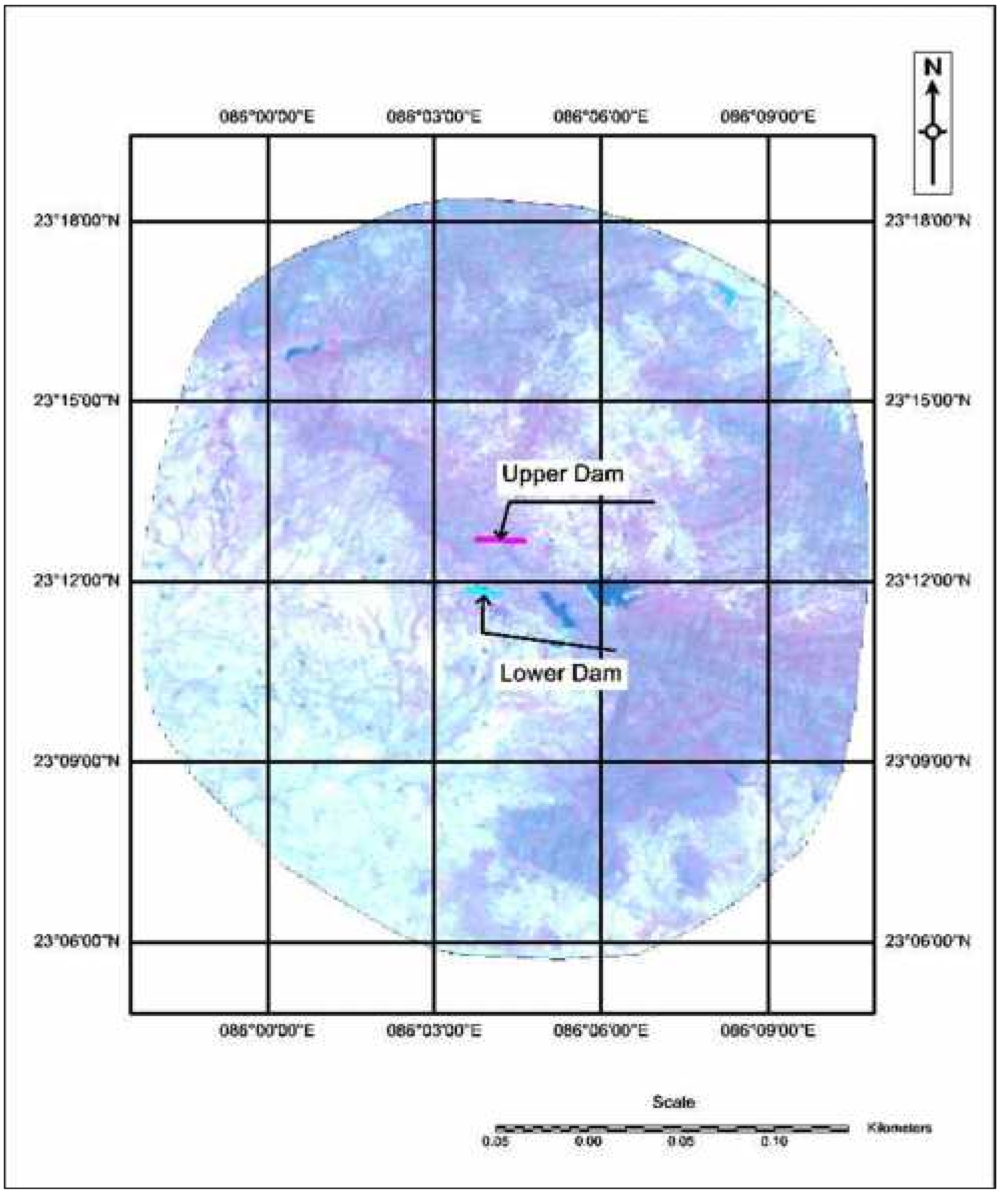


Figure-6.11: FCC of the Study Area

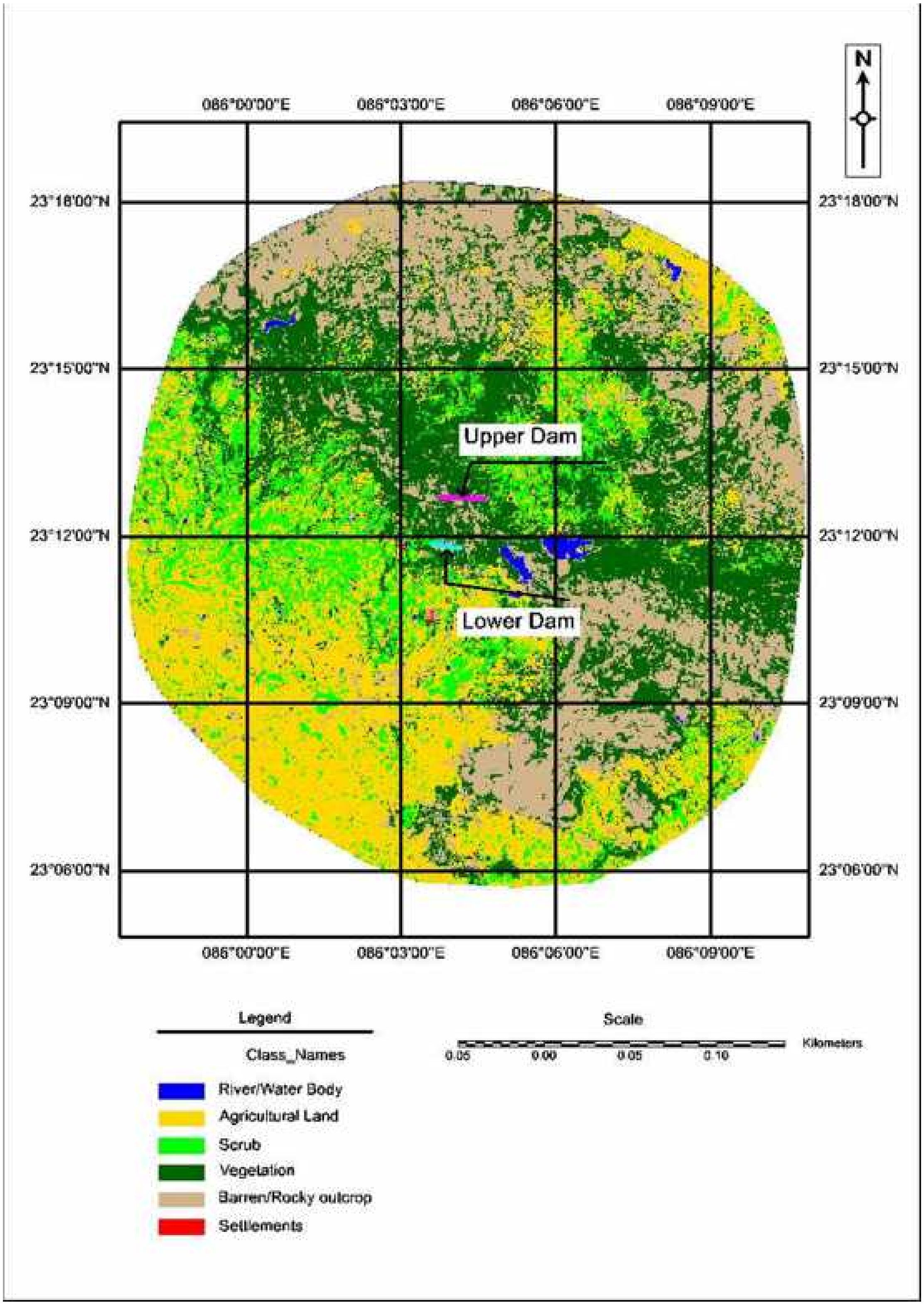


Figure-6.12: Classified Imagery of the Study Area

6.7 AMBIENT AIR QUALITY

The ambient air quality with respect to the study area 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 vehicular traffic, dust arising from unpaved village roads and domestic fuel burning. The prime objective of the baseline air quality study was to establish the existing ambient air quality of the area.

The sampling location is listed as below:

- Near Upper Dam Site
- Near Lower Dam Site
- Village Baghmundi
- Downstream of Lower Dam Site

The map showing location of ambient air quality monitoring stations is enclosed as Figure-6.13.

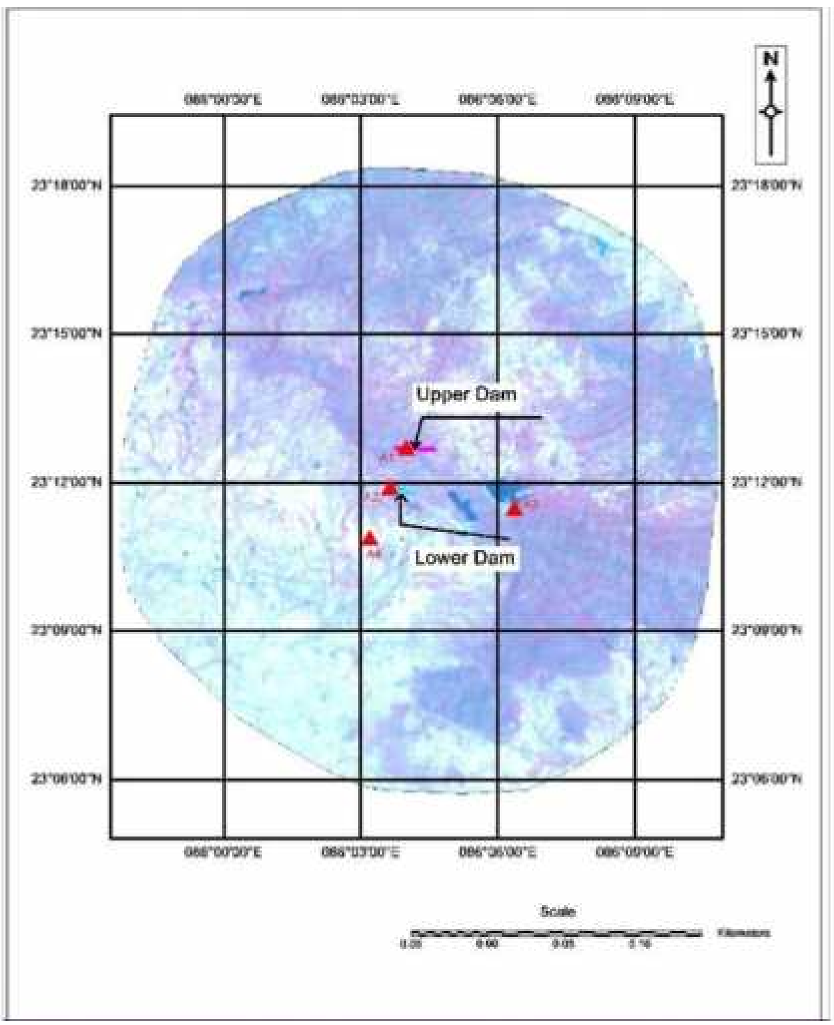


Figure-6.13: Sampling location map of ambient air quality monitoring stations

Ambient air quality monitoring has been carried out with a frequency of two samples per week for four weeksper season. The monitoring was conductedfor three seasons, i.e. winter, summer and monsoon seasons. The monitoring seasons covered as part of the study are covered in Table-6.1.

The baseline data of ambient air environment is generated for the mentioned parameters as given below:

- Particulate Matter less than 10 microns (PM_{10})
- Sulphur dioxide (SO_2)
- Nitrogen dioxide (NO_2)

The results of ambient air quality survey conducted in winter, summer and monsoon seasons are given in Table-6.7. The National Ambient Air Quality Standards are given in Table-6.8.

Table- 6.7:Results of ambient air quality monitoring (Unit :«g/m^3)

Station	**PM_{10}**	**SO_2**	**NOx**
Winter Season (December 2013 – January 2014)			
Near Upper Dam Site	31	10	15
	34	9	18
	30	8	17
	36	7	15
	33	10	20
	31	11	18
	37	11	20
	28	10	16
Near Lower Dam Site	36	7	14
	32	9	20
	40	7	19
	37	9	22
	38	9	15
	34	11	17
	35	12	20
	35	12	18
Village Baghmundi	32	10	22
	37	12	15
	38	9	19
	38	10	20
	40	8	18
	36	12	23
	32	9	18
	30	11	20
Downstream of Lower Dam Site	36	8	24
	30	10	15
	36	12	20
	31	7	18
	37	9	16

Station	**PM_{10}**	**SO_2**	**NOx**
	34	7	20
	40	12	17
	30	10	20
Summer Season (April 2014)			
Near Upper Dam Site	30	11	16
	32	15	20
	34	12	15
	32	9	22
	32	9	20
	30	8	18
	34	10	20
	34	12	24
Near Lower Dam Site	32	10	21
	30	9	22
	32	12	18
	36	10	20
	30	10	15
	35	8	18
	30	11	15
	32	9	20
Village Baghmundi	31	8	16
	36	8	20
	32	7	18
	34	10	15
	32	12	18
	35	10	22
	37	13	24
	29	10	17
Downstream of Lower Dam Site	38	8	20
	40	10	23
	32	8	20
	37	8	18
	32	7	25
	35	8	21
	40	10	20
	38	12	24
Monsoon Season (August – September 2014)			
Near Upper Dam Site	35	9	25
	32	11	20
	32	7	17
	36	12	13
	34	9	12
	32	12	17
	36	8	15
	30	10	19
Near Lower Dam Site	34	8	23
	29	11	20

Station	PM_{10}	SO_2	NOx
	31	9	15
	32	10	18
	34	8	15
	31	10	15
	34	8	20
	28	10	15
Village Baghmundi	37	8	16
	34	7	20
	30	11	21
	29	9	19
	30	12	16
	34	8	20
	32	8	20
	30	10	18
Downstream of Lower Dam Site	30	10	20
	32	8	16
	30	11	12
	34	9	14
	37	8	20
	31	9	18
	34	8	24
	32	10	24

Table-6.8: National Ambient Air Quality Standards (Unit :«g/m^3)

S. No.	Pollutants	Time Weighted Average	Concentration of Ambient Air		
			Industrial, Residential Rural and other area	Ecologically Sensitive area (notified by Central Government)	Method of Measurement
1	Sulphur Dioxide (SO_2) , µg/m^3	Annual* 24 hours **	50 80	20 80	-Improved west and Gacke -Ultraviolet fluorescence
2	Nitrogen Dioxide (NO_2) , µg/m^3	Annual* 24 hours **	40 80	30 80	- Modified Jacab&Hochheister (Na-Arsentire) -Chemiluminescene
3	Particulate Matter (Size less than 10, µm) or PM_{10} , µg/m^3	Annual* 24 hours **	60 100	60 100	-Gravimetric -TOEM -Beta attenuation
4	Particulate Matter (Size less than 2.5 , µm) or $PM_{2.5}$, µg/m^3	Annual* 24 hours **	40 60	40 60	-Gravimetric -TOEM -Beta attenuation

* Annual arithmetic mean of minimum 104 measurement 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 exceeded the limits but not on two consecutive days of monitoring.

Summary of Ambient Air Quality Monitoring

The summary of results of ambient air quality monitoring is given in Table-6.9.

Table-6.9: Summary of ambient air quality monitoring in the Study Area (Unit: «g/m³)

Season	Station	Average	Maximum	Minimum
Winter season	**PM_{10}**			
	Near Upper Reservoir Site	32.5	37	28
	Near Lower Reservoir Site	35.88	40	32
	Near Village Baghmundi	35.38	40	30
	Downstream of Lower Reservoir	34.25	40	30
	SO_2			
	Near Upper Reservoir Site	9.5	11	7
	Near Lower Reservoir Site	9.5	12	7
	Near Village Baghmundi	10.13	12	8
	Downstream of Lower Reservoir	9.38	12	7
	NO_2			
	Near Upper Reservoir Site	17.38	20	15
	Near Lower Reservoir Site	18.13	22	14
	Near Village Baghmundi	19.38	23	15
	Downstream of Lower Reservoir	18.75	24	15
Summer Season	**PM_{10}**			
	Near Upper Reservoir Site	32.25	34	30
	Near Lower Reservoir Site	32.13	36	30
	Near Village Baghmundi	33.25	37	29
	Downstream of Lower Reservoir	36.5	40	32
	SO_2			
	Near Upper Reservoir Site	10.75	15	8
	Near Lower Reservoir Site	9.98	12	8
	Near Village Baghmundi	9.75	13	7
	Downstream of Lower Reservoir	8.88	12	7
	NO_2	19.38	24	15
	Near Upper Reservoir Site	18.63	22	15
	Near Lower Reservoir Site	18.75	24	15
	Near Village Baghmundi	21.38	25	18
	Downstream of Lower Reservoir			
Monsoon Season	**PM_{10}**			
	Near Upper Reservoir Site	33.38	24	15

Season	Station	Average	Maximum	Minimum
	Near Lower Reservoir Site	31.3	22	15
	Near Village Baghmundi	32	24	15
	Downstream of Lower Reservoir	32.5	37	30
	SO_2			
	Near Upper Reservoir Site	9.75	12	7
	Near Lower Reservoir Site	9.25	11	8
	Near Village Baghmundi	9.13	12	7
	Downstream of Lower Reservoir	9.13	11	8
	NO_2			
	Near Upper Reservoir Site	17.25	25	12
	Near Lower Reservoir Site	17.63	23	15
	Near Village Baghmundi	18.75	21	16
	Downstream of Lower Reservoir	18.5	24	12

Observations on ambient PM_{10} levels

The maximum PM_{10} level observed in survey conducted during the survey was 40µg/m^3.The average PM_{10} level at various monitoring stations ranged from 32.5µg/m^3 (Near Upper Reservoir Site) to 35.88µg/m^3 (Near Lower Reservoir Site) in winter season, 32.13 µg/m^3 (Near Lower Reservoir Site) to 36.5 µg/m^3 (Downstream of Lower Reservoir) in summer season and 31.63 µg/m^3 (Near Lower Reservoir Site) to 33.38 µg/m^3 (Near Upper Reservoir Site) in monsoon season. During field studies,PM_{10} level was observed to be well below the permissible limit of 60 µg/m^3, specified for residential, rural and other areas at various stations covered during the survey. (referTable-6.8).

Observation on ambient SO_2 levels

The maximum SO_2 level of 15µg/m^3 was observed at station located at Near Upper Reservoir Site in summer season. The average SO_2 level in this season ranged from 8.88 to 10.75µg/m^3. The SO_2 level observed at various stations was much lower than the permissible limit of 50 µg/m^3 specified for residential, rural and other areas (refer Table-6.8).

Observations on NO_2 levels

In the winter season, highest average NO_2 values of 21.38µg/m^3 was observed at station located at Downstream of Lower Reservoir. The highest value of 25µg/m^3 too was also observed at the same station. The NO_2 level observed at various sampling stations was much lower than the permissible limit of 40 µg/m^3 for residential, rural and other areas (refer Table-6.8).

6.8 AMBIENT NOISE LEVEL

Noise levels monitoring was conducted for three 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 was conducted for three seasons as outlined in Table-6.1. The ambient noise level monitoring results, which were observed during the field survey in winter (December 2013 to January 2014), summer (April 2014) and monsoon (August - September 2014) for the study area are presented in Table-6.10. The sampling locations are shown in Figure-6.14.The noise standard for various categories is given in Table-6.11. The day time equivalent noise levels are given in Table-6.12.

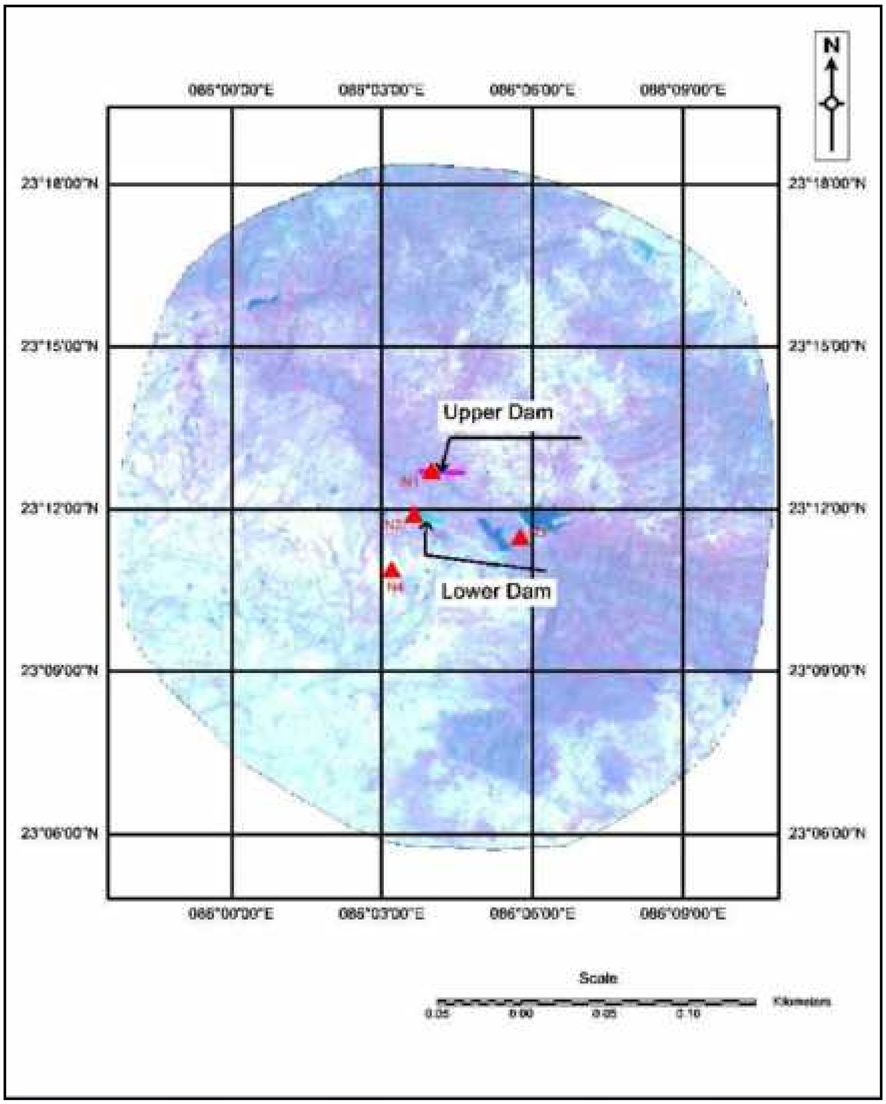


Figure-6.14: Sampling location map of Noise Monitoring Stations

Table-6.10: Hourly equivalent noise levels

Location	Near Upper Dam Site	Near Lower Dam Site	Village Baghmundi	Downstream of Lower Dam Site
Winter Season (December 2013 - January 2014)				
6-7 AM	37	37	38	37
7-8 AM	38	39	40	38
8-9 AM	40	40	42	40
9-10 AM	42	42	42	40
10-11 AM	42	44	42	42
11-12 Noon	44	44	44	43
12 noon – 1 PM	40	42	44	43
1-2 PM	42	42	43	41
2-3 PM	44	43	44	42
3-4 PM	45	42	44	42
4-5 PM	45	42	45	42
5-6 PM	46	44	45	44
6-7 PM	44	45	42	45
7-8 PM	43	42	40	45
8-9 PM	42	40	40	38
Summer Season (April 2014)				
6-7 AM	37	37	38	40
7-8 AM	39	39	39	42
8-9 AM	42	42	40	42
9-10 AM	43	42	42	44
10-11 AM	44	43	44	44
11-12 Noon	44	44	44	43
12 noon – 1 PM	44	44	43	43
1-2 PM	42	42	42	43
2-3 PM	42	42	42	44
3-4 PM	42	42	42	44
4-5 PM	44	44	44	45
5-6 PM	45	45	45	46
6-7 PM	46	45	46	44
7-8 PM	44	44	43	43
8-9 PM	42	41	42	41
Monsoon Season (August – September 2014)				
6-7 AM	37	37	38	38
7-8 AM	39	39	39	40
8-9 AM	42	42	42	40
9-10 AM	42	44	43	42
10-11 AM	44	44	44	42
11-12 Noon	43	43	43	43
12 noon – 1 PM	42	42	42	42
1-2 PM	42	42	42	42
2-3 PM	42	44	44	42
3-4 PM	43	45	45	44
4-5 PM	45	47	47	45
5-6 PM	46	46	47	47

Location	Near Upper Dam Site	Near Lower Dam Site	Village Baghmundi	Downstream of Lower Dam Site
6-7 PM	45	43	44	44
7-8 PM	42	42	43	42
8-9 PM	40	40	42	40

Table-6.11: 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 AM and 9 PM
2. Night time is 9 PM and 6 AM
3. Silence zone is defined as areas upto 100 metres 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 Gazettee notification, Government of India, date 14.2.2000.

Table-6.12:Average ambient noise levels

S. No.	Location	Zone	WinterSeason (December 2013-January 2014)	Summer Season (April 2014)	Monsoon Season (August - September 2014)
1.	Near Upper Reservoir Site	Residential	42.91	43.14	42.80
2.	Near Lower Reservoir Site	Residential	42.30	42.84	43.33
3.	Near Village Baghmundi	Residential	42.76	42.87	43.61
4.	Downstream of Lower Reservoir	Residential	42.08	43.44	42.76

The day time equivalent noise level at various sampling stations ranged from 42.08 to 42.91 dB(A),42.84 to 43.44dB(A) and 42.76 to 43.61 dB(A) in winter, summer and monsoon seasons respectively. The noise levels were observed to be well within permissible limits specified for residential area (Refer Table-6.11).

6.9 WATER QUALITY

Turga river sub basin is a part of Subarnarekha river system, originates from the Ayodhya hills in West Bengal. It is flowing in north to south and joins Sobhariver. Water Sampling was conducted at five sites listed as below:

- W1 (Turga dam site upper)
- W2 (downstream of upper dam site)
- W3 (upstream upper dam site)
- W4 (reservoir lower dam site)

- W5 (downstream lower dam site)

The map showing location of water quality monitoring stations is enclosed as Figure-6.15.

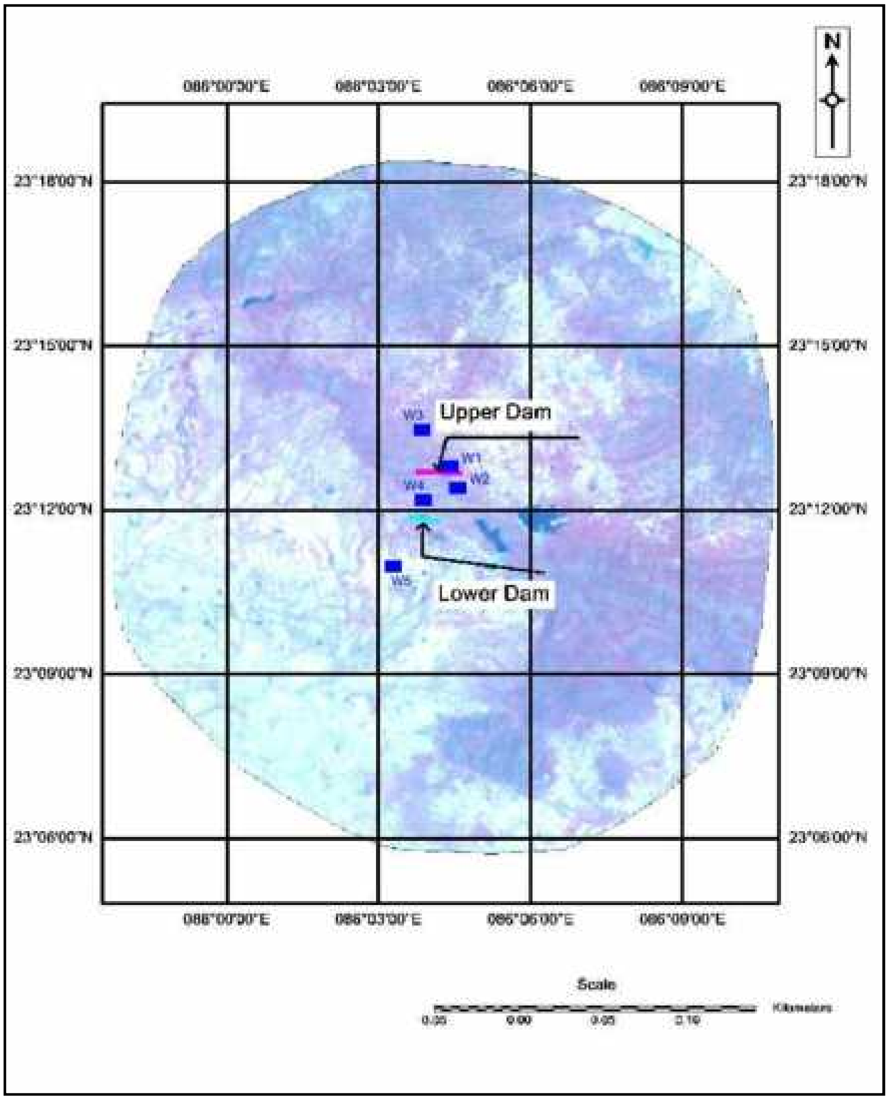


Figure-6.15: Sampling location map of water quality monitoring stations

Water temperature was recorded with the help of graduated mercury thermometer. In case of water, care was taken in measuring the temperature as it was recorded from surface, column and near the bottom of the river. Average values of these readings were computed for final results. A 20 m stretch of the river was measured and marked at both ends. A float was thrown at upper end and the time taken by the float to travel the marked distance, was recorded by a stop watch. Three replicates were obtained and averaged for final results. For monitoringturbidity,water, samples were collected in sampling bottles from different sites in the field and brought to the laboratory for analysis. The turbidity was recorded with the help of digital turbidity meter (TN 100; Eutech). The pH was recorded with the help of pH Scan

(Eutech) and pH meter (EI – 132 E) in the field. The total dissolved solids were measured with the help of TDScan 1 (Eutech) at each site. Similarly, Electrical conductivity was recorded with the help of TDScan 3 (Eutech) at the sites. Dissolved oxygen was measured by iodometric titration method using Oxygengen test kit (Aquamerck). Total alkalinity, alkalinity as carbonates and bicarbonates, total hardness, Ca and Mg contents, and chloride were measured with the help of APHA (2005) and Adoni (1985). Nitrate (NO_3 – N), Silicate and phosphate (PO_4 – P) were measured by photometric method using UV/visible spectrophotometer (Ultrospec 3000). Other ions like Na, and K and a few heavy metals (Iron, Cu, Cd) were detected by Atomic Absorption Spectrometry (AA 6300). The results of water quality monitoring conducted for three seasons as a part of the study are given in Tables-6.13 to 6.15. The water quality standards are given in Table-6.16.

Table-6.13 Water quality characteristics of Turga river and other water bodies in the Study Area (Winter Season)

Parameters	W1	W2	W3	W4	W5
Water Temperature (°C)	28.00	29.00	30.00	30.00	30.50
Turbidity (ntu)	0.72	0.77	0.40	0.83	0.34
pH	7.85	7.71	7.61	8.40	7.20
Dissolved Oxygen (mg/l)	7.23	6.43	5.93	7.13	5.27
Electrical Conductivity (μS)	135.30	132.63	131.07	125.63	146.90
Total dissolved solids (mg/l)	99.13	97.03	87.13	93.87	109.63
Total Hardness (mg/l)	118.00	130.00	116.00	128.00	122.00
Calcium Hardness (mg/l)	65.10	67.20	67.20	63.00	73.50
Calcium ions (mg/l)	26.07	26.91	26.91	25.23	29.44
Magnesium Hardness (mg/l)	52.90	62.80	48.80	65.00	48.50
Magnesium Ions (mg/l)	12.85	15.26	11.86	15.80	11.79
Total Alkalinity (mg/l)	90.00	94.00	100.00	88.00	104.00
Chloride (mg/l)	24.00	24.00	24.00	22.00	24.00
Nitrate (mg/l)	0.32	0.36	0.34	0.31	0.30
Phosphate (mg/l)	0.74	0.30	0.24	ND	0.08
Silicate (mg/l)	5.59	5.30	5.05	5.02	4.90
Sulphate (mg/l)	0.82	0.72	0.98	1.21	1.01
Sodium (mg/l)	3.12	3.87	3.07	3.76	3.22
Potassium (mg/l)	1.24	1.87	1.28	1.75	1.21
Iron (mg/l)	0.061	0.099	0.11	0.18	0.11
Cadmium (mg/l)	0.003	0.003	ND	0.002	0.001
Copper (mg/l)	0.012	0.013	0.009	0.010	0.013
Mercury (mg/l)	BDL	BDL	BDL	BDL	BDL
Chromium (mg/l)	BDL	BDL	BDL	BDL	BDL
BOD, (mg/l)	2.2	2.0	2.1	2.2	2.2
COD (mg/l)	4.3	3.9	4.1	4.4	4.3

Table 6.14 Water quality characteristics of Turga river and other water bodies in the Study Area (Summer Season)

Parameters	W1	W2	W3	W4	W5
Water Temperature (˚C)	26.00	25.00	28.00	32.00	25.00
Turbidity (ntu)	5.55	10.60	2.46	1.93	5.66
pH	7.75	7.88	8.02	8.04	7.94
Dissolved Oxygen (mg/l)	6.13	6.20	5.24	5.90	6.67
Electrical Conductivity (μS)	91.80	108.40	105.53	105.80	105.03
Total dissolved solids (mg/l)	58.70	69.40	67.50	67.70	67.20
Total Hardness (mg/l)	100.00	96.00	130.00	88.00	104.00
Calcium Hardness (mg/l)	54.60	48.30	86.10	54.60	56.70
Calcium ions (mg/l)	21.87	19.34	34.48	21.87	22.71
Magnesium Hardness (mg/l)	45.40	47.70	43.90	33.40	47.30
Magnesium Ions (mg/l)	11.03	11.59	10.67	8.12	11.49
Total Alkalinity (mg/l)	80.00	76.00	112.00	84.00	88.00
Chloride (mg/l)	14.00	11.00	17.00	14.00	14.00
Nitrate (mg/l)	0.10	0.15	0.10	0.10	0.10
Phosphate (mg/l)	0.72	0.78	0.36	0.53	0.86
Silicate (mg/l)	1.21	1.12	1.11	1.31	1.35
Sulphate (mg/l)	0.32	0.5	0.4	0.52	0.58
Sodium (mg/l)	3.65	4.12	3.18	3.24	3.21
Potassium (mg/l)	1.28	1.98	1.29	1.11	1.33
Iron (mg/l)	0.088	0.098	0.12	0.12	0.098
Cadmium (mg/l)	ND	0.001	0.002	0.001	ND
Copper (mg/l)	0.011	0.014	0.006	0.013	0.012
Mercury (mg/l)	BDL	BDL	BDL	BDL	BDL
Chromium (mg/l)	BDL	BDL	BDL	BDL	BDL
BOD (mg/l)	1.5	1.7	1.8	1.5	1.5
COD (mg/l)	2.9	3.2	3.5	2.8	3.0

Table-6.15 Water quality characteristics of Turga river and other water bodies in the Study Area (Monsoon Season)

Parameters	W1	W2	W3	W4	W5
Water Temperature (˚C)	28.00	29.00	30.00	30.00	30.50
Turbidity (ntu)	10.2	10.3	9.5	10.8	11.9
pH	7.7	7.6	7.5	8.2	7.1
Dissolved Oxygen (mg/l)	7.2	6.3	5.8	7.0	5.2
Electrical Conductivity (μS)	75	79	80	79	82
Total dissolved solids (mg/l)	48	50	52	50	54
Total Hardness (mg/l)	63	61	75	80	89.7
Calcium Hardness (mg/l)	45	40	50	43	50
Calcium ions (mg/l)	18	16	20	17	20
Magnesium Hardness (mg/l)	29	21.0	25.0	37	29.7
Magnesium Ions (mg/l)	7.2	5.0	6.0	8.9	7.2
Total Alkalinity (mg/l)	49	51	45	41	40
Chloride (mg/l)	10.0	11.0	9.2	10.0	7.5
Nitrate (mg/l)	ND	ND	ND	ND	ND
Phosphate (mg/l)	0.70	0.28	0.20	ND	0.05

Parameters	W1	W2	W3	W4	W5
Silicate (mg/l)	0.5	0.7	0.7	0.8	0.9
Sulphate (mg/l)	0.2	0.25	0.5	0.4	0.4
Sodium (mg/l)	2.7	3.2	2.8	3.5	3.0
Potassium (mg/l)	1.0	1.7	1.2	1.5	1.2
Iron (mg/l)	0.07	0.08	0.07	0.12	0.08
Cadmium (mg/l)	0.003	0.003	ND	0.002	0.001
Copper (mg/l)	0.010	0.010	0.008	0.007	0.009
Chromium (mg/l)	BDL	BDL	BDL	BDL	BDL
Mercury (mg/l)	BDL	BDL	BDL	BDL	BDL
BOD (mg/l)	1.1	1.2	1.2	1.2	1.6
COD (mg/l)	2.2	2.5	2.5	2.4	3.0

Table-6.16 : 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 the project area of Turga Pumped Storage project ranged from 7.1 to 8.4 at various sampling sites covered as a part of the study. The pH level indicates neutral to marginally alkaline nature of the water, and is within the permissible limit specified for meeting drinking water requirements (Refer Table-6.16).

The TDS level ranged from 87.13 to 109.63 mg/l, 58.7 to 69.4 mg/l and 48 to 54 mg/lin post-monsoon, summer and monsoon seasons respectively, which is well below the permissible limit of 500 mg/l specified for drinking water. The TDS level was found to be lowest in monsoon season. This trend was observed for various cations and anions monitored as a part of the study. This could be attributed to higher discharges in monsoon months.

The hardness level ranged from 61 to 130 mg/l in various seasons monitored as a part of the study. The hardness level was well below the permissible limit of 200 mg/l specified for drinking water. Hardness is caused by divalent metallic cations. The principal hardness causing cations are calcium, magnesium, strontium and ferrous and iron. The low levels of calcium and magnesium are mainly responsible for the soft nature of water.

Alkalinity of water is a measure of its capacity to neutralize acids. The alkalinity of natural water is due primarily because of the salts of weak acids. The alkalinity was observed to be lower than the total hardness in all the water sampling stations monitored as a part of the study.

Chlorides occur in all natural waters in widely varying concentrations, chlorides is available in natural water, mainly through solvent power of water, which dissolves chlorides from top soil and deeper formations. The chlorides level ranged from 7.5 to 24 mg/l, which is well below the permissible limit of 200 mg/l, specified for meeting drinking water requirements.

Sulphates ion is one of the major anions occurring in natural water. It is an important parameter because of its cathartic affect, when it is present in higher concentration. The sulphates level at various sampling stations ranged from 0.2 to 1.21 mg/l in various samples monitored for three seasons as a part of the study. The sulphate was found to be well below the permissible limit of 200 mg/l specified for drinking water purposes.

The concentration of nitrates at various sampling locations was observed range from 0.30 to 0.36 mg/l and 0.1 to 0.15 mg/l in post-monsoon and summer season respectively. The nitrate level was below detectable limit in monsoon season.

The concentration of various cations, e.g. sodium, potassium, calcium and magnesium was observed to be quite low which is also reflected by the low TDS level. Iron was found to be well below the permissible limit of 1 mg/l specified for drinking water purposes.

The concentration of various heavy metals was found to be well below the permissible limits. Concentration of phenolic compounds and oil & grease as expected in a region with no major sources of water pollution from domestic or industrial sources was observed to be quite low.

The BOD values are well within the permissible limit, 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 indicate the absence of chemical pollution loading in the area. The marginal quantity of pollution load which enters Turganalla, gets diluted.

The DO level ranged from5.2 to 7.23 mg/l at various sampling locations monitored for three seasons as a part of the study. The DO levels indicate low organic pollution in the catchment area. This is expected as the site has low population density and virtually no industries. Thus, pollution loading is low in the catchment area, which is reflected in low BOD and high DO Values the excellent quality of water in the study area.

CHAPTER-7
FLORAL ASPECTS

7.1 INTRODUCTION

The floral aspects of the study area has been conducted in order to understand the ecological status of the existing flora and fauna to generate baseline information and evaluate the probable impacts on the biological environment. The survey was conducted for three seasons. The objectives of the study are as follows:

- Identification of forest type and density, bio-diversity in the study area
- Preparationofcomprehensivechecklistof flora (Angiosperm,Gymnosperm, Bryophyte, pteridophyte, algae, fungi, Lichen)
- Importance value index of the dominant vegetation in the study area of proposed project
- Frequency, Abundance and Density of each species of Trees, Shrubs, Herbs & Grasses at representative sampling sites will be estimated
- Identification and listing of Rare Endangered species -RET
- Identification and listing of plants of genetically, biologically, economical and medicinal importance
- Ethno botanical aspects of each species need to be assessed
- Identification of potentially important species from conservation and economic point of view

7.2 METHODOLOGY

7.2.1 Sampling

Quadrats were laid down at various locations in the Study Area. Similarly, faunal survey was also followed in the same tract while following visual observation with line transects methodology only. The river flows in the high gradient surface in the Ayodhaya hill ranges. Therefore, to have an holistic view of complete ecology and biodiversity of the area, study sites are selected with respect to location of various project appurtenances. A total of five study sites were selected at different locations of the Study Area.

- Proposed Lower Dam (Proposed Saddle area towards right bank of Turga Nala- V1)
- Downstream of Existing Turga Irrigation dam (Turga nallah at Gosaidah / Patherdih V2)
- Downstream of proposed Upper Dam axis site (d/s of Tar pania / d/s V-notch-dam axis site of Turga Nala -V3)

- ProposedUpper dam axis site (Tar pania, Darelehar / Baralahar submergence site, Turga Nala- V4)
- Catchment Area (Near Ranga Basti to Buingera and Saildih / Bharipani villages in vicinity of Turga Nala- V5).

The description of study area is given in **Table-7.1**.

Table-7.1: Description of Study Sites for terrestrial ecology (Floral and Faunal accounts) w.r.t. Project Appurtenances

Sampling sites	Location	Description
A. Area between Bagmundi and Existing Lower dam site (Gosaidh)		
Site I:	Proposed Saddle area towards right bank of Turga Nala	Bagmundi site with Agriculture land followed by vegetation of Pattardih Forest i.e. u/s west site
Site II:	Turga Nallah at Gosaidih /Pathar dih, Downstream of Existing Lower dam Site	Lower dam axis site, gosaidih has mixed dense vegetation, Forest block Pattardih – Bhagmundi.
B. Area beyond Gosaidh and up to Upper dam site (Tar pania)		
Site III:	Dam axis site-near V Notch Turga Nalla & d/s area of Tar pania	Sal foreset dominant in mixed jungle vegetation following palaash plantation on hill slopes of both of the banks of Turga nalla.
C. Area between Upper dam (Tar pania), BaraLahar & Ranga Basti-Submergence zone		
Site IV:	Upper dam axis site -Tar pania: Darelehar / Baralahar submergence site	Sal foreset dominant in mixed jungle vegetation on hill slopes of both of banks of Turga nalla
D. Area beyond Ranga Basti up to Saildih Basti - Catchment Area		
Site V:	Ranga or Tanrpaniya Village (RB hill aspect of Turga Nala)	U/s Upper dam in NE direction, Ranga basti to Buingera -23.23567^{o} N, 86.08434^{o} E, El-1902.54 ft. In Buingera area, patchy vegetation, pasture land, rocky terrain, palaash forest: Open scrubs
	Saildih /Bharipani village (LB hill aspect of Turga Nala	U/s Upper dam in NW direction-Kurapahari area: Kurapahari : 23.23980 ^{o}N, 86.04562 ^{o}E, El- 1729.97 ft –Sal forest & Saildih-- 23.23359 ^{o}N, 86.05773 ^{o}E, El- 1622.36 ft

7.2.2 Floral Accounts

The details on forest types and forest cover in the catchment area were based on our primary surveys in the area supplemented with the working plans and records of Purulia Forest Division. The major forest types encountered in the area were described based on the classification of Champion & Seth (1968), Negi, (1989, 1996), Sikdar and Samanta (1984), Sanyal (1994) and Mudgal & Hajra (1999). Floristic study in the project areawas undertaken during different seasons (post-monsoon, summer and monsoon seasons) within 10 km radius from power house site, lower dam and upper dam). The field surveys were carried out for description of vegetation along the altitudinal gradient (up to 500 m) in the study area (**Table 7.1**). Listing of economically important and medicinal and rare/endangered plant taxa, was prepared by conducting primary surveys along all project components.

Sampling sites in four different zones were selected for vegetation structure study on the basis of the presence of forest patches in the area. At each of the sampling sites, 10 plots of 10 m x 10 m were randomly established for determination of phytosociological characteristics of the vegetation. Within each sampling plot, four vegetation layers i.e. tree, saplings, shrubs and herbs were analyzed. Tree species were counted as those individuals in 10 m x 10 m plots whose circumference at breast height (cbh) was greater than 30 cm (> 30 cm). All individuals with 10 – 30 cm cbh were listed as shrubs and saplings and these were analyzed in 5 m x 5m plots randomly laid within 10 m x 10 m plots. Herbs (< 10 cm cbh) were analyzed in 1 m x 1m plots randomly laid within same 10 m x 10 m plots. The tree basal area was also determined as an index of dominance as:

Basal Area = πr^2

$C = 2 \pi r$

where, C= Circumference at breast height

r = Radius

Relative frequency, Relative density and Relative dominance indicate different aspects of the importance of a species in a community. Therefore, the sum of these three values gives a good overall estimate of the importance of a species and this sum is called importance value index (IVI). The IVI for trees, herbs and shrubs were determined as the sum of relative density, relative frequency and relative dominance (Curtis and Cottom, 1956).

The index of diversity was computed by using Shanon-Wiener information index (Shanon Wiener, 1963) as :

$H = -\Sigma (ni/n) \times \ln (ni/n)$

Where, ni is individual density of a species and n is total density of all the species.

Identification of Rare, Endangered and Threatened plant species : Rare and endangered species were identified referring to the Red Data Book of India, following the IUCN Red list of plants and other available literature, flora and herbarium pertaining to the rare/endangered species of state of West Bengal.

Medicinal & Economic important Plants

An Ethno botanical survey was carried out to identify the wild plants used by the locals for different purposes.

7.3 FOREST TYPES IN THE PROJECT AREA

The forests in the proposed project area along the Turga Nalla fall in Purulia Forest Division of West Bengal. As per classification, the forest under this division is Northern tropical Dry Deciduous Forest typeandDry peninsular sal forest. This is further classified as Reserved Forest, Protected forest, Unclassed state forest, khas forest, vested waste land, forest owned by corporate bodies and forest owned by private individuals as per the information available with Divisional Forest Office –Purulia division, Soil Conservation Division I & II & Extension Forest Division.

The major forest types found in study area are briefly described in the following paragraphs.

5B Northern Tropical Dry Deciduous Forests

This is a dry deciduous forest in which the upper canopy is light but continuous in the climax form. The second storey is rarely found and an irregular often broken canopy and smaller height. The undergrowth is generally thin and shrubby including some evergreen xerophytic species. These forests belong to the following forest types:

5B/C1 Dry Sal-bearing forest

This is a low quality forest dominated by *Shorea robusta*. It is often broken up into pure groups or mixed patches of varying extent in which either sal or its associates predominate. The canopy is irregular and tree is rarely over 18 m height. It may further be sub-divided into the following sub-types:

- 5B/C1c Dry Peninsular Sal Forest
- 5B/C2 Northen Dry Mixed Deciduous Forest

5B/C1c Dry Peninsular Sal Forest

This sub-type occurs on shallow soils that have been derived from crystalline and metamorphic rocks wherever soil moisture conditions are unfavourable for the development of moist sal, even in areas with higher rainfall. The soil often laterite and is sometimes calcareous. The main tree associates found in the first storey are *Anogeissus latifolia, Buchanania latifolia, Bombax ceiba, Madhuca indica, Schleichera trijuga, Semecarpus anacardium, Shorea robusta, Terminalia chebula* and *T. tomentosa*. Second storey comprises of the speciesincluding *Bauhinia* spp., *Butea monosperma, Diospyros tomentosa, Holarrhena pubescens, Mallotus philippinensis*and *Wenlandia tinctoria*. This type of forest was observed near the Upper dam and Tar pania area. The shrub layer is represented by the species like

Ardisia paniculata, Carissa spinarum, Chromolaena odoratum, Dendrocalamus hamiltonii, Woodfordia fruticosa, Zizyphus mauritiana, etc. Climbers are few viz., *Cissampelos pareira, Combretum decandrum, Dioscorea fasciculata, Jaminum pubescens,* and *Smilax prolifera*.

5B/C2 Northern Dry Mixed Deciduous Forest

This is an open, dry deciduous forests, with thin upper canopy but fairly complete. Most trees have low spreading crowns. This type of forest is observed in the Lower dam and adjoining Bagmundi area. The important tree species occurring in the first storey are *Adina cordifolia, Anogeisus latifolia, Bauhinia variegata, Bridelia retusa, Butea monosperma, Ficus bengalensis, Flacourtia indica, Lannea coromandelica, Lagerstroemia parviflora, Shorea robusta, Terminalia bellerica* and *Terminalia tomentosa*. Second storey comprises of *Acacia leucopholea, Casearia graveolens, Ficus hispida, F. semicordata, Holarrhena pubescens, Mallotus philippinensis, Randia dumetorum*, and *Zizypus mauritiana*. Climbers are few and represented by *Butea superba, Combretum decandrum, Derris scandens, Smilax prolifera*, etc. The shrub layer is represented by *Carissa spinarum, Chromolaena odoratum, Clerodendrum viscosum, Costus speciosus, Lantana indica* and *Woodfordia fruticosa*.

7.4 VEGETATION PROFILE IN THE STUDY AREA

The study area is located in the Ayodhya hills a part-extension of the Dalma Hills. This land is characterised by undulating hills of red soil and lush green woods of *Sal, Mahua, Sirish, Teak* and many other species **(Table-7.2)**. Sal (*Shorea robusta*) is the dominant tree species in the area. It is the Piasal *(Pterocarpus marsupium*) which is prevalent in lower Hills though the Muchkunda *(Pterospermum acerifolium*), a tall evergreen tree, is not very common. Bel *(Aegle marmelos)* is commonly found in the wild, but Kat bel *(Limonia acidissima*) is not so common. The tun (*Toona ciliata*) is a tall elegant tree the crowns of which spread out in form of numerous parasols of delicate foliage. Matkam, Mohul or Mahua *(Madhuca indica*) is another very important plant of the area. It has been observed that the area has a rich assemblage of timber, fibre and oil yielding and especially medicinal plants. The dominant tree species are *Shorea robusta, Butea monosperma, Madhuca longifolia* var *latifolia, Alangium salviifolium, Streblus asper, Diospyros melanoxylon* and *Holoptelea integrifolia*.

A total of 173 species of flora including trees, shrubs, climbers and herbs were recorded at various sampling sites during study period (**Table-7.2**). Based on habit wise classification 51 are trees, 26 shrubs, 58 herbs, 14 climbers, 15 grasses, 7 sedges and 2 orchids were recorded in the study area. Some terrestrial pteridophytic species like *Adiantum, Marselia, Lygodium, Pteris*, etc were also observed in damp, swampy and moist areas (**Table-7.2, Plates 7.1 to 7.5**).

Table -7.2: List of Floral species recorded from the proposed project area

Plant Species	Local Name	Family	Habit
Acacia catechu	Khair	Mimosaceae	Tree
Adina cordifolia	Haldu	Rubiaceae	Tree
Aegle marmelos	Bel	Rutaceae	Tree
Aglaia roxburghiana	Priyangru	Meliaceae	Tree
Albizia odoratissima	Jang Siris	Mimosaceae	Tree
Albizia procera	Safed Siris	Mimosaceae	Tree
Albizzia lebbek	Kala siris	Mimosaceae	Tree
Altsonia scholaris	Saptparni	Apocynaceae	Tree
Artocarpus lacucha	Dhao	Moraceae	Tree
Azadirachta indica		Meliaceae	Tree
Barringtonia actangula	Neora	Myrtaceae	Tree
Bauhinia variegata	Khairwal	Caesalpiniaceae	Tree
Bombax ceiba	Semal	Bombacaeae	Tree
Bridelia retusa	Kassi	Euphorbiaceae	Tree
Buchanania latifolia	Piyal	Anacardiaceae	Tree
Butea monosperma	Palas	Papilionaceae	Tree
Canthium glabrum	-	Rubiaceae	Tree
Casearia graveolens	Chilla	Flacourticeae	Tree
Cassia fistula	Sonari	Rubiaceae	Tree
Cordia rothii	Liar	Boraginaceae	Tree
Croton caudatus	Putla	Euphorbiaceae	Tree
Dalbergia sissoo	Sisham	Fabaceae	Tree
Diospyros melanoxylon	Tendu	Ebenaceae	Tree
Ficus auriculata	Dumari	Moraceae	Tree
Ficus bengalensis	Bargad	Moraceae	Tree
Ficus racemosa	Gular	Moraceae	Tree
Flacourtia jangomas	Coffe plum	Flacouticeae	Tree
Garuga pinnata	Kharpat	Burseraceae	Tree
Gmelina arborea	Gambari	Verbenaceae	Tree
Holarrhena pubescens	Kurchi	Apocynaceae	Tree
Holoptelea integrifolia	-	Ulmaceae	Tree
Lannea coromandelica	Doka	Anacardiaceae	Tree
Madhuca indica	Mahwa	Sapotaceae	Tree
Mallotus philippinensis	Kamla	Euphorbiaceae	Tree
Mangifera indica	Aam	Anacardiaceae	Tree
Melia azedarach	Bakayan	Meliaceae	Tree
Oroxylum indicum	Sonpatti	Bignoniaceae	Tree
Phoenix sylvestris	Khajur	Arecaceae	Tree
Phyllanthus emblica	Amla	Euphorbiaceae	Tree
Pongamia pinnata	Papri	Papilionaceae	Tree
Rhus chinensis	Amlio	Anacardiaceae	Tree
Schleichera trijuga	Kusum	Sapindaceae	Tree
Semecarpus anacardium	Bhela	Anacardiaceae	Tree
Shorea robusta	Sal	Dipterocarpaceae	Tree
Streblus asper	Sahora	Moraceae	Tree
Syzygium cumini	Kala Jamb	Myrtaceaer	Tree

Plant Species	Local Name	Family	Habit
Tectona grandis	Teak	Verbenaceae	Tree
Terminalia arjuna	Arjun sal	Combretaceae	Tree
Terminalia bellirica	Bahera	Combretaceae	Tree
Terminalia chebula	Haritaki	Combretaceae	Tree
Terminalia tomentosa	Asan	Combretaceae	Tree
Abutilon indicum		Malvaceae	Shrub
Agave sisalana		Agavaceae	Shrub
Allophyllus cobbe	-	Sapindaceae	Shrub
Annona squamosa		Annonaceae	Shrub
Asparagus racemosus		Liliaceae	Shrub
Bixa orellana		Bixaceae	Shrub
Calotropis gigantean		Asclepiadaceae	Shrub
Carissa spinarum	Auka Kuli	Apocynaceae	Shrub
Cassia occidentalis	-	Caesalpiniaceae	Shrub
Chromolaena odoratum	-	Asteraceae	Shrub
Clerodendrum viscosum	Ghato	Verbenaceae	Shrub
Combretum roxburghii		Combretaceae	Shrub
Datura fastuosa		Solanaceae	Shrub
Flemingia strobilifera		Fabaceae	Shrub
Glycosmis pentaphylla		Rutaceae	Shrub
Helicteris isora		Sterculiaceae	Shrub
Ipomoea carnea	-	Convolvulaceae	Shrub
Lantana indica	Lantana	Verbenaceae	Shrub
Leea alata	-	Leeaceae	Shrub
Maytenus senegalensis	-	Celastraceae	Shrub
Mimosa rubicaulis	-	Mimosaceae	Shrub
Piper longum		Piperaceae	Shrub
Randia dumetorum	Maidan	Rubiaceae	Shrub
Vitex negundo	Sandbhalu	Verbenaceae	Shrub
Woodfordia fruticosa	Dhora	Lythraceae	Shrub
Zizyphus mauritiana	Ber	Rhamnaceae	Shrub
Carex cruciata	-	Cyperaceae	Sedge
Carex filicina	-	Cyperaceae	Sedge
Cyperus niveus	-	Cyperacerae	Sedge
Cyperus rotundus	-	Cyperaceae	Sedge
Cyperus speciosa	-	Cyperaceae	Sedge
Fimbristylis dichotoma	-	Cyperaceae	Sedge
Fimbristylis monostachya	-	Cyperaceae	Sedge
Curculigo orchioides	-	Hypoxidaceae	Orchid
Geodorum densiflorum	-	Orchidaceae	Orchid
Ageratum conyzoides	-	Asteraceae	Herb
Achyranthes aspera	-	Amaranthaceae	Herb
Aerva lanata	-	Amaranthaceae	Herb
Alternanthera sessilis	-	Amaranthaceae	Herb
Andrographis paniculata	-	Acanthaceae	Herb
Anisomeles ovata	-	Lamiaceae	Herb
Argemone mexicana	-	Papaveraceae	Herb

Plant Species	Local Name	Family	Habit
Artemisia indica	-	Asteraceae	Herb
Bacopa monnieri	-	Scrophulariaceae	Herb
Barleria lupulina	-	Acantaceae	Herb
Bidens pilosa	-	Asteraceae	Herb
Biophytum reinwarrdtii	-	Oxalidaceae	Herb
Boerhavia diffusa	-	Nyctaginaceae	Herb
Cajanus cajan	-	Fabaceae	Herb
Cajanus scarabaeoides	-	Fabaceae	Herb
Cassia tora	-	Caesalpiniaceae	Herb
Centella asiatica	-	Apiaceae	Herb
Chenopodium album	-	Chenopodiaceae	Herb
Cleome viscosa	-	Capparaceae	Herb
Coleus aromaticus	-	Lamiaceae	Herb
Colocasia esculenta	-	Araceae	Herb
Commelina benghalensis	-	Commelinaceae	Herb
Corchorus aestuans	-	Tiliaceae	Herb
Costus speciosus	-	Zingiberaceae	Herb
Crassocephalum crepidioides	-	Asteraceae	Herb
Curcuma longa	-	Zingiberaceae	Herb
Cyanotis axillaris	-	Commelinaceae	Herb
Desmodium diffusum	-	Fabaceae	Herb
Eclipta alba	-	Asteraceae	Herb
Eclipta prostrata	-	Asteraceae	Herb
Elephantopus scaber	-	Asteraceae	Herb
Euphorbia hirta	-	Euphorbiaceae	Herb
Evolvulus numlaria	-	Convolvulaceae	Herb
Galium asperuloides	-	Rubiaceae	Herb
Gloriosa superba	-	Liliaceae	Herb
Hedychium coronarium	-	Zingiberaceae	Herb
Hemidesmus indicus	-	Asclepiadaceae	Herb
Hydrocotyle nepalense	-	Apiaceae	Herb
Impatiens balsamina	-	Balsaminaceae	Herb
Indigofera tinctoria	-	Fabaceae	Herb
Leonotis nepetifolia	-	Lamiaceae	Herb
Leucas cephalotes	-	Lamiaceae	Herb
Majus rugosus	-	Scrophulariaceae	Herb
Martynia diandra	-	Martyniaceae	Herb
Melilotus indica	-	Fabaceae	Herb
Ocimum canum	-	Lamiaceae	Herb
Oldenlandia corymbosa	-	Rubiaceae	Herb
Oxalis corniculata	-	Oxalidaceae	Herb
Persicarea barbata	-	Polygonaceae	Herb
Phyllanthus urinaria	-	Euphorbiaceae	Herb
Ruellia prostrata	-	Acanthaceae	Herb
Scoparia dulcis	-	Scrophulariaceae	Herb
Sida cordata	-	Malvaceae	Herb
Sida veronicifolia	-	Malvaceae	Herb

Plant Species	Local Name	Family	Habit
Tylophora indica	-	Asclepiadaceae	Herb
Urena lobata	-	Malvaceae	Herb
Urginea indica	-	Liliaceae	Herb
Zornia diphylla	-	Fabaceae	Herb
Arthraxon hispidus	-	Poaceae	Grass
Bothriochloa pertusa	-	Poaceae	Grass
Chrysopogon aciculatus	-	Poaceae	Grass
Chrysopogon serrulatus	-	Poaceae	Grass
Cynodon dactylon	-	Poaceae	Grass
Cyrtococcum accrescens	-	Poaceae	Grass
Dactyloctenium aegypticum	-	Poaceae	Grass
Digitaria sanguinalis	-	Poaceae	Grass
Eragrostis nardoides	-	Poaceae	Grass
Eragrostis unioloides	-	Poaceae	Grass
Kyllinga brevifolia	-	Poaceae	Grass
Oplismenus compositus	-	Poaceae	Grass
Paspalidium flavidum	-	Poaceae	Grass
Paspalum scrobiculatum	-	Poaceae	Grass
Sporobolus diander	-	Poaceae	Grass
Asparagus racemosus	Satmuli	Liliaceae	Climber
Butea superba	Lat Plas	Fabaceae	Climber
Cissampelos pareira	Ekleja	Menispermaceae	Climber
Combretum decandrum	Atena	Combretaceae	Climber
Cuscuta reflexa	Haldi algusi	Cuscutaceae	Climber
Derris scandens	Noalata	Fabaceae	Climber
Dioscorea bulbifera	Rat-alo	Dioscoreaceae	Climber
Hoya pendula	-	Asclepiadaceae	Climber
Jasminum pubescens	-	Oleaceae	Climber
Porana paniculata	Bridal creeper	Convolvulaceae	Climber
Pueraria tuberosa	Tirra	Fabaceae	Climber
Rubia cordifolia	Manjith	Rubiaceae	Climber
Smilax prolifera	-	Smilacaceae	Climber
Stephania hernandifolia	Khandi	Menispermaceae	Climber

Plate-7.1: Submergence area of Upper Dam

Plate-7.2: Upper Dam axis site

Plate-7.3: Lower plants in submergence area (*Adiantum capillus-veneris*)

Plate-7.4: Climbing fern (*Lygodium circinatum*) in submergence area

Plate-7.5: *Athyrium* sp. with other herbaceous associates

Further, area wise description of vegetation of the project area, which has been presented in terms of zones correspond to topographic/elevational class within the Study Area are given in the subsequent sections.

i) Area between Bagmundi and Existing Turga Irrigation dam Site (Gosaidh)

This plateau area predominantly has open, dry deciduous forests in the lower reaches. Gosaidah and adjoining downstream of Existing Lower Dam Area on Turga Nalla near Bagmundi town is having gentle slopes where the lower plains are converted into agricultural fields. The vegetation here is mostly scrub with few tree species. Thin patches of a few deciduous tree species are found in association with *Phoenix sylvestris* along the Turga Nala. The natural vegetation comprises of trees i.e.,*Aegle marmelos, Bauhinia variegata, Beilschmiedia roxburghiana, Boswellia serrata, Butea monosperma, Diospyros melanoxylon,Ficus bengalensis, Holarrhena pubescens,* and *Sterculia urens tree species*. The shrub elements comprise of *Cassia tora, Carissa spinarum, Chromolaena odoratum, Clerodendrum viscosum, Ipomoea carnea, Lantana indica, Zizyphus mauritiana,* etc. The ground floor is covered with herbaceous elements like *Ageratum conyzoides, Achyranthes aspera, Andrographis paniculata, Artemisia nilagirica, Colocasia esculenta, Bothriochloa pertusa, Coleus aromaticus,Crassocephalum crepidioides, Dichanthium annulatum, Desmodium diffusum, Hydrocotyle nepalensis, Melanocenchris jacqumontii, Oxalis corniculata, Paspalum scrobiculatum, Poa annua, Oplismenus compositus, Sida veronicifolia and Sporobolus diander,* etc. Some epiphytic mosses and ferns are also seen growing on shaded and damp areas. Terrestrial ferns are represented byspecies of*Eqisetum, Selaginella, Adiantum, Pteris, Athyrium,* etc.

The Saddle Area is proposed on the right bank under a hillock near Gosaidah Basti. The vegetation in the area is mostly open, mixed dry deciduous type with a patchy population of *Phoenix sylvestris* along the Turga Nala. The important associates of the tree layer include *Aegle marmelos, Bauhinia variegata, Beilschmiedia roxburghiana, Boswellia serrata, Butea monosperma, Diospyros melanoxylon,Ficus bengalensis, Holarrhena pubescens,* and *Sterculia urens*. The shrub layer consists of decumbent and spreading species, viz., *Cassia tora, Carissa spinarum, Chromolaena odoratum, Ipomoea carnea, Lantana indica, Zizyphus mauritiana,* etc. The ground floor is represented by herbaceous species like *Ageratum conyzoides, Achyranthes aspera, Andrographis paniculata, Bothriochloa pertusa, Coleus aromaticus, Dichanthium annulatum, Oplismenus compositus, Sida veronicifolia, Sporobolus diander,* etc.

ii) Area beyond Gosaidh and upto proposed Upper dam Site (Tar pania)

The vegetation on the hill slopes along Turga nalla banks, from existing Lower dam (Gosaidah) to proposed upper dam axis site (*Tar pania*), consists of a number of deciduous trees such as *Albizia procera, Bombax ceiba, Butea monosperma, Casearia graveolens, Diospyros melanoxylon, Flacourtia jangomas, Mallotus philippinensis, Phoenix sylvestris, Semecarpus anacardium, Sygygium cumini, Terminalia bellerica* and *T. chebula*. The tree trunks of some small trees are seen often laden with vines and parasitic plants. *Butea superba, Cissampelos pareira, Combretum decandrum, Cuscuta reflexa*, *Dioscorea bulbifera, Smilax prolifera*, *Stephania hernandifolia,* etc. are some of the important twiners in the area. Few large trees of Mango can be seen along roadside area.

A patch of mixed growth of Dry Peninsular Sal Forest was observed on shallow soil in upland area. Shrubby layer includes dense undergrowth of some exotic shrubs like *Chromolaena odoratum, Lantana indica* and *Woodfordia fruticosa*. Other scattered shrubs include species of *Cassia, Carissa, Clerodendrum, Indigofera, Randia, Strobilanthes* and *Zizyphus*. Herbaceous vegetation consists of few ferns, grasses and weeds viz., *Ageratum conyzoides, Adiantum capillus-veneris, Bidens pilosa, Chrysopogon serrulatus, Desmodium diffusum, Elephantopus scaber, Evolvulus numularis, Ocimum gratissimum, Sida veronicifolia, Urena lobata,* etc.

iii) Area between proposed Upper Dam, Bara Lahar and Ranga Basti-Submergence Area

At Tar pania (nearupper dam axis site of Turga PSP dam), vegetation is mixed dry deciduous and riverine type. Adjacent area of Turga Nala, the top storey of forest represented by some tall trees like *Albizia odoratissima, Altsonia scholaris,Buchanania latifolia, Cassia fistula,* *Flacoutia jangomas, Lagerstoemia parviflora, Pongamia pinnata, Madhuca indica, Schleichera trijuga, Semecarpus anacardium, Shorea robusta, Terminalia bellerica, T. chebula* and *T. tomentosa*. Second storey of the forest consists of few small trees and tall shrubs viz., *Bauhinia purpurea, Butea monosperma, Diospyros melanoxylon, Holarrhena pubescens, Mallotus philippinensis, Phyllanthus emblica, Randia dumetorum, Wenlandia tinctoria,* etc. Shrubby elements are represented by many spreading and exotic weeds such as *Cassia tora, Carissa spinarum, Chromolaena odoratum, Lantana indica, Woodfordia fruticosa, Zizyphus mauritiana*, etc. Lakh (Bara Duma) deposition can be seen in this area on *Zizyphus* and *Schlichera* trees. Climbers are not common such as *Cissampelos pariera, Combretum decandrum, Dioscorea bulbifera, Jaminum pubescens,* and *Smilax prolifera*. Ground floor is mainly occupied by herbs and weeds such as *Achyranthes aspera, Ageratum conyzoides, Barleria cristata, Biophytum reinwardtii, Evolvulus numularis, Oplismenus compositus, Sida veronicifolia, Sporobolus diander,* etc.

The submergence area is located upstream of Tar pania along the Turga Nala watershed. The vegetation is sparse and patchy interspersed with agricultural fields in the lower reaches of Ranga Basti. Vegetation around Bara Lahar and Ranga Basti i.e. upper reaches to lower reaches is tropical mixed dry deciduous forest and patchy dry peninsular sal forest. The middle reaches are gently sloped and vegetated with few scattered trees. The important trees of the first storey are *Albizia procera, Bauhinia variegata, Buchanania latifolia, Holarrhena pubescens, Madhuca indica, Mallotus philippinensis,Phoenix sylvestris, Schleichera trijuga, Shorea robusta, Syzygium cumini,Terminalia chebula* and *T.tomentosa*. The main constituents at middle storey are *Albizia chinensis, A. procera, Anogeisus latifolia, Butea monosperma, Holarrhena pubescens, Lagerstroemia parviflora, Oroxylum indicum, Semecarous anacardium, Shorea robusta*, *Vitex negundo*, etc. A parasitic plant (*Cuscuta reflexa*) is seen laden on *Vitex negundo shrubs*. Lower storey consists of few small trees and shrubs like *Allophylus cobbe*, *Cassia mimosoides, C. tora, Clerodendrum viscosum, Croton caudatus, Chromolaena* sp, *Leea* sp, *Lantana indica,* and *Zizyphus mauritiana*.Climbers and epiphytes are very few and represented by species like *Cissampelos pareira, Combretum decandrum, Cuscuta reflexa, Dioscorea bulbifera, Jasminum pubescens, Smilax prolifera*, etc. common trailing twiners. Forest floor is disturbed and show gaps covered with weeds, ferns and grasses. Predominant herbs are species of *Ageratum*, *Artemisia, Achyranthes, Andrographis, Bidens, Biophytum, Cheilanthes , Conyza, Cardamine, Digitaria, Elephntopus, Hedyotis, Impatiens, Oxalis, Phyllanthus, Poa, Sida, Sporobolus, Urena, Pteris* sp.etc. Some terrestrial pteridophytic species like *Adiantum, Marselia, Lygodium, Pteris*, etc were also observed in damp, swampy and moist areas (**Table-7.2**, **Plates 7.1 to 7.5**).

iv) Area beyond Ranga Basti up to Saildih Basti –Catchment Area

Along Turga Nala, the top canopy consists of trees like *Albizia odoratissima, Altsonia scholaris,Buchanania latifolia, Flacoutia jangomas, Pongamia pinnata, Madhuca indica, Schleichera trijuga, Semecarpus anacardium, Shorea robusta, Terminalia bellerica, T. chebula* and *T. tomentosa*. Second storey is represented by *Bauhinia purpurea, Butea monosperma, Diospyros melanoxylon, Holarrhena pubescens, Mallotus philippinensis, Phyllanthus emblica, Randia dumetorum* and *Wenlandia tinctoria*. Shrubs are represented by decumbent and spreading species like *Cassia tora, Carissa spinarum, Chromolaena odoratum, Jasminum arborescens, Lantana indica, Woodfordia fruticosa* and *Zizyphus mauritiana*. Epiphytes and climbers are few. Among climbing species are *Cissampelos pareira, Combretum decandrum, Dioscorea bulbifera, Jasminum pubescens,* and *Smilax prolifera*. Ground floor consists of herbaceous species like *Achyranthes aspera, Barleria cristata, Elephantopus scaber, Evolvulus numularis, Oplismenus compositus, Persicaria barbata, Sida veronicifolia, Sporobolus diander,* etc.

The area beyond Ranga Basti up to Saildih Basti in the catchment has predominantly riverine mixed dry deciduous forests interspersed with rice cultivation. The vegetation is patchy comprising of *Albizia procera, Bauhinia variegata, Cassia fistula, Holarrhena pubescens, Madhuca indica, Mallotus philippinensis,Phoenix sylvestris, Schleichera trijuga, Shorea robusta, Syzygium cumini,Terminalia chebula* and *T.myriocarpa*. Shrubby elements are composed of *Cassia mimosoides, C. tora, Clerodendrum viscosum, Croton caudatus, Lantana indica* and *Zizyphus rugosa*.Climbers and epiphytes are very few. *Ficus bengalensis* and *F. religiosa* were often seen growing as an epiphytic species on the trunks of some large trees.A notable parasitic plant like *Cuscuta reflexa* was noticed climbing on bushes of Ber (*Zizyphus maurtiana*) in the area. In addition, some epiphytic orchids like *Bulbophyllum triste, Dendrobium macrostachyum*, *Vanda roxburghii,* etc were observed on some large tree species like Kusum. Common climbers include species of *Butea, Cissampelos, Combretum, Dioscorea, Jasminum, Lygodium, Ipomoea* and *Stephania*. The ground vegetation is disturbed, shows gaps and is covered with weeds, ferns and grasses. *Adiantum capillus-veneris, Ageratum conyzoides, Andrographis paniculata, Bidens pilosa, Biophytum reinwardtii, Cyperus niveus, Desmodium diffusum, Digitaria sanguinalis, Elephantopus scaber, Majus rugosus, Persicaria barbata, Pteris ludens, Urena lobata,* etc. are common herbs.

Further, at upper reaches of this zone, a fairly dense mixed or open dry peninsular Sal forest occurs. Around Sadil Basti area (catchment area), open, mixed dry deciduous forest occurs. Important constituents of the tree layer include *Adina cordifolia, Anogeisus latifolia,Lagerstoemia parviflora, Madhuca indica, Schleichera trijuga, Semecarpus anacardium, Shorea robusta, Terminalia bellerica, T. chebula* and *T. tomentosa*. Shrub layer is thin comprised of few spreading and procumbent species like *Chromolaena odoratum, Clerodendrum viscosum, Lantana indica, Woodfordia fruticosa,* etc.

7.5 COMMUNITY STRUCTURE AND DIVERSITY INDICES

Community is a sociological unit of any rank, occupying a territory and having a charactristic composition and structure. In order to understand the community structure, vegetation samplings were carried out at different locations of proposed project and in catchment area. As a part of the study, five sites listed as below were covered.

- ProposedLower Dam (Proposed Saddle area towards right bank of Turga Nallah V1),
- Downstream of existing Turga Irrigation dam (Turga Nallah at Gosaidah / Patherdih-V2),
- Downstream of proposedUpper Dam axis site (d/s of Tar pania / d/s V-notch-dam axis site of Turga Nallah -V3)
- ProposedUpper dam axis site (Tar pania, Darelehar / Baralahar submergence site, Turga Nala- V4)
- Catchment Area (Near Ranga Basti to Buingera and Saildih / Bharipani villages in vicinity of Turga Nallah- V5)

The sampling location map for terrestrial ecology is enclosed as **Figure-7.1.**

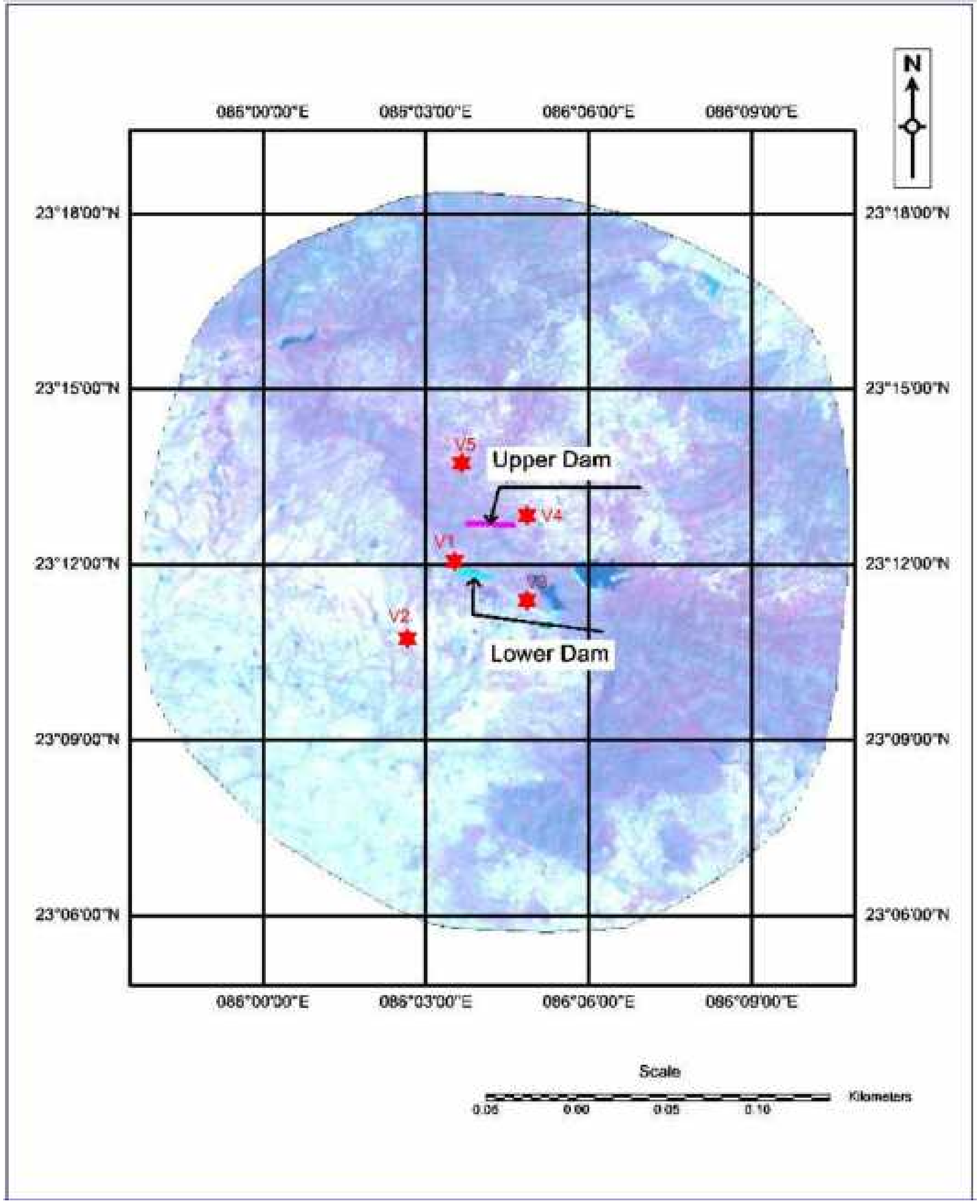


Figure-7.1: Sampling location map for terrestrial ecology

The findings of the floral survey are given in the following sections.

7.5.1 Density and Abundance of woody vegetation

The maximum number of tree species was recorded from the Upper Dam axis site (Tanrpania, left bank of Turga Nala). The proposed Lower Dam Saddle area (right bank of Turga Nala) and Downstream of Lower dam site (Gosaidah, left bank of Turga Nala) did not show as many tree species due to past and on-going land use changes and extensive felling of trees for various purposes including timber. The number of herb species was recorded higher at Lower dam Saddle area and downstream of Lower dam (**Table-7.3**).

On the Lower dam (Saddle Area, Lower dam site Bagmundi), the tree stratum was dominated by *Butea monosperma* with maximum density (200 trees/ha). The associated species in the tree layer were *Phoenix sylvestris* and *Diospyros melanoxylon*. In the sapling stratum, *Diospyros melanoxylon* was found to be the most dominant species. The presence of more saplings of this species attributed to the adaptability of this species in the area and high human pressure.In the shrub stratum, *Chromolaena odoratum* was found to be the most dominant with high density. The dominance of *Chromolaena odoratum* may be due to its non palatable nature and capability to grow in dry and disturbed areas. Other competing species in the layer were*Lantana indica, Ipomoea carnea, Zizyphus mauritiana, Clerodendrum viscosum, Cassia tora*and *Carissa spinarum* (**Table-7.3**).

At the downstream of existing Turga Irrigation dam site (Gosaidih /patherdih),the tree and sapling strata were dominated by *Holarrhena pubescens* having maximum frequency and density. The associated species of the tree layer were *Aegle marmelos, Ficus racemosa, Moringa oleifera, Bombax ceiba, Beilschmiedia roxburghiana, Butea monosperma, Bauhinia variegata, Acacia leucophloea,* and *Phoenix sylvestris*. In the shrub stratum, *Chromolaena odoratum* was found to be the most dominant species having high density. Other competing species of the layer were *Clerodendrum viscosum, Lantana indica, Cassia occidentalis, C. tora, Pogostemone plectranthoides*and *Ipomoea carnea* (**Table-7.3**).

At the downstream of the proposed Upper dam axis site (d/s of Tar pania, middle reach between lower dam to upper dam of Turga Nala), the tree stratum was dominated by *Shorea robusta* having maximum frequency (70%) and density (70 trees/ha). The associated species in the tree canopy were *Terminalia chebula, Mangifera indica, Wendlandia exserta, Celtis tetrandra, Bauhinia variegata, Cassia fistula, Callicarpa arborea, Terminalia bellerica, T. tomentosa, Mallotus philippinensis, Semecarpus anacardium, Albizia procera* and *Ficus racemosa*. In the sapling stratum *Croton caudatus* was found to be the most dominant species having maximum density. In the shrub layer*Clerodendrum viscosum* was found to be the most dominant species having high density. Other competing species in the layer were *Lantana indica, Chromolaena odoratum, Combretum decandrum, Strobilanthes pectinatus, Zizyphus mauritiana Carissa spinarum,Woodfordia fruticosa, Randia ulginosa,Cassia occidentalis* and *Abelmoschus manihot*.

At proposedUpper Dam axis site and its upstream (Tar pania), the tree stratum was dominated by*Shorea robusta* having maximum frequency (70%) and density (160 trees/ha).

The associated species in the tree layer were *Semecarpus anacardium, Syzygium cumini, Terminalia tomentosa, Flacourtia jangomas, Buchanania latifolia, Schleichera trijuga, Terminalia bellerica, T. chebula, Albizia odoratissima* and *Phyllanthus emblica*. In the sapling stratum, *Holarrhena pubescens* was recorded as the dominant species with high density. In the shrub stratum *Clerodendrum viscosum* was found to be the most dominant species with high density. Other competing species in the understorey were *Chromolaena odoratum, Cassia tora, Woodfordia fruticosa, Desmodium gangeticum, Uvaria tomentosa, Celastrus paniculata, Combretum decandrum,* and *Leea alata*.

At catchment area of Turga Nallah, the tree stratum was dominated by *Holarrhena pubescens* having maximum frequency (30%) and density (50 trees/ha). The associated species in the tree layer were *Albizia procera, Shorea robusta, Phoenix sylvestris, Mallotus philippinensis, Croton caudatus, Syzygium cumini, Schleichera trijuga, Ficus auriculata, Cassia fistula* and *Madhuca indica*. In the sapling stratum, *Croton caudata* was found to be the most dominant species having maximum density. In the shrub stratum, *Lantana indica* was recorded as the most dominant species having high density. Other competing species in the layer were *Chromolaena odoratum, Clerodendrum viscosum, Zyzyphus rugosa* and *Cassia mimosoides*. The presence of *Lantana indica, Chromolaena odoratum* and *Zizyphus* sp.as a throny and spreading species shows biotic disturbance in the area due to grazing and lopping.

Across all the sites/stands the total tree density ranged from 210 trees/ha at the downstream of dam site (Gosaidah) to 410 trees/ha at Upper dam axis site (Tar pania). In the sapling layer highest density was recorded at Lower dam Saddle area. Complete absence of seedlings of all major species in all the forest sites indicates heavy anthropogenic pressure in the area. The total density for shrubs varied from 3840 to 7520 individuals ha^{-1}. It was comparatively higher at the downstream of lower dam site (7520 individual ha^{-1}) as compared to other sites. The maximum individual shrub density was recorded for *Chromolaena odoratum* (3720 individual ha^{-1}) at the downstream of dam site (V2) and *Lantana indica* (3240 individual ha^{-1}) at submergence area (V5) (**Table-7.3**).

The total basal area ranged from 78.11 m^2/ha at Lower dam (Saddle area) to 220.57 m^2/ha at Upper Dam axis site (Tar pania) (Table-7.3). *Butea monosperma, Semecarpus anacardium* and *Albizia procera* were the dominant species with an IVI of 186.60, 33.59, 59.16 at proposed Lower dam (Saddle area), Upper dam axis site, submergence and catchement area, respectively.

Table-7.3: Vegetational attributes of woody vegetation in Turga Pumped Storage Project

Sl. No.	Species	Frequency (F%)	Density (Ha^{-1})	TBC (m^2ha^{-1})	IVI	H
V1	**Lower Dam (Proposed Saddle area towards right bank of Turga Nala) 250m**					
Trees						
1	*Butea monosperma*	100	200	55.02	186.60	
2	*Phoenix sylvestris*	60	100	20.90	90.39	
3	*Diospyros melanoxylon*	20	30	2.19	23.01	
	Total	**180**	**330**	**78.11**		**0.883**
Saplings						
1	*Albizia procera*	20	80	0.90	9.56	
2	*Diospyros embryopteris*	60	520	6.38	44.03	
3	*Phoenix sylvestris*	30	200	5.37	23.61	
4	*Buchanania latifolia*	10	120	1.22	8.71	
5	*Holarrhena pubescens*	40	480	6.17	36.96	
6	*Butea monosperma*	40	200	5.79	26.99	
7	*Diospyros melanoxylon*	30	720	18.31	62.21	
8	*Azadirachta indica*	30	120	1.04	13.82	
9	*Tectona grandis*	10	40	2.46	8.08	
10	*Casearia graveolens*	30	120	2.88	16.85	
11	*Madhuca indica*	30	160	4.30	20.51	
12	*Morinda angustifolia*	20	80	1.61	10.71	
13	*Sterculia urens*	10	40	2.55	8.23	
14	*Flacourtia jangomas*	10	120	1.85	9.74	
	Total	**370**	**3000**	**60.84**		**2.280**
Shrubs						
1	*Carissa spinarum*	20	80	1.14	14.43	
2	*Zizyphus mauritiana*	50	320	3.62	41.06	
3	*Clerodendrum viscosum*	20	320	3.26	25.91	
4	*Lantana indica*	50	960	12.35	79.26	
5	*Chromolaena odoratum*	50	1520	13.16	95.83	
6	*Ipomaea carnea*	10	480	5.61	31.09	
7	*Cassia tora*	10	160	1.41	12.41	
	Total	**210**	**3840**	**40.55**		**1.601**
V2	**Downstream of Existing Lower dam (Turga nallah at Gosaidah / Patherdih) 260m**					
	Trees					
1	*Holarrhena pubescens*	20	30	20.51	53.25	
2	*Phoenix sylvestris*	10	10	6.36	19.55	
3	*Moringa oleifera*	20	20	2.21	26.47	
4	*Bauhinia variegate*	10	10	3.68	16.34	
5	*Boswellia serrata*	10	10	15.39	30.41	
6	*Aegle marmelos*	20	30	3.22	32.45	
7	*Bombax ceiba*	10	20	12.83	32.10	
8	*Ficus racemosa*	10	30	4.65	27.03	
9	*Beilschmiedia roxburghiana*	10	20	8.83	27.29	
10	*Acacia leucopholea*	10	10	1.52	13.73	
11	*Butea monosperma*	10	20	3.93	21.39	
	Total	**140**	**210**	**83.13**		**2.310**

Sl. No.	Species	Frequency (F%)	Density (Ha^{-1})	TBC (m^2ha^{-1})	IVI	H
Saplings						
1	*Randia dumetorium*	40	240	6.45	57.00	
2	*Ficus racemosa*	30	160	5.23	42.65	
3	*Holarrhena pubescens*	50	600	12.36	106.28	
4	*Phoenix sylvestris*	10	40	0.62	9.57	
5	*Casearia graveiolens*	10	40	0.45	9.03	
6	*Ficus benghalensis*	20	80	1.86	21.21	
7	*Azadirachta indica*	10	40	0.38	8.79	
8	*Butea monosperma*	30	160	1.81	31.37	
9	*Oroxylum indicum*	10	80	1.14	14.10	
	Total	**210**	**1440**	**30.29**		**1.771**
Shrubs						
1	*Clerodendrum viscosum*	80	2080	21.59	76.56	
2	*Chromolaena odoratum*	100	3720	34.06	119.32	
3	*Cassia occidentalis*	50	400	3.53	23.57	
4	*Lantana indica*	70	880	17.68	52.99	
5	*Cassia tora*	40	280	2.42	17.83	
6	*Pogostemone plectranthoides*	10	80	0.68	4.68	
7	*Ipomaea carnea*	10	80	0.98	5.05	
	Total	**360**	**7520**	**80.95**		**1.330**
V3	**D/s of Upper Dam axis site (d/s of Tar pania or d/s V-notch on Turga Nala) 384m**					
Trees						
1	*Shorea robusta*	70	70	24.79	84.60	
2	*Terminalia chebula*	20	20	7.37	24.43	
3	*Bauhinia variegate*	10	10	0.78	9.60	
4	*Mangifera indica*	20	20	62.80	74.40	
5	*Ficus racemosa*	10	10	1.26	10.03	
6	*Wendlandia exserta*	10	20	2.56	15.55	
7	*Cassia fistula*	10	10	0.91	9.71	
8	*Callicarpa arborea*	10	10	0.80	9.62	
9	*Terminalia bellerica*	10	10	1.38	10.14	
10	*Syzygium cumini*	10	10	3.85	12.36	
11	*Terminalia myriocarpa*	10	10	0.83	9.64	
12	*Mallotus philippinensis*	10	10	0.85	9.66	
13	*Semecarpus anacardium*	10	10	1.81	10.52	
14	*Albizia procera*	10	10	0.93	9.74	
	Total	**220**	**230**	**110.92**		**2.362**
Saplings						
1	*Shorea robusta*	10	80	1.81	17.91	
2	*Casearia graveolens*	30	280	3.55	48.34	
3	*Bauhinia variegata*	10	40	0.37	8.90	
4	*Clausena heptaphylla*	10	40	0.41	9.08	
5	*Wendlandia exserta*	10	40	0.45	9.27	
6	*Syzygium cumini*	20	80	0.69	17.63	
7	*Cassia fistula*	20	120	1.85	25.37	
8	*Croton caudatus*	40	400	4.91	67.08	

Sl. No.	Species	Frequency (F%)	Density (Ha^{-1})	TBC (m^2ha^{-1})	IVI	H
9	*Semecarpus anacardium*	10	80	4.92	31.30	
10	*Helictrus isora*	10	40	0.38	8.96	
11	*Madhuca indica*	10	40	1.26	12.73	
12	*Holarrhena pubescens*	20	120	1.57	24.17	
13	*Ficus oligodon*	10	40	0.62	9.97	
14	*Ficus racemosa*	10	40	0.45	9.27	
	Total	**220**	**1440**	**23.23**		**2.267**
Shrubs						
1	*Woodfordia fruticosa*	50	200	2.26	20.38	
2	*Clerodendrum viscosum*	70	1400	14.28	75.93	
3	*Lantana indica*	40	640	7.00	37.46	
4	*Butea superba*	20	80	1.09	8.53	
5	*Antidesma acuminatum*	10	80	0.90	5.88	
6	*Carissa spinarum*	50	200	3.08	22.01	
7	*Zizyphus maurtiana*	40	240	2.36	19.21	
8	*Randia uliginosa*	10	80	4.92	13.89	
9	*Strobilanthes pectinatus*	20	320	2.82	17.38	
10	*Combretum decandrum*	60	440	4.73	32.98	
11	*Chormolaena odoratum*	40	640	5.54	34.55	
12	*Cassia occidentalis*	10	40	0.35	3.88	
13	*C. tora*	10	40	0.35	3.86	
14	*Abelmoschus manihot*	10	40	0.45	4.08	
	Total	**440**	**4440**	**50.14**		**2.122**
V4	**Upper dam axis site (Tar pania, Darelehar / Baralahar :submergence site) 410m**					
Trees						
1	*Buchanania latifolia*	20	20	44.84	32.10	
2	*Flacourtia jangomas*	20	30	4.56	16.28	
3	*Semicarpus anacardium*	40	40	22.16	33.59	
4	*Syzygium cumini*	20	30	39.80	32.26	
5	*Pongamia pinnata*	10	10	20.10	15.00	
6	*Altsonia scholaris*	10	10	2.83	7.17	
7	*Melia azedarach*	10	10	1.96	6.78	
8	*Schleichera trijuga*	10	10	37.99	23.11	
9	*Shorea robusta*	70	160	29.45	76.51	
10	*Terminalia tomentosa*	20	30	7.21	17.48	
11	*T. bellerica*	10	10	1.96	6.78	
12	*T. chebula*	10	10	3.52	7.48	
13	*Oroxylum indicum*	10	10	0.73	6.22	
14	*Randia dumatorum*	10	10	0.80	6.25	
15	*Albizia odoratissima*	10	10	1.52	6.58	
16	*Phyllanthus emblica*	10	10	1.13	6.40	
	Total	**290**	**410**	**220.57**		**2.221**
Saplings						
1	*Buchanania latifolia*	20	120	1.10	14.21	
2	*Phoenix sylvestris*	10	40	2.83	10.52	
3	*Jasminum arborescens*	10	40	0.80	6.68	

Sl. No.	Species	Frequency (F%)	Density (Ha^{-1})	TBC (m^2ha^{-1})	IVI	H
4	*Schleichera trijuga*	20	160	2.46	18.62	
5	*Mallotus philippinensis*	20	200	4.02	23.39	
6	*Flacourtia jangomas*	10	80	0.69	8.28	
7	*Syzygium cumini*	20	120	1.36	14.70	
8	*Shorea robusta*	30	280	11.97	45.47	
9	*Butea monosperma*	50	320	10.56	51.26	
10	*Holarrhena pubescens*	40	360	9.16	47.09	
11	*Casearia graveolens*	30	160	2.29	21.62	
12	*Semecarpus anacardium*	10	40	0.51	6.13	
13	*Croton caudatus*	20	240	4.24	25.63	
14	*Oroxylum indicum*	10	40	0.66	6.41	
	Total	**300**	**2200**	**52.65**		**2.409**
Shrubs						
1	*Cletrodendrum viscosum*	90	2640	25.08	142.53	
2	*Combretum decandrum*	10	40	0.45	5.51	
3	*Lantana indica*	30	320	3.32	24.96	
4	*Chromolaena odoratum*	80	1240	11.35	80.00	
5	*Cassia tora*	10	160	1.38	10.03	
6	*Desmodium gangeticum*	10	80	0.68	6.84	
7	*Uvaria tomentosa*	10	80	1.23	8.03	
8	*Celastrus paniculata*	10	80	1.03	7.59	
9	*Woodfordia fruticosa*	10	120	1.40	9.23	
10	*Leea alata*	10	40	0.34	5.27	
	Total	**270**	**4800**	**46.27**		**1.349**
V5	**Catchment Area Turga (Near Ranga Basti-Buingera-Saildih-Bharipani villages) 430m**					
Trees						
1	*Albizia procera*	30	40	29.70	59.16	
2	*Croton caudatus*	10	30	2.19	16.10	
3	*Shorea robusta*	30	40	3.28	29.45	
4	*Holarrhena pubescens*	30	50	4.81	34.20	
5	*Cassia fistula*	10	10	0.80	8.48	
6	*Ficus auriculata*	10	20	5.01	16.24	
7	*Syzygium cumini*	20	20	8.88	25.14	
8	*Phoenix sylvestris*	10	30	8.48	23.17	
9	*Zizyphus mauritiana*	10	10	0.91	8.60	
10	*Terminalia tomentosa*	10	10	1.26	8.99	
11	*Madhuca indica*	10	10	5.02	13.23	
12	*Schleichera trijuga*	20	20	9.19	25.49	
13	*Bauhinia variegata*	10	10	0.75	8.42	
14	*Mallotus philippinensis*	10	30	8.62	23.33	
	Total	**220**	**330**	**88.90**		**2.491**
Saplings						
1	*Croton caudatus*	90	680	12.01	127.02	
2	*Syzygium cumini*	10	40	1.02	10.46	
3	*Holarrhena pubescens*	40	240	9.79	65.23	
4	*Mallotus philippinensis*	30	120	1.98	28.13	

Sl. No.	Species	Frequency (F%)	Density (Ha^{-1})	TBC (m^2ha^{-1})	IVI	H
5	*Casearia graveolens*	10	40	1.26	11.18	
6	*Terminalia chebula*	10	40	2.83	15.94	
7	*Butea superba*	10	40	1.26	11.18	
8	*Shorea robusata*	10	40	1.81	12.86	
9	*Ficus auriculata*	10	40	0.62	9.24	
10	*Allophylus cobbe*	10	40	0.45	8.75	
	Total	**230**	**1320**	**33.02**		**1.611**
Shrubs						
1	*Clerodendrum viscosum*	30	520	5.88	36.53	
2	*Chromolaena odoratum*	50	760	6.58	53.81	
3	*Lantana indica*	80	3240	49.85	187.92	
4	*Zizyphus rugosa* var. *glabrescens*	10	80	0.90	8.61	
5	*Cassia mimosoides*	10	80	3.93	13.11	
	Total	**180**	**4680**	**67.14**		**0.933**

Note:- TBC= Total Basal Cover ; IVI = Impotantance value Index; H= Shannon Diversity Index

7.5.2 Density and Abundance of Herbaceous vegetation

Among the herbaceous species, *Coleus aromaticus* was the dominant species having maximum density (72000 plants/ha) during post-monsoon at Lower dam (Saddle Area). It was followed by *Desmodium diffusum, Chrysopogon aciculatus* and *Cynodon dactylon* (**Table-7.4**).As per IVI values, *Coleus aromaticus* was the most dominant species (75.02) followed by *Desmodium diffusum* (25.45), *Chrysopogon aciculatus* (23.01), *Cynodon dactylon* (19.78), and *Bothriochloa pertusa* (18.19) during monsoon. Hebaceous species abundance for summer and monsoon period are shown in **Tables-7.5** and **7.6**.

At the downstream of Lower dam site (Gosaidh), *Oplismenus compositus* was found to be most dominant species having maximum density (79000 plants/ha) during post-monsoon. It was followed by *Desmodium diffusum* and *Sida veronicifolia* in terms of density (**Table-7.4**). Maximum value of IVI was observed in *Oplismenus compositus* during post-monsoon (40.30). It was followed by *Coleus aromaticus* (37.53), *Sida veronicifolia* (21.91) and *Desmodium diffusum* (18.17).

During summer season, *cynodon dactylon* was found dominant species. It was followed by *Urena lobata, Ageratum conyzoides*, and *Alternanthera* sp. The maximum IVI value observed was 48.35 for *Cyanodon dactylon* and minimum IVI 6.32 for *Euphorbia hirta***(Table-7.5).** In monsoon season, *Saccharum munja* was the dominant species having maximum density (18000 plants/ha). It was followed by *Brachiaria villosa* and *Ageratum conyzoides* in terms of density. As per IVI values, *Ageratum conyzoides* was the dominant species (24.10). It was followed by

Brachiaria villosa (23.98). The minimum IVI of 5.89 was recorded in *Dioscorea bulbifera* **(Table-7.6)**.

On Lower dam site Saddle area, *Melilotus indica* was the dominant species having maximum density (64000 plants/ha) during monsoon. It was followed by *Chrysopogon aciculatus* and *Mazus delavayi* in terms of density. Maximum IVI was observed in *Melilotus indica* (50.32) followed by *Mazus delavayi* (28.21). The lowest IVI of 2.38 was recorded in *Oldenlandia corymbosa* (**Table-7.6**).

At the downstream of Upper dam axis (d/s of Tar pania or d/s V-notch on Turga Nala), *Desmodium diffusum* was the most dominant species having maximum density (46000 plants/ha) during post-monsoon (Refer **Table-7.4**). It was followed by *Hedyotis thomsoni, Digitaria pedicillaris* and *Arthraxon hispidus* in terms of density. As per IVI values, *Elephantopus scaber* (40.69) was the dominant species followed by *Desmodium diffusum* (35.99). The minimum IVI of 3.15 was recorded in *Sporobolus diander*. **Table-7.4**detailsthe presesnce of herbaceous flora during summer season at various sites. As far as IVI value is concerned, species like *Alternanthera* sp. (35.21) was dominant followed by *Indigofera* sp. (32.45), *Ageratumconyzoides* (29.24) and *Cynodondactylon* (18.45).

At Upper dam axis (Tar pania), *Oplismenus compositus* was the most dominant species having maximum density (42000 plants/ha) during post-monsoon. It was followed by *Desmodium diffusum* and *Elephantopus scaber* in terms of density. Maximum value of IVI was observed in *Elephantopus scaber* (62.99) followed by *Oplismenus compositus* (47.63) and *Urena lobata* (40.27). *Phyllanthus urinaria* was the most dominant species having maximum density (15000 plants/ha) during monsoon season **(Refer Table-7.6).** It was followed by *Oplismenus compositus, Persicaria barbata* and *Elephantopus scaber* in terms of density. As per IVI values, *Oldenlandia corymbosa* was the dominant species (28.25) followed by *Oplismenus compositus* (21.99), *Elephantopus scaber* (20.98) and *Phyllanthus urinaria* (20.10). The minimum IVI of 3.77 was recorded in *Panicum repens* and *Dioscorea bulbifera*.

At the catchment area, *Oplismenus compositus* and *Desmodium diffusum*were the most dominant species having maximum density (22000 plants/ha) during post-monsoon season. It was followed by *Ageratum conyzoides* and *Phyllanthus urinaria* in terms of density. Maximum IVI was observed in *Sida veronicifolia* (34.04) during post-monsoon season. It was followed by *Oplismenus compositus* (28.90) and *Ageratum conyzoides* (27.11). The lowest IVI of 3.91 was recorded in *Ruellia prostrata* during post-monsoon sampling (Refer **Table-7.4**).

In summer season, *Arthraxon hispidus* (29.25) *was the dominant species followed by Chrysopogon aciculatus* (21.85) and *Cynodon dactylon* (27.35) whereas the minimum value was 2.85 for *Oxalis corniculata* **(Refer Table-7.5)**. In monsoon season, *Cynodon dactylon* was found to be most dominant species having maximum density (22000 plants/ha). It was followed by *Phyllanthus urinaria* and *Melilotus indica* in terms of density (Refer **Table-7.6**). Maximum value of IVI was observed in *Phyllanthus urinaria* (32.39) followed by *Hedyotis corymbosa* (30.28) and *Cynodon dactylon* (28.25) during monsoon. The minimum IVI of 4.60 was recorded for *Elephantopus scaber*.

Table-7.4:Vegetational attributes of herbaceous vegetation in study area (Post Monsoon)

Sl. No.	Species	Frequency (F%)	Density (Ha^{-1})	TBC (m^2ha^{-1})	IVI	H
V1	**Lower Dam (Proposed Saddle area towards right bank of Turga Nala) 250m**					
1	*Andrographis paniculata*	50	12000	0.12	15.67	
2	*Coleus aromaticus*	90	72000	1.14	75.02	
3	*Sida veronicifolia*	30	14000	0.13	13.20	
4	*Cynodon dactylon*	40	36000	0.11	19.78	
5	*Oplismenus composites*	20	26000	0.08	12.78	
6	*Hedyotis thomsoni*	30	14000	0.10	12.16	
7	*Desmodium diffusum*	50	47000	0.15	25.45	
8	*Urginia indica*	10	1000	0.06	4.28	
9	*Anisomeles ovate*	10	4000	0.03	3.72	
10	*Bothriochloa pertusa*	30	34000	0.13	18.19	
11	*Zornia diphylla*	10	4000	0.01	3.14	
12	*Cyperus niveus*	10	8000	0.03	4.58	
13	*Eragrostis cynosuroides*	10	4000	0.01	3.14	
14	*Ocimum gratissimum*	10	5000	0.06	5.23	
15	*Sporobolus diander*	10	10000	0.03	5.42	
17	*Sacciolepis indica*	20	6000	0.02	5.56	
18	*Chrysopogon aciculatus*	30	45000	0.19	23.01	
19	*Gomphrena globosa*	30	22000	0.08	13.56	
20	*Evolvulus numlaria*	10	4000	0.01	3.14	
21	*Kyllinga brevifolia*	20	9000	0.03	6.64	
22	*Chloris barbata*	10	8000	0.03	4.58	
23	*Dichanthium annulatum*	10	4000	0.02	3.40	
24	*Fimbristylis monostachya*	10	4000	0.01	3.14	
25	*Urena lobata*	10	2000	0.04	3.63	
26	*Eragrostis nardoides*	10	4000	0.02	3.52	
27	*Cyanotis axillaris*	10	4000	0.01	3.14	
28	*Impatiens balsamina*	10	4000	0.06	5.02	
	Total	**590**	**407000**	**2.72**		**2.786**
V2	**Downstream of Existing Lower dam (Turga nallah at Gosaidah / Patherdih 260m**					
1	*Phyllanthus urinaria*	40	18000	0.07	13.43	
2	*Sida veronicifolia*	50	24000	0.23	21.91	
3	*Boerhavia diffusa*	20	6000	0.05	6.38	
4	*Chrysopogon serrulatus*	20	15000	0.08	9.78	
5	*Galium asperuloides*	10	4000	0.01	3.08	
6	*Leucas cephalotes*	10	2000	0.03	3.18	

Sl. No.	Species	Frequency (F%)	Density (Ha^{-1})	TBC (m^2ha^{-1})	IVI	H
7	*Oplismenus composites*	60	79000	0.30	40.30	
8	*Dactyloctenium aegypticum*	50	20000	0.10	16.54	
9	*Digitaria pedicillaris*	40	22000	0.08	14.74	
10	*Cynodon dactylon*	10	8000	0.03	4.54	
11	*Caex cruciata*	20	16000	0.05	9.08	
12	*Melilotus indica*	20	18000	0.07	10.20	
13	*Desmodium diffusum*	40	32000	0.10	18.17	
14	*Achyranthes aspera*	10	4000	0.03	3.59	
15	*Corchorus aestuans*	10	2000	0.04	3.42	
16	*Kyllinga brevifolia*	40	25000	0.08	15.60	
17	*Coleus aromaticus*	30	14000	0.89	37.53	
18	*Eragrostis nardoides*	20	14000	0.04	8.35	
19	*Eclipta alba*	10	2000	0.01	2.35	
20	*Cyanotis axillaris*	30	12000	0.05	9.63	
21	*Paspalidium flavidum*	10	8000	0.04	4.90	
22	*Blepharis maderaspatensis*	10	4000	0.03	3.72	
23	*Euphorbia hirta*	10	2000	0.01	2.35	
24	*Elephantopus scaber*	10	9000	0.16	9.29	
25	*Carex filicina*	10	4000	0.01	3.12	
26	*Eragrostis unioloides*	10	8000	0.03	4.54	
27	*Anisochilus carnosus*	10	3000	0.46	17.44	
28	*Evolvulus numularis*	10	4000	0.01	2.90	
	Total	**620**	**379000**	**3.07**		**2.902**
V3	**D/s of Upper Dam axis site (d/s of Tar pania or d/s V-notch on Turga Nala) 384m**					
1	*Andrographis paniculata*	10	2000	0.03	4.89	
2	*Oplismenus composites*	40	15000	0.06	17.59	
3	*Dioscorea hamiltoni*	20	4000	0.02	6.79	
4	*Elephantopus scaber*	40	19000	0.37	40.69	
5	*Achyranthes asper*	20	3000	0.04	7.88	
6	*Chrysopogon serrulatus*	20	16000	0.15	20.15	
7	*Desmodium diffusum*	40	46000	0.14	35.99	
8	*Digitaria pedicillaris*	20	22000	0.08	18.37	
9	*Cyanotis axillaris*	40	15000	0.06	17.59	
10	*Urena lobata*	70	10000	0.13	26.02	
11	*Bidens pilosa*	20	6000	0.06	10.18	
12	*Cochorus aestuans*	10	2000	0.05	5.96	
13	*Hedyotis thomsoni*	50	22000	0.08	24.14	
14	*Adiantum capillus-veneris*	10	10000	0.03	8.08	
15	*Euphorbia hirta*	20	8000	0.02	8.44	
16	*Kickxia ramosissima*	10	2000	0.01	3.34	
17	*Sida veronicifolia*	10	2000	0.01	3.69	
18	*Phyllanthus urinaria*	10	4000	0.01	4.38	
19	*Cynodon dactylon*	20	12000	0.03	10.74	
20	*Pueraria tuberose*	10	3000	0.01	3.98	
21	*Sporobolus diander*	10	2000	0.01	3.15	
22	*Majus rugosus*	10	4000	0.01	4.38	

Sl. No.	Species	Frequency (F%)	Density (Ha^{-1})	TBC (m^2ha^{-1})	IVI	H
23	*Arthraxon hispidus*	10	20000	0.06	13.81	
	Total	**520**	**249000**	**1.47**		**2.758**
V4	**Upper dam axis site (Tar pania, Darelehar / Baralahar submergence site) 410m**					
1	*Urena lobata*	40	12000	0.34	40.27	
2	*Oplismenus composites*	70	42000	0.13	47.63	
3	*Elephantopus scaber*	70	24000	0.47	62.99	
4	*Phyllanthus urinaria*	20	4000	0.01	7.31	
5	*Curculigo capitulate*	10	4000	0.03	6.40	
6	*Galium asperuloides*	20	5000	0.02	8.35	
7	*Selaginella indica*	30	12000	0.03	15.16	
8	*Cynodon dactylon*	10	4000	0.01	5.23	
9	*Lygodium japonicum*	20	4000	0.02	8.21	
10	*Sporobolus diander*	10	8000	0.03	8.57	
11	*Veronica anagallis -aquatica*	10	3000	0.03	5.77	
12	*Oldenlandia corymbosa*	10	2000	0.01	3.66	
13	*Desmodium diffusum*	40	25000	0.08	28.00	
14	*Biophytum reinwardtii*	20	3000	0.01	6.92	
15	*Hedyotis thomsoni*	10	2000	0.01	3.66	
16	*Cyrtococcum accrescens*	10	4000	0.01	5.23	
17	*Pilea microphylla*	10	2000	0.02	4.54	
18	*Cyanotis axillaris*	20	5000	0.02	8.48	
19	*Adiantum capillus-veneris*	30	13000	0.04	16.48	
20	*Stephania hernandifolia*	10	1000	0.01	3.16	
21	*Dioscorea bulbifera*	10	2000	0.01	4.17	
	Total	**480**	**181000**	**1.34**		**2.55**
V5	**Catchment Area Turga (Near Ranga Basti-Buingera-Saildih-Bharipani villages) 430m**					
1	*Phyllanthus urinaria*	40	13000	0.06	24.38	
2	*Majus rugosus*	10	2000	0.01	4.47	
3	*Melilotus indica*	10	4000	0.02	6.45	
4	*Selaginella indica*	20	12000	0.04	15.93	
5	*Oplismenus composites*	30	22000	0.08	28.90	
6	*Ruellia prostrate*	10	1000	0.01	3.91	
7	*Hedyotis thomsoni*	20	12000	0.05	17.59	
8	*Cyperus niveus*	10	8000	0.03	9.74	
9	*Elephantopus scaber*	10	2000	0.03	6.96	
10	*Ageratum conyzoides*	30	15000	0.11	27.11	
11	*Urena lobata*	20	2000	0.04	10.34	
12	*Oldenlandia corymbosa*	10	4000	0.01	5.95	
13	*Sida veronicifolia*	40	12000	0.17	34.04	
14	*Desmodium diffusum*	20	22000	0.07	24.81	
15	*Cynodon dactylon*	20	8000	0.03	12.37	
16	*Biophytum reinwarrdtii*	10	2000	0.02	5.39	
17	*Justicia simplex*	10	1000	0.02	4.87	
18	*Kyllinga brevifolia*	10	4000	0.01	6.19	
19	*Cyanotis axillaris*	10	4000	0.02	6.74	
20	*Persicaria barbata*	10	8000	0.10	17.28	

Sl. No.	Species	Frequency (F%)	Density (Ha^{-1})	TBC (m^2ha^{-1})	IVI	H
21	*Bidens pilosa*	10	4000	0.03	7.76	
22	*Digitaria sanguinalis*	10	4000	0.01	6.19	
23	*Fimbristylis diphylla*	10	8000	0.06	12.88	
	Total	**380**	**174000**	**1.00**		**2.833**

TBC= Total Basal Cover ; IVI = Impotantance Value Index; H= Shannon Diversity Index

Table-7.5: Vegetational attributes of herbaceous vegetation in the study area (Summer)

S. No.	Plant species	Frequency (%)	Density (ha^{-1})	IVI	H’
V1	**Lower Dam (Proposed Saddle area towards right bank of Turga Nala) 250m**				
1	*Cynodon dactylon*	40	30000	28.21	
2	*Ageratum conyzoides*	30	42000	26.41	
3	*Corchorus aestuans*	20	16000	14.21	
4	*Paspalum scrobiculatum*	50	22000	32.14	
5	*Euphorbia hirta*	20	6000	12.45	
6	*Indigofera tinctoria*	30	15000	16.24	
7	*Argemone mexicana*	20	4000	7.25	
8	*Bidens pilosa*	20	2000	6.78	
9	*Impatiens balsamina*	30	18000	15.69	
10	*Oxalis corniculata*	40	35000	25.35	
11	*Carex cruciata*	30	41000	34.52	
12	*Cyperus speciosa*	20	14000	11.09	
13	*Barleria lupulina*	20	4000	6.32	
14	*Bothriochloa pertusa*	40	8000	8.45	
15	*Cyrtococcum accrescens*	10	4000	3.65	
16	*Scoparia dulcis*	10	2000	7.21	
17	*Tylophora indica*	20	10000	14.26	
18	*Eclipta prostrata*	20	6000	8.65	
19	*Leucas cephalotes*	20	6000	7.88	
20	*Sida cordata*	10	8000	13.24	
	Total	**500**	**293000**		**2.11**
V2	**Downstream of Existing Lower dam (Turga nallah at Gosaidah / Patherdih) 260m**				
1	*Oxalis corniculata*	30	22000	29.57	
2	*Sida cordata*	20	8000	7.32	
3	*Alternanthera sessilis*	30	16000	23.47	
4	*Cyperus rotundus*	20	3000	15.24	
5	*Achyranthes aspera*	10	4000	11.35	
6	*Phyllanthus urinaria*	20	2000	9.25	
7	*Carex cruciata*	20	5000	16.56	
8	*Cynodon dactylon*	40	46000	48.35	
9	*Urena lobata*	20	26000	36.25	
10	*Coleus aromaticus*	10	2000	21.14	
11	*Indigofera tinctoria*	30	12000	29.35	
12	*Bidens pilosa*	20	6000	8.35	
13	*Euphorbia hirta*	20	9000	6.32	

S. No.	Plant species	Frequency (%)	Density (ha^{-1})	IVI	H'
14	*Ageratum conyzoides*	30	24000	19.65	
15	*Eragrostis nardoides*	20	1000	10.47	
16	*Cyanotis axillaris*	10	2000	7.36	
	Total	**350**	**188000**		**2.16**
V3	**D/s of Upper Dam axis site (d/s of Tar pania or d/s V-notch on Turga Nala) 384m**				
1	*Coleus aromaticus*	20	8000	10.25	
2	*Corchorus aestuans*	10	6000	7.21	
3	*Indigofera tinctoria*	30	24000	35.21	
4	*Paspalum scrobiculatum*	20	6000	5.54	
5	*Achyranthes aspera*	20	16000	20.45	
6	*Ageratum conyzoides*	40	36000	29.24	
7	*Argemone mexicana*	10	4000	7.32	
8	*Chrysopogon aciculatus*	30	2000	16.14	
9	*Euphorbia hirta*	20	8000	4.98	
10	*Cynodon dactylon*	50	26000	18.45	
11	*Cyperus rotundus*	10	2000	9.47	
12	*Alternanthera sessilis*	50	48000	32.45	
13	*Bidens pilosa*	30	14000	19.47	
14	*Cassia tora*	20	3000	11.56	
15	*Impatiens balsamina*	10	2000	12.54	
16	*Oxalis corniculata*	30	12000	26.42	
17	*Phyllanthus urinaria*	20	1000	13.45	
18	*Carex cruciata*	30	6000	6.4	
19	*Cyperus niveus*	10	2000	13.45	
	Total	**460**	**226000**		**2.39**
V4	**Upper dam axis site (Tar pania, Darelehar-Baralahar : Submergence site) 410m**				
1	*Chrysopogon aciculatus*	40	30000	46.31	
2	*Cynodon dactylon*	20	280000	35.78	
3	*Ageratum conyzoides*	30	12000	14.57	
4	*Alternanthera sessilis*	30	20000	5.23	
5	*Barleria lupulina*	10	4000	16.54	
6	*Corchorus aestuans*	10	1800	25.24	
7	*Oldenlandia corymbosa*	20	3000	3.45	
8	*Cyperus rotundus*	10	8000	14.25	
9	*Bothriochloa pertusa*	30	32000	28.14	
10	*Cyrtococcum accrescens*	20	14000	13.16	
11	*Paspalum scrobiculatum*	30	9000	17.36	
12	*Andrographis paniculata*	20	10000	16.45	
13	*Coleus aromaticus*	10	2000	4.35	
14	*Euphorbia hirta*	20	10000	11.58	
15	*Indigofera tinctoria*	30	6000	19.34	
16	*Scoparia dulcis*	20	16000	21.71	
17	*Tylophora indica*	10	3000	6.54	
	Total	**360**	**460800**		**2.56**
V	**Catchment Area Turga (Near Ranga Basti-Buingera-Saildih-Bharipani villages)430m**				
1	*Achyranthes aspera*	30	11000	19.57	

S. No.	Plant species	Frequency (%)	Density (ha^{-1})	IVI	H’
2	*Ageratum conyzoides*	40	20000	36.47	
3	*Alternanthera sessilis*	30	15000	8.57	
4	*Argemone mexicana*	20	8000	17.36	
5	*Arthraxon hispidus*	40	24000	29.25	
6	*Barleria lupulina*	10	2000	3.54	
7	*Bidens pilosa*	20	10000	13.4	
8	*Cassia tora*	40	24000	8.35	
9	*Chrysopogon aciculatus*	30	42000	21.85	
10	*Corchorus aestuans*	10	12000	7.57	
11	*Cynodon dactylon*	40	36000	27.35	
12	*Eclipta prostrata*	20	1000	18.5	
13	*Impatiens balsamina*	10	2000	5.25	
14	*Leucas cephalotes*	10	4000	8.28	
15	*Sida cordata*	20	8000	13.41	
16	*Phyllanthus urinaria*	10	8000	4.25	
17	*Carex cruciata*	10	1500	10.36	
18	*Cyperus niveus*	10	6000	5.68	
19	*Cyperus rotundus*	20	20000	11.57	
20	*Oldenlandia corymbosa*	30	8000	8.32	
21	*Oxalis corniculata*	10	1000	2.85	
22	*Urena lobata*	20	1400	18.25	
	Total	**480**	**264900**		**2.31**

Table-7.6: Vegetational attributes of herbaceous vegetation in the study area (Monsoon)

Species		Frequency (%)	Density (ha^{-1})	IVI	H
V1	**Lower Dam (Proposed Saddle area towards right bank of Turga Nala) 250m**				
1	*Fimbristylis dichotoma*	10	4000	7.60	
2	*Brachiaria villosa*	20	14000	23.98	
3	*Kyllinga brevifolia*	20	8000	15.20	
4	*Digitaria ciliaris*	10	5000	8.79	
5	*Commelina bengalensis*	20	7000	15.14	
6	*Anisomeles indica*	10	2000	11.80	
7	*Urena lobata*	20	3000	16.56	
8	*Phyllanthus uraria*	10	2000	6.40	
9	*Oldenlandia corymbossa*	10	4000	7.60	
10	*Biophytum reinwardtii*	10	2000	5.53	
11	*Anotis wightiana*	10	2000	7.85	
12	*Paspalumpaspalodes*	20	4000	11.78	
13	*Nepeta ciliaris*	10	2000	7.85	
14	*Dioscorea bulbifera*	10	2000	5.89	
15	*Sida veronicifolia*	20	6000	13.97	
16	*Ageratum conyzoides*	10	14000	24.10	
17	*Cyperus cyperoides*	10	3000	7.11	
18	*Crotalaria cystisoides*	20	6000	15.75	
19	*Evolvus alsinoides*	10	4000	7.60	

Species		Frequency (%)	Density (ha^{-1})	IVI	H
20	*Saccharum munja*	30	18000	79.48	
	Total	**290**	**112000**		**2.73**
V2	**Downstream of Existing Lower dam (Turga nallah at Gosaidah / Patherdih 260m**				
1	*Capillipedium assimile*	10	2000	3.38	
2	*Evolvulus alsinoides*	40	23000	19.62	
3	*Hedyotis vestita*	10	6000	5.66	
4	*Mazus delavayi*	60	30000	28.21	
5	*Cyanotis vaga*	40	9000	14.28	
6	*Echinochloa colona*	10	4000	3.98	
7	*Phyllanthus urinaria*	20	6000	7.25	
8	*Uraria rufescens*	20	7000	11.33	
9	*Sida veronicifolia*	40	13000	21.56	
10	*Corchorus aestuans*	10	2000	4.87	
11	*Melilotus indica*	60	64000	50.32	
12	*Cynodon arcuatus*	40	20000	18.02	
13	*Cyperus niveus*	20	6000	6.89	
14	*Blepharis madraspatina*	20	7000	7.42	
15	*Zorina gibbosa*	10	4000	4.39	
16	*Anotis wightiana*	10	3000	3.69	
17	*Sacciloepis indica*	20	8000	7.95	
18	*Polycarpea prostratum*	20	6000	6.89	
19	*Abrus precatorius*	10	4000	7.88	
20	*Chrysopogon aciculatus*	10	38000	28.81	
21	*Chilanthus belangeri*	10	2000	3.38	
22	*Oplismenus compositus*	10	4000	3.98	
23	*Andrographis paniculata*	10	12000	11.01	
24	*Elephantopus scaber*	10	5000	11.95	
25	*Paspalum scrobiculatum*	10	4000	4.91	
26	*Oldenlandia corymbosa*	10	1000	2.38	
	Total	**540**	**290000**		**2.73**
V3	**D/s of Upper Dam axis site (d/s of Tar pania or d/s V-notch on Turga Nala) 384m**				
1	*Elephantopus scaber*	20	11000	20.98	
2	*Adiantum proliferum*	30	9000	13.95	
3	*Cyperus rotundus*	20	7000	11.95	
4	*Oplismenus compositus*	50	14000	21.99	
5	*Sacciolepis indica*	10	8000	13.07	
6	*Phyllanthus urinaria*	40	15000	20.10	
7	*Ageratum conyzoides*	10	4000	6.40	
8	*Cyrtococcum accrescens*	10	4000	5.91	
9	*Hedyotis corymbosa*	20	6000	8.91	
10	*Anisomeles indica*	10	1000	13.14	
11	*Oxalis corniculata*	20	7000	11.15	
12	*Persicaria barbata*	20	12000	15.52	
13	*Cyanotis vaga*	20	6000	9.50	
14	*Commelinas bengalensis*	10	3000	7.19	
15	*Desmodium triquetrum*	20	8000	15.06	

Species		Frequency (%)	Density (ha^{-1})	IVI	H
16	*Kyllinga brevifolia*	10	8000	7.77	
17	*Achyranthes aspera*	10	1000	10.87	
18	*Lygodium salicifolia*	10	4000	6.40	
19	*Colocasia esculenta*	10	4000	16.59	
20	*Dioscorea bulbifera*	10	2000	3.77	
21	*Carex cruciata*	10	1000	4.23	
22	*Biohytum reinwardtii*	10	2000	4.09	
23	*Chillanthes belangeri*	10	3000	5.73	
24	*Sida veronicifolia*	20	4000	8.51	
25	*Panicum repens*	10	2000	3.77	
26	*Galium affine*	10	1000	4.88	
27	*Oldenlandia corymbosa*	10	3000	28.55	
	Total	**440**	**150000**		**3.05**
V4	**Upper dam axis site (Tar pania, Darelehar-Baralahar: submergence site) 410m**				
1	*Adiantum proliferum*	10	10000	11.97	
2	*Oplismenus compositus*	10	4000	6.22	
3	*Melilotus indica*	30	16000	22.49	
4	*Elephantopus scaber*	10	1000	4.60	
5	*Biophytum reinwardtii*	30	9000	15.78	
6	*Cyrtococcum accrescens*	10	12000	14.95	
7	*Echinochloa colona*	10	3000	5.26	
8	*Mazus delavayi*	10	8000	10.05	
9	*Hedyotis corymbosa*	40	14000	30.28	
10	*Cyndon dactylon*	30	22000	28.25	
11	*Ageratum conyzoides*	30	13000	20.76	
12	*Phyllanthus virgatus*	10	4000	6.22	
13	*Sporobolus diander*	20	4000	8.60	
14	*Kyllinga brevifolia*	30	10000	16.73	
15	*Cyanotis vaga*	20	6000	11.04	
16	*Phyllanthus urinaria*	40	20000	32.39	
17	*Chrysopogon aciculatus*	10	2000	5.35	
18	*Cyperus cyperoides*	10	2000	5.61	
19	*Sacciolepis indica*	20	11000	15.31	
20	*Sida acuta*	10	4000	8.31	
21	*Dioscorea bulbifera*	10	2000	5.35	
22	*Desmodium reinifolium*	10	4000	8.31	
23	*Evolvulus alsinoides*	10	4000	6.22	
	Total	**420**	**185000**		**2.88**
V5	**Catchment Area Turga (Near Ranga Basti-Buingera-Saildih-Bharipani villages) 430m**				
1	*Adiantum proliferum*	30	22000	17.57	
2	*Athyrium attenuatum*	10	6000	10.49	
3	*Phyllanthus urinaria*	40	12000	14.95	
4	*Dioscorea bulbifera*	10	2000	3.92	
5	*Elephantopus scaber*	30	11000	15.33	
6	*Biophytum reinwardtii*	30	15000	14.22	
7	*Ageratum conyzoides*	40	15000	19.46	

Species		Frequency (%)	Density (ha^{-1})	IVI	H
8	*Digitaria ciliaris*	10	4000	4.23	
9	*Mazus delavayi*	30	10000	10.91	
10	*Galium affine*	20	10000	9.12	
11	*Melilotus indica*	30	26000	19.79	
12	*Oplismenus compositus*	20	18000	13.56	
13	*Carex cruciata*	10	2000	2.90	
14	*Andrographis paniculata*	10	2000	3.92	
15	*Kyllinga brevifolia*	30	8000	9.80	
16	*Hedyotis corymbosa*	30	14000	17.64	
17	*Brachiaria reptans*	20	8000	8.78	
18	*Chillanthus belangeri*	10	4000	4.01	
19	*Hemigraphis hirta*	20	10000	10.76	
20	*Sacciolepis indica*	10	2000	2.90	
21	*Cassia tora*	30	6000	30.74	
22	*Chrysopogon aciculatus*	40	28000	24.79	
23	*Persicaria capitata*	10	8000	13.39	
24	*Euphorbia hirta*	10	4000	4.15	
25	*Oldenlandia corymbosa*	10	8000	6.23	
26	*Evolvulus alsinoides*	10	3000	3.45	
27	*Bidens pilosa*	10	2000	3.05	
	Total	**560**	**260000**	**1.84**	**3.04**

7.5.3 Species diversity

The diversity index value (H) in the tree layer ranged from 0.883 at proposed Lower dam saddle site to 2.491 at submergence site. The species diversity for sapling and shrub strata ranged from 1.611 to 2.409 and 0.993 to 2.122, respectively (**Refer Table-7.3**). The occurrence of shrubs in large numbers at the downstream of upper dam site can be attributed to the anthropogenic disturbances. The value of species diversity (H) in the herbaceous layer ranged from 2.55 (upper dam axis site) to 2.902 (downstream of Lower dam site), respectively (Refer **Table-7.3**).

Herbaceous floral diversity ranged from 2.786 (Saddle Area of Lower existing Dam) to 2.883 (catchment area u/s of upper dam site), respectively during post monsoon season (Refer **Table-7.4)**. The value H was ranged from 2.11 (Saddle area of lower dam) to 2.56 (Upper dam site) during summer season (Refer **Table-7.5**). The value of species diversity (H) in the herbaceous layer ranged from 2.73 (Lower Dam site & Downstream of Lower Dam site) to 3.05 (Upper Dam axis site), respectively during monsoon season (Refer **Table-7.6**).

7.5.4 Lower plant diversity

Cryptogamic flora of Western undulating highland and plateau area is not very rich but shows the extension of Central and Peninsular Indian species to this bordering district of West Bengal. A list of some mosses, lichens and ferns recorded in the influence zone are:

Species	Family	Species	Family
Ferns /Pteridophytes		**Mosses /Bryophytes**	
Equisetum ramosissimum	Equisetaceae	*Fissidens crenulata*	Funariaceae
Selaginella chrysocaulos	Selaginellaceae	*Garckea flexuosa*	*Ditrichaceae*
S. ciliaris	Selaginellaceae	*Dicranum crispifolium*	Dicranaceae
Marsilea minuta	Marsileaceae	*Barbula gracilenta*	Pottiaceae
Lygodium salvifolium	Lygodiaceae	*Bryum plumosum*	*Bryaceae*
Adiantum lunulatum	Adiantaceae		
A. capillus-veneris	Adiantaceae	**Lichens**	
A. proliferum	Adiantaceae	Bulbothrix sp.	-
Pteris ludens	Pteridaceae	Heteroderma sp.	-
Cheilanthus belangeri	Sinopteridaceae	Cladonia sp.	-
Athyrium falcatum	Athyraceae	Usnea sp.	-
Mosses /Bryophytes		**Liverworts**	
Funaria hygrometrica	Funariaceae	Riccia frostii	Ricciaceae

* *Mudgal & Hajra (1997); Ghosh & Ghosh (2004); Dandotiya et al (2011)*

7.5.5 Endemic Species

With such a wide area and distinct biogeographic regions, West Bengal bound to have many endemic taxa. Chatterjee (1940) has discussed some new or endemic plant taxa from different districts of West Bengal such as *Cadenthera ulginosa* var. *birbhumensis, Cuscuta sharmanum, Hydrocotyle himalaica, Hypericum assamacum* and *Dalbergia duarensis*. Besides these newly described endemic species, some endemic species viz., *Acer osmastonii, Begonia rubella, Calamus inermis, Cymbidium eburnum,* etc. are described from the extreme Northern boundary of West Bengal. Since entire Purulia district and Midnapur districts constitute the western undulating uplands and plateau, there is no possibility that these plants may occur in the project area.

7.5.6 Threatened flora

The project area is largely a degraded ecosystem due to high human pressure, large scale lopping and removal of fodder and timber species for preparation of agricultural fields, grazing, construction of road, etc. As per Red Data Book of India, no rare and endangered species are reported from the project area. However, Nayar and Sastry (1987-1990) have discussed some rare and endangered plant species viz., *Acer osmastonii, Begonia rubella, B. satrapsis, Calamus inermis, Codonopsis affinis, Cymbidium eburnum, Phoenix rupicola*, etc. from northern part of West Bengal includes Darjeeling, Kurseong, Sewak and Jalpaiguri area.

Since these species are distributed above 600 m elevation in northern and southern wet part of West Bengal, hence these species are not observed in the proposed project.

7.5.7 Parasitic flora

A long twining parasitic plant *(Cuscuta reflexa)* was found growing on bushes of *Zizyphus mauritiana*, whereas *Loranthus longiflorus* on trunks of some large tree species like *Buchnania latifolia*, *Schleichera oleosa,* etc.

7.5.8 Epiphytes

Epiphytes often grow attached to the trunks and branches of forest trees. The seedlings of *Ficus bengalensis* and *F. religiosa* are often seen growing on trunk of some talltree species in the area.A few orchids belonging to the genera *Bulbophyllum triste, Dendrobium moschatum,Vanda roxburghii*, etc.were also observed growing on thick kusum tree (*Schleichera trijuga*). In addition to these, some non-vascular epiphytes such as lichens and mosses also occur on bark of some tree species.

7.5.9 Economically important plants

Since time immemorial the local people have been using large number of wild plant resources as medicinal value, edible plants, fodder, timber, etc. Comprehensive account of these plant resources is given in following paragraphs.

i) Medicinal Plants

The hills rising above Baghmundi and adjoining area in Purulia district are rich in diversity of medicinal plants. Many tribal population or local people inhabited in the various pockets of the forest areas, use these plants for curing their diseases. However, a literature survey reveales that the existing information is insufficiently documented with regard to their floral wealth used in curring diseases (Chakraverty *et al.* (1999); Mudgal & Hajra (1999). Different parts of medicinal plant species were used by local tribe as medicine. Some of the important medicinal and aromatic plants of the project area are given in **Table-7.7** and images are shown in **Plates-7.6 to 7.8**.

Table-7.7: Some of the medicinal plants in the Turga pumped Storage Project area

Species	Local name	Family	Uses
Abelmoschus moschatus	Mushkdana	Malvaceae	Tonic
Abroma angusta	Ulat kambal	Sterculiaceae	Abortifacient
Achyranthes aspera	Bankhat	Amaranthaceae	Skin disease
Andrographis paniculata	Kalmegh	Acanthaceae	Tonic
Artemisia nilagirica	Teetapati	Asteraceae	Asthama
Azadirachta indica	Neem	Meliaceae	Skin disease
Bauhinia purpurea	Rakta Kanchan	Caesalpiniaceae	Carminative

Species	Local name	Family	Uses
Butea monosperma	Palash	Papilionaceae	Astringent
Cissampelos pareira	Aknadi	Menispermaceae	Antiperiodic
Clerodendrum viscosum	Ghato	Vebenaceae	Vermifuge
Cuscuta reflexa	Sarnalata	Cuscutaceae	Jaundice
Evolvulus alsinoides	Sankhpuspi	Convolvulaceae	Tonic
Helicteres isora	Marodphali	Sterculiaceae	Tonic
Holarrhena pubescens	Kuruchi	Apocynaceae	Antidysentric
Mintha arvensis	Carminative	Lamiaceae	Carminative
Phyllanthus emblica	Amloki	Euphorbiaceae	Astringent
Rubia cordifolia	Manjistha	Rubiaceae	Antiseptic
Semicarpus anacardium	Bhela	Anacardiaceae	Vermifuge
Terminalia bellirica	Bahera	Combretaceae	Purgative
T. chebula	Haritaki	Combretaceae	Laxative
Vitex negundo	Nishindha	Verbenaceae	Vermifuge
Woodfordia fruticosa	Dhai	Lythraceae	Seminal weakness

Plate-7.6: Medicinal plant species (*Achyranthes aspera* withother associates)

Plate-7.7:Medicinal plant species (*Holarrhena pubescens* withother associates)

Plate-7.8: Medicinal plant species (*Helicteres isora*)

ii) Food Plants

A variety of wild edible plants occurs in the project and influence area. The cultivation of such plants is not practiced by local peple in the area and they rely on the forest around them for their supply. Some of the food plants occurring in and around the project area are given in **Table-7.8**.

Table-7.8: Some of the food plants observed in Turga Pumed Storage Project area

Species	Local Name	Family	Part used
Bauhinia purpurea	Rakto Chandan	Caesalpiniaceae	Flower buds
Bombax ceiba	Simul	Bombacaceae	Fruits
Boswellia serrata	Shalga	Burseraceae	Fruits
Carissa spinarum	Huka	Apocynaceae	Fruits
Chenopodium album	Bhetu	Chenopodiaceae	Leaves
Colocasia esculenta	Kachu	Araceae	Tubers
Dioscorea bulbifera	Chuprialu	Dioscoreaceae	Fruits

Species	Local Name	Family	Part used
Ficus auriculata	Dumur	Moraceae	Figs
Madhuca indica	Mohua	Sapotaceae	Seeds
Nymphaea nouchali	Shapla	Nymphaeaceae	Stem
Phyllanthus emblica	Amloki	Euphorbiaceae	Fruits
Randia dumatorum	Madan	Rubiaceae	Fruits
Schleichera trijuga	Kusum	Sapindaceae	Fruits
Spondias pinnata	Amra	Anacardiaceae	Fruits
Zizyphus mauritiana	Ber	Rhamnaceae	Fruits

iii) Oil Yielding Plants

The project area as well surrounding influence area exhibits good diversity of oil yielding plants. Some of such plants are *Brassica campestris* (Shoshey), *Linum usitatissimum* (Teeshi), *Sesamum indicum* (Til), *Madhuca indica* (Mohua), *Schleichera trijuga* (Kusum), etc.

iv) Fodder Plants

Important and preferable fodder yielding plants of the area are *Bauhinia variegata, Desmodium gangeticum, Echinochloa colona, Ficus auriculata, F. racemosa, Oryza sativa*, etc.(**Plates-7.9-7.19).**

v) Timber Trees and Fuel-wood

The most important and durable timber yielding species of the area are *Shorea robusta* (Sal), *Terminalia myriocarpa* (Asin), *Schleichera trijuga* (Kusum), *Mangifera indica* (Aam) and *Tectona grandis* (Teak). For fire-wood, villagers usually trek long distances for their domestic needs. The commonly used wood for Fuel-wood are *Butea monosperma, Holarrhena pubescens, Diospyros melanoxylon, Lagerstroemia parviflora, Mallotus philippinensis, Terminalia bellerica,* etc.

Plate-7.9:*Tridax procumbens* - Lower dam site along Turga nalla

Plate-7.10:Ipomea sp- Lower dam site along Turga nalla-Macrophytes

Plate-7.11: *Polygonum barbetum* -grass

Plate-7.12:*Fimbristylis dichotoma* - grass

Plate-7.13:Butea monosperma – Plass

Plate-7.14:Phoenix sp

Plate-7.15:Ficus sp

Plate-7.16:*Caesalpinia sp (C.sappan)*

Plate-7.17:Delbergia sishoo & Red Ants nests

Plate-7.18:Sizygium communis- jamun

Plate-7.19:Cassia siamia

CHAPTER-8

FAUNAL ASPECTS

8.1 INTRODUCTION

The surrounding areas of the proposed project harbours relatively good forest cover, known as Ajyodhya hills attaining a maximum elevation of about 665 m. Ajyodhya hills are extension of Dalma hill range of Jharkhand. The area is considerably affected by monsoonal rains and defines the flora and fauna of that area. The immediate surroundings of the proposed project are characterized by low land, sparse open forests and agricultural land. The fauna of the study area consists mostly of species with zoo-geographic affinities of palaearctic, Indo-Malayan and indigenous variably. Though major part of Gangetic and Subernrekha basin is influenced of agricultural practices and settlements and know to harbour relatively low biodiversity. However, many isolated hills with good forest cover are prominent in the region of Chhotanagapur plateau, which is inhabited by a good number of faunal elements.

The information of important animal group such as Insects (butterflies), reptiles, birds, rodents and mammals were collected by trekking project influenced area, and in the project sites along the river. However, to gain an insight in the existing fauna, the survey was conducted in the study area.

8.2 METHODOLOGY

The study was carried out in post monsoon, summer and monsoon seasons (2013-14) in the selected study sites with respect to project appurtenance and project influenced area as described in **Table-8.1**. The sampling location map is enclosed as Figure-8.1.

Table-8.1: Description of Study Sites for terrestrial ecology (Floral and Faunal accounts) w.r.t. Project Appurtenances

Sampling site	Location	Description
A. Area between Bagmundi and Existing Lower dam site (Gosaidh)		
Site I:	Proposed Saddle area towards right bank of Turga Nala	Bagmundi site with Agriculture land followed by vegetation of Pattardih Forest i.e. u/s west site
Site II:	Turga Nallah at Gosaidih/Pathardih, Downstream of Existing Lower dam Site	Lower dam axis site, gosaidih has mixed dense vegetation, Forest block Pattardih – Bhagmundi.
B. Area beyond Gosaidh and up to Upper dam site (Tar pania)		
Site III:	Dam axis site-near V Notch Turga Nalla & d/s area of Tar pania	Sal foreset dominant in mixed jungle vegetation following palaash plantation on hill slopes of both of the banks of Turga nalla.
C. Area between Upper dam (Tar pania), Bara Lahar& Ranga Basti-Submergence zone		

Sampling site	Location	Description
Site IV:	Upper dam axis site -Tar pania: Darelehar / Baralahar submergence site	Sal foreset dominant in mixed jungle vegetation on hill slopes of both of banks of Turga nalla
D. Area beyond RangaBasti up to SaildihBasti - Catchment Area		
Site V:	Ranga or Tanrpaniya Village (RB hill aspect of TurgaNala)	U/s uppar dam in NE direction, Ranga basti to Buingera -23.23567° N, 86.08434° E, El-1902.54 ft. In Buingera area, patchy vegetation, pasture land, rocky terrain, palaash forest: Open scrubs
	Saildih /Bharipani village (LB hill aspect of TurgaNala	U/s upper dam in NW direction-Kurapahari area: Kurapahari : 23.23980°N, 86.04562°E, El- 1729.97 ft –Sal forest &Saildih--23.23359°N, 86.05773°E, El- 1622.36 ft

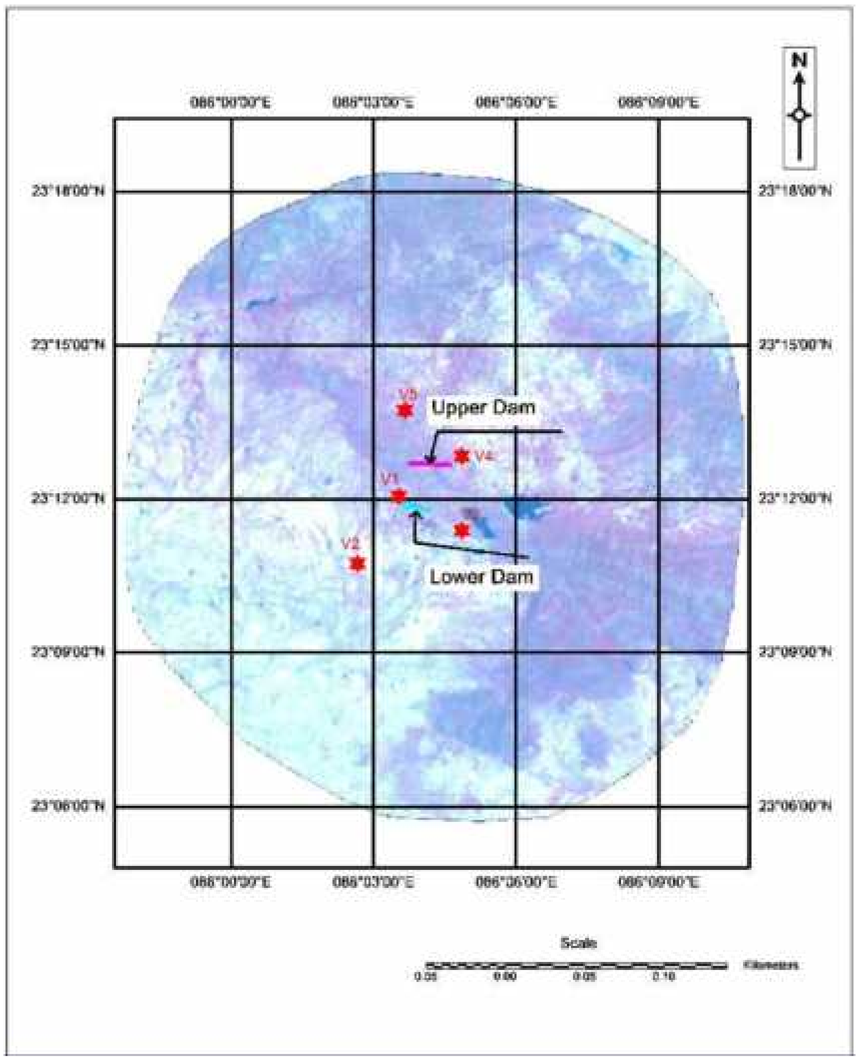


Figure-8.1: Sampling location map for terrestrial fauna

The baseline information on the faunal elements was collected through primary surveys and review of available literature. Primary surveys included direct evidences and indirect evidences. This was done by trekking the project vicinity area inhabiting faunal species i.e. along the riverbanks, adjoining forest on the slopes, nallahs, hill top and agricultural fields etc. During primary surveys, species belonging to mammals, birds, reptiles, amphibians, butterflies and insects were spotted at the various sites. In addition, presence of species was confirmed indirectly with the help of calls, presence of trophies, pellets and hides and by interviewing locals.

The information through secondary sources from the adjoining and surrounding areas were also used to prepare the faunal inventory. The information especially for the catchment area was collected by with help of secondary sources e.g. CAMP (2002), Chanda and Mukherjee (2012), Dey et al. (2013), Verma (2011). The papers of Ali & Ripley (1983) and Grewal et al. (2002) were consulted to identify and confirm the presence of avi-faunal species. The criteria of IUCN (2014) and Indian Wildlife (Protection) Act (1970) were followed to assess the conservation status of species. The possible accounts of sighting of wild animals and other faunal groups in the study area are taxed in this section.

8.3 BIO-GEOGRAPHIC ZONES

There are innumerable peaks and waterfalls in Ayodhya hills plateau, which support different forms of life varied from animals to plants species. There is good number of wild animals found in the forests like elephant, deer, wild hog, wolves, rabbit, wolf, wild pig, peacock, bear, deer, porcupine etc., found in the forest as per the secondary information available. The fauna observed during field study and also reported from the secondary data of forest working plan for mammals, herpetofauna- reptiles and amphibians, and avifauna in the study area is given in**Tables-8.2 to 8.6**respectively.

8.3.1 Mammals

The project influenced area and submergence zone consists of Reserve Forests, Protected Forests and Revenue Forests. However, notified eco-sensitive area such as national park, wildlife sanctuary, Bird Sanctuary, wetland, wildlife corridor etc. arenot reported in the study area. Therefore, wildlife observed in the study area is based on direct sighting and secondary data from the District Forest Office working plan and published literature. The list of mammals sighted in the study area is given in **Tables-8.2 and 8.3**.

Mammalian fauna of the surrounding areas of Turga Pumped Storage project comprises of more than 25 species that come from 16 families. Rhesus Macaque and Common Langur inhabit forested as well as settlement areas and are common in their presence. All the members of cat family mentioned below prefer to inhabit the lower and open areas in the region. Jungle Cat is sighted frequently by villagers near settlement area at day time. Jackal covers a wide range of habitat and spotted by villagers frequently in and around the settlement. Wild Boar is a nocturnal animal and raids agricultural fields at night. It is found in inner and open forest areas. Grey Mongoose, Brush-tailed Porcupine, Indian Hare prefer to inhabit scrub forests while Pangolin is predominant in the Sal and mixed forest to meet its food requirement, feeds on ants. Tree Shrew is widely distributed in the area, found in forest as well as settlement areas.

Squirrels (Sciuridae) comprises of 2 species which are widely distributed and spotted frequently. Muridae is represented by 4 species, which are generally common in distribution. Chiroptera (Bats) comprises of 4 species of 3 families. The species like Yellow House Bat (*Scotophiluskuhlii*), and Short-nosed Fruit Bat (*Cynopterus sphinx sphinx*) inhabit settlement areas while remaining species restricted to forested areas especially in Ayodhya hills.

Asian Elephant is found in lower reaches and is not reported from the project or its surrounding area.

Table-8.2: List of Mammal species reported in the Study Area

Common name	**Family**	**Scientific name**	**Conservation Status**	
			IUCN	**IWPA**
Rhesus macaque	Cercopithecidae	Macacamulatta	LC	II
Common Langur	Colobidae	*Presbytia entellus*	LC	II
Jungle Cat	Felidae	Felischaus	LC	II
Golden Jackal	Canidae	Canisaureus	LC	II
Indian Fox	Canidae	Vulpesbengalensis	LC	III
Common Mongoose	Herpestidae	Herpestesedwardsii	LC	IV
Wild Boar	Suidae	Susscrofa	LC	III
Indian Hare	Leporidae	Lepusnigricollis	LC	IV
Sahi- Porcupine	Hystricidae	Atherurusmacrourus	LC	IV
Indian Palm Squirrel	Sciuridae	Funambuluspalmarum	LC	IV
Five Stripped Squirrel	Sciuridae	*Funambuluspennantii*	LC	II
Bandicoot Rat	Muridae	Bandicotabengalensis	LC	V
Indian house rat	Muridae	*Rattusrattus-refescena*	LC	V
Indian Field Rat	Muridae	*Musbooduga*	LC	V
Long-tailed Tree Mouse	Muridae	Vandeleuriaoleracea	LC	
Indian Bush Rat	Tupaiidae	*Golundaellioti*	LC	V
House Shrew	Tupaiidae	Suncusmurinus	LC	-
Indian Flying Fox	Pteropodidae	Pteropusgiganteus	LC	V
Short-nosed Fruit Bat	Pteropodidae	Cynopterus sphinx sphinx	LC	IV
Bearded Sheath Tailed Bat	Emballonuridae	*Taphozousmelanopogon*	LC	V
Indian Pygmy Bat	Vespertilionidae	*Pipistrellustenuis*	LC	V
Yellow House Bat	Vespertilionidae	*Scotophiluskuhlii*	LC	V

*Note: –Recorded only from Forest Working Plan, however, not direct cited, LC – Least Concern, NT- Near Threatened, VU- Vulnerable

Livestock in Ayodhya hills &Bhagmundi Area

Livestock is an important component of an agro ecosystem. For instance, livestock provide the critical energy input to the croplands required for ploughing, threshing and other farm operations. Animal dung provides essential nutrients required for soil fertility and crop yields in the form of organic manure. Most of the faunal species among mammals are general in nature and domesticated. Among domestic animals like bulls, cows, buffaloes, horses, sheep and goats are found among domesticated mammals. These cattle besides being a source of milk supply are used as draught animal for the plough or the cart and transportation.

Table-8.3: List of domesticated mammalian Fauna found in the Study Area

Local Name	Zoological Name	Family
Cow	Bosindicus	Bovidae
Buffalo	Bubalusindicus	Bovidae
Dog	Cainsfamilieris	Canidae
Goat	Capra hircus	Bovidae
Horse	Equuscabilus	Equidae
Ass	Equushermionus	Equidae
Cat	Felisdomesticus	Canidae
Sheep	Oviuspolic	Bovidae

8.3.2 Avi-fauna

For enumeration of avifauna, the survey was conducted in surrounding area during the study period. Interviews and group discussions with villagers and local residents was used as a main source of information.

A total number of 66 species of birds were encountered during the present survey. The species belonging to families Anatidae, Ardeidae, Charadridae, Rallidae, Phalacrocoracidaeetc are common in lower region in open places and wetland while members of Picidae, Megailaimidae, Strigidae, etc are inhabitants of woody forests in the catchment. Dominant bird species observed during the survey are Blue jay, dove, myna, house crow, house sparrow, lapwing, little egret and grey wagtail etc. The list of bird species found in study area is given in **Table-8.4**and **Plates-8.1 to 8.4**.

About 66% of the total species found in the study area of proposed project were widespread residents while sparse residents were represented by 3.5%. Widespread resident birds were followed by widespread winter visitor, represented by 17.4% of the total species. Among Summer visitor species like Common Sandpiper (*Actitishypoleucos*), Green Sandpiper (*Tringaochropus*), Little Cormorant (*Phalacrocoraxniger*), Indian Golden Oriole

(*Orioluskundoo*), Red-breasted Flycatcher (*Ficedulaparva*) and Grey-backed Shrike (*Laniustephronotus*). Most common species recorded from the different sites of study area were *Francolinuspondicerianus*, *Megalaimahaemacephala*, *Psittacula eupatria*, *Centropus sinensis*, *Dicrurus macrocercus*, *Dendrocittavagabunda*, *Chloropsiscochinchinensis*, *Sturnuspagodarum*, *Phylloscopusfuliginventer* and *Turdoidesstriatus* (**Plates-8.1 to 8.4**).

Table-8.3: List of Avi-Fauna reported in the Study Area

Family/Scientific Name	Common Name	Residential Status	Threat Status
Accipitridae			
Accipiter badius(Gmelin)	Shikra	R	LC
Gyps bengalensis	Bengal Vulture	R	LC
Aquila refax	Towny Eagle- Oukab	R	LC
Anatidae			
Sarkidiornismelanotos	Comb Duck	R	LC
Ardeidae			
Egrettagarzetta(Linnaeus)	Little Egrets	*R*	LC
Egrettaintermedia	Intermediate Egret	R	LC
*Bubulcus*coromandus(Linnaeus)	Cattle Egret	*R*	LC
*Ardeolagrayii*Linnaeus	Indian Pond Heron	R	LC
Burhinidae			
Burhinusoedicnemus	Indian Stone-curlew	R	LC
Capitonidae			
Megalaimahaemacephala	Coppersmith Barbet	R	LC
Cisticolidae			
Priniasocialis	Ashy Prinia	R	LC
Ciconiidae			
Mycterialeucocephala	Painted Stork	LM	LC
Anastomusoscitans	Asian Openbill	LM	LC
Phalacrocoracidae			
Phalacrocoraxniger(Vieillot)	Little Cormorant	R	LC
*Phalacrocoraxfuscicollis*Stephens	Indian Shag /Cormorant	R	LC
Columbidae			
*Columba livia*Gmelin	Blue Rock Pigeon	R	LC
Treronphoenicoptera	Harial -green pigeon		
Streptopeliasenegalensis(Linnaeus)	Little Brown Dove	*R*	LC
Streptopeliadecaocto	EuraisionCollor dove	R	LC
Streptopeliachinensis	Spotted Dove	R	LC
Corvidae			
*Corvusmacrorhynchos*Wagler	Jungle Crow	*R*	LC
*Corvussplendens*Vieillot	House Crow	*R*	LC
Dendrocittavagabunda(Latham)	Indian Treepie	*R*	LC
Cuculidae			
Eudynamysscolopacea(Linnaeus)	Asian Koel	*R*	LC
Centropussinensis(Stephens)	Greater Coucal	*R*	LC
Hierococcyxvarius(Vahl)	Brainfever Bird	*R*	LC
Strigidae			

Family/Scientific Name	**Common Name**	**Residential Status**	**Threat Status**
Athenebrama(Temminck)	Spotted Owlet	*R*	LC
Bubo benghalensis(Linnaeus)	Indian Eagle-Owl	*R*	LC
Alcedinidae			
Alcedoatthis(Linnaeus)	Small Blue Kingfisher	*R-S*	*LC*
Halcyon smyrnensis(Linnaeus)	White breasted Kingfisher	*R-S*	*LC*
Daniidae			
Laniuscristatus	Brown Shrike	*R*	*LC*
Muscicapidae			
Copsychussaularis	Oriental magpie-robin	*R*	*LC*
Meropidae			
*Meropsorientalis*Latham	Small green Bee-eater	*R*	*LC*
Family : Coraciidae			
Coraciasbenghalensis(Linnaeus)	Indian Roller-Blue jay	*R*	*LC*
Family : Upupidae			
*Upupaepops*Linnaeus	Common Hoopoe	*R*	*LC*
Family : Picidae	Woodpecker		
Dendrocoposnanus(Vigors)	Brown-capped Pygmy	R	LC
Dendrocoposmahrattensis(Latham)	Yellow-fronted Pied	R	LC
Dinopiumbenghalense(Linnaeus)	Lesser Golden-backed	R	LC
Family: Passeridae			
Subfamily : Passerinae			
Passer domesticus(Linnaeus)	House Sparrow	*R*	*LC*
Subfamily : Ploceinae			
PloceusPhilippinus(Linnaeus)	Baya Weaver	*R*	*LC*
Family : Motacillidae			
*Anthusrufulus*Vieillot	Paddyfield Pipit	R	LC
Family : Pycnonotidae			
Pycnonotuscafer(Linnaeus)	Red-vented Bulbul	R	LC
Family : Laniidae			
Turdoidescaudatus(Dumont)	Common Babbler	R	LC
Turdoidesstriatus(Dumont)	Jungle Babbler	R	LC
Orthotomussutorius(Pennant)	Common Tailorbird	R	LC
Phylloscopusfuligiventer	Smoky Warbler	R	LC
Family : Nectariniidae			
Nectariniaasiatica(Latham)	Purple Sunbird	R	LC
Family:Phasianidae			
Francolinuspondicerianus(Gmelin)	Grey Francolin-Teeter	*R*	*LC*
*Pavocristatus*Linnaeus	Marrah Peacock	*R*	*LC*
Family : Charadriidae			
Vanellusindicus(Boddaert)	Red-wattled Lapwing	*R*	*LC*
Metopidiusindicus	Bronjed winged jacana		
Psittaculidae			
Psittaculakrameri(Scopoli)	Rose-ringed Parakeet	R	LC
Sturnidae			
Acridotheresfuscus(Wagler)	Jungle Myna	*R*	*LC*

Family/Scientific Name	Common Name	Residential Status	Threat Status
Acridotherestristis(Linnaeus)	Common Myna	*R*	LC
Sturnus contra Linnaeus	Asian Pied Starling	*R*	LC
Sturnuspagodarum(Gmelin)	Brahminy Starling	*R*	LC
Gracupica contra(Linnaeus)	Pied Myna	*R*	LC
Family : Dicruridae			
*Dicrurusmacrocercus*Vieillot	Black Drongo	*R*	LC
Dicruruscaerulescens(Linnaeus)	White-bellied Drongo	*R*	LC
Dicrurusleucophaeus	Ashy drongo	*R*	LC
Family : Oriolidae			
Oriolusoriolus(Linnaeus)	Eurasian Golden Oriole	*R*	LC
Orioluskundoo	Indian Golden Oriole	*M*	LC
Estrildidae			
Lonchuramalabarica	Indian Silverbil	*R*	LC
Irenidae			
Chloropsis cochinchinensis	Blue-winged Leaf Bird	*R*	LC
Megalaimidae			
Megalaimahaemacephala	Coppersmith Barbet	*R*	LC

Abbrs. Residential status: R- Resident; LM-Local Migrant; Status Abbrs.: LC- Least Concern, NR Not Rare, NT-not threatened.

8.3.3 Reptiles and Amphibians

The presence of a total of 18 species of Herpetofauna grouped under 10 families could be confirmed in the surrounding areas of proposed project from different sources including direct sightings and by interviewing local people. The present study area falls under the tropical limits and stands for the warm temperature for most of the months. The climatic condition seems highly conducive for herpetofaunal diversity. However, the area is considerably unexplored and very limited information is available on the herpetofaua. Out of 20, three species *Duttaphrynusmelanostictus*, *Laloulapulchera* and Rana /*Hoplobatrachustigerinus* belong to Amphibia, one species of pond turtle from Geomydidae family and remaining comes from Reptiles (**Table-8.5**).

The agriculture fields in the study area provides ideal habitat for many snakes and reptiles. Reptiles such as cobra, and python were found occasionally in the dense vegetation areas as narrated by local people. Monitor Lizard was observed along the roadside during the survey. Out of Seven species of reptiles recorded, three species of lizard i.e *Hemidactylis*sp (House lizard) and *Calotes*sp (Garden lizard) are common in occurrence. Majority of the species are categorized as ‘Least Concerned’ as per IUCN criterion. Cobra is protected under schedule II of Indian Wildlife Protection Act (1972). None of the reptile species is present in the IUCN Red List of threatened animals (2014).


Francolinuspondicerianus


Chloropsiscochinchinensis


Psittacula eupatria


Centropus sinensis


Dicrurus macrocercus


Phylloscopusfuligiventer

Plate-8.1: Common bird species recorded in the vicinity of proposed project


Green Bee Eater


Little Green Bee-eater


Purple Sunbird


Bramhy Starling


Red-vented Bulbul


Coppersmith Barbet-

Plate-8.2 : Common bird species recorded in the vicinity of proposed project

Indian Robin

Eurasian Golden Oriole

Common Myna

Dendrocittavagabunda

PiiedMyna

Plate-8.3: Common bird species recorded in the vicinity of proposed project

White Breast Kingfisher

Indian Golden Oriole

Intermediate Egrets

Asian Openbill-Anastomusoscitans

Vanellusindicus(Boddaert)

Red napped Ibis / Black Ibis

Plate-8.4: Common bird species recorded in the vicinity of proposed project

Table-8.5: List of Reptiles & Amphibians reported in the study area

Scientific Name	**Common Name**	**Family**	**Status WPA/IUCN**
Hemidactylisbrooki	House Gecko	Gekkonidae	-
Gekko gecko	lizard	Gekkonidae	
Eublepharishardwickii	Hill lizard	Gekkonidae	- / LC
Calotesversicolor	Kakru Garden	Agamidae	-
Psammophilusblanfordanus	Rock Agama	Agamidae	IV/ LC
Varanusbengalensis	Moniter Lizard	Varanidae	II /LC
Mabuyacarinata	Common skink	Scincidae	- / LC
Ptyasmucosus	Rat Snake Dhamna	Colubridae	IV /LC
*Najanaja**	Indian /Ayang Cobra	Elapidae	II / LC
*Viperarusseli**	Viper	Elapidae	IV/ LC
*Xenochrophispiscator**	Common Water Snake	Colubridae	IV/ LC
Amphiesmastolata	Buff-striped keelback	Colubridae	IV -
Lycodonjara	Twin-spotted Wolf Snake	Colubridae	IV / LC
Bungarusfasciatus	Sakhamuti- Banded krait	Elapidae	IV/LC
Bufomelanostictus	Common indian toad	Bufonidae	LC/ IV
Bufoviridis	Common toad	Bufonidae	LC/ IV
Ranaspp	Common Frog	Ranidae	LC/ IV
Laloulapulchera	Banded Tree Frog	Microphylidae	LC/ IV

*Secondary data based; LC = least concerned, NT = near threatened, VU = vulnerable

***Calotesversicolor*(Reptilia)**

8.3.4 Insects-Butterflies

Insects are the most numerous, and dominant life forms on the earth. Among insects butterflies are considered as environment indicator which plays important role in pollination. The butterflies sighted in the area are shown in **Table-8.6 and Plates-8.5 and 8.6**. The species listed in **Table-8.6** were observed during the primary survey during post-monsoon, summer and monsoon seasons. The insect fauna listed consists of mostly 'common' and generalist species as none of them is threatened globally as per the IUCN Red list 2014. A total of 51 species from 6 families could be located from study area of proposed project, of which 32 species were observed in post-monsoon season, 24 species during summers and 38 species in monsoon season, respectively. A total of 18 species like Common Rose

(*Pachlioptaaristolochiae*), Common Mormon (*Papiliopolytes*), Common Grass Yellow (*Euremahecabe*), Small Grass Yellow (*Euremabrigitta*), Dark Cerulean (*Jamidesbochus*), Common Cerulean (*Jamidesceleno*), Glassy Tiger (*Paranticaaglea*), Common Crow (*Euploea core*), Blue admiral (*Nymphaliscanace*), etcwere common in nature. Common Mormon (*Papiliopolytes*), Elbowed Pierrot (*Caletaelnanoliteia*), Common Cerulean (*Jamidesceleno*), Common Grass Yellow (*Euremahecabe*), Small Grass Yellow (*Euremabrigitta*), Himalayan Fivering (*Ypthima sacra*) and Common Sailer (*Neptishylas*) were most common and abundant species.

Table-8.6: Butterfly species spotted in the area

Common Name*	Scientific Name	Family	Occurrrence		
			PM	S	M
Common Indian Crow	*Euploea core core(Cramer)*	Danaidae	+	+	+
Indian Palm Bob	*Suastusgremius*	Hesperidae	-	-	+
Grass Demon	*Udaspesfolus*	Hesperidae	-	-	+
Plum Judy	*Abisaraecherius*	Lycaenidae	-	-	+
Large Oak Blue	*Arhopalaamantes*	Lycaenidae	-	-	+
Elbowed Pierrot	*Caletaelnanoliteia*	Lycaenidae	+	-	-
Forget-me-not	*Catochrysopsstrabo*	Lycaenidae	-	-	+
Dark Cerulean	*Jamidesbochus*	Lycaenidae	+	-	+
Common Cerulean	*Jamidesceleno*	Lycaenidae	+	-	+
Yamfly	*Loxuraatymnus*	Lycaenidae	-	-	+
Common Acacia Blue	*Surendraquercetorum*	Lycaenidae	-	-	+
Assam Pierrot	*Tarucusvenosus*	Lycaenidae	+	-	-
Tawny Coster	*Acraeaviolae (Fabricius)*	Nymphalidae	-	+	+
Colour Sergeant	*Athymanefte*	Nymphalidae	-	+	+
Common Sergeant	*Athymaperius (Linnaeus)*	Nymphalidae	-	+	+
Leopard Lacewing	*Cethosiacyane*	Nymphalidae	-	-	+
Common / Plain Tiger	*Danauschrysippus (Linn.)*	Nymphalidae	-	+	+
Striped Tiger	*Danausgenutia (Cramer)*	Nymphalidae	-	+	+
Gaudy Baro	*Euthalialubentina*	Nymphalidae	-	-	+
Great Eggfly	*Hypolimnasbolina (Linn.)*	Nymphalidae	+	+	-
DanaidEggfly	*Hypolimnasmissipus(Linn.)*	Nymphalidae	+	+	-
Peacock pansy	*Junonia almanac (Linnaeus)*	Nymphalidae	+	+	+
Blue Pansy	*Junoniaorithya (Linn.)*	Nymphalidae	+	+	+
Bright-eye Bushbrown	*Mycalesis patina*	Nymphalidae	+	-	-
Common Bushbrown	*Mycalesisperseus*	Nymphalidae	+	-	+
Glassy Tiger	*Paranticaaglea*	Nymphalidae	+	-	+
Common Leopard	*Phalantaphalantha(Drury)*	Nymphalidae	+	+	-
Common Baronet	*Euthalianais(Baronet)*	Nymphalidae	+	+	+
Grey Count	*Tanaecialepidea*	Nymphalidae	-	-	+
Common Fourring	*Ypthimahubneri*	Nymphalidae	+	+	+
Himalayan Fivering	*Ypthimasakra*	Nymphalidae	-	+	+
Common Mime	*Chilasaclytia*	Papilionidae	+	-	+
Glassy Bluebottle	*Graphiumcloanthus*	Papilionidae	+	+	-

Common Name*	Scientific Name	Family	Occurrrence		
			PM	S	M
Common Jay	*Graphiumdoson (C.&R. Felder)*	Papilionidae	+	+	+
Common Sailer	*Neptishylas*	Papilionidae	+	+	+
Common Rose	*Pachlioptaaristolochiae*	Papilionidae	+	-	+
The Blue Mormon	*Papiliopolymnestor*	Papilionidae	+	+	-
Common Mormon	*Papiliopolytes*	Papilionidae	+	+	+
Great Zebra	*Pathysaxenoclesphrontis -*	Papilionidae	-	-	
Yellow Helen	*Pricepsnepheluschoan*	Papilionidae	+	-	+
Orange Albatross	*Appiasnero*	Pieridae	+	-	-
Pioneer	*Belenoisaurota*	Pieridae	+	-	-
Common Emigrant	*Catopsilia Pomona (Fabricius)*	Pieridae	-	+	+
Mottled Emigrant	*Catopsiliapyranthe (Linnaeus)*	Pieridae	-	+	+
The Common Gull	*Ceporanerissaphryne (Fabricius)*	Pieridae	-	+	+
Red Spot Jezebel	*Deliasdescombesi*	Pieridae	+	+	-
Common Jezebel	*Delias eucharis*	Pieridae	+	+	+
Small Grass Yellow	*Euremabrigitta (Cramer)*	Pieridae	+	+	+
Common Grass Yellow	*Euremahecabe (Linnaeus)*	Pieridae	+	+	+
Psyche	*Leptosianina*	Pieridae	+	-	-
Common Wanderer	*Pareroniavaleria*	Pieridae	-	-	+

Note : M = monsoon, PM = Post-monsoon, S=Summer Season

8.3.5 Other Invertebrates

Other invertebrates taxa include a wide variety of species like annelids, mollusks, insects etc however, a few species having ethnobiological importance in the area are included here. *Bellamyabengalensis* (Snail), *Gerrisgibbifer* (Water Spider), *Nephilapilipes* (Wood spider), *Pheritimaposthuma* (Earthworm), etc. are most common invertebrates in the surrounding areas. These species play an important role in Ethnobiology of the area. Other invertebrate species from gastropods are also found in ponds and reservoir. The terrestrial insects which lay their eggs in water comprise of Mayflies (Ephemeroptera), Cadisflies (Trchiptera), Stoneflies (Placoptera), Bugs (Hemiptera), etc.

	
Common Mormon (*Papiliopolytes*)	Common Grass Yellow (*Euremahecabe*)
	
Himalayan Fivering (*Ypthima sacra*)	DanaidEggfly (*Hypolimnasmisippus*)

Plate-8.5: Common butterfly species recorded in the surroundings of proposed project

	
Euthalianais (Baronet)	Blue Pansy, Junoniaorithya (Linnaeus)
	
The *Common Jay* (Graphiumdoson)	The *Common Jay* (Graphiumdoson)
	
The Peacock Pansy- Junoniaalmana	Danausgenutia

Plate-8.6: Images of butterflies commonly observed in the study area

8.4 ECO-SENSITIVE ZONE

The project area is situated in the Ayodhya hills in Baghmundiblock of Purulia district of West Bengal. The study area does not fall under zone of any eco-sensitive area, i.e. wildlife parks or national parks, etc.

8.5 ELEPHANTS CORRIDORS [*ElephasmaximusIndicus*]

As per the primary field investigations conducted and information collected from the locals revealed that the immediate vicinity of the proposed project does not fall under any

Elephants Corridors or migration route. Further, Irrigation dam of I&W directorate of Government of West Bengal, already exists and near to Baghmundi town of Purulia district.

Elephant movement of some herds were reported from the Khariyrabedah Earthen Dam setup on Karungda nadi at Nischintpur village located at a distance of about 15km from Baghmundi town. This Dam exists on Karungadanadi, a small rainfed rivulet that also originates from Kurupahari hills at Saildih on the opposite watershed of right bank of Turga in the Catchment area. The movement in search of food, water and shelter, was rarely reported by the locals before construction of this earthen dam. Therefore, the movement is not regular and happened to be in springs or summer months as the area lacks perennial water sources.

Information about further movement in the Ayodhaya hills adjoining to proposed Turga Pumped Storage Project was also collected. The proposed project falls under Bagmundi block –an unclassified forest range of Baghmundi Forest Range. On the other site, Baghmundi forest range makes boundary with Jaldha Forest Range where Kalimati is located. The area between Mahilong Forest Range to Kalimati RF at either banks of Subernarekha river (Jharkhand and West Bengal) is known for Elephant Corridor, which is crossing Jaldha- Bagmundi Road about 30 km from Baghmundi on the way to Ranchi. **Plate-8.7** shows Sign Boards Indicating Mahilong to Kalmati Corridor and Baghmundi&Jaldha Boarder posts, which is also end or begning of respective forest ranges. Both Bagmundi and Jaldh fall under Purulia district of West Bengal. Purulia district in Bengal and Ranchi district in Jharkhand are part of Elephant Corridors of Central India (Tiwari et al. 2005; Elephant Corridors of Central India, In: Right of Passage: Elephant Corridors of India. WTI).

The elephant habitats of central India are spread over an area of 17,000 km^2 in the states of Jharkhand, Orissa and a part of southern West Bengal. The 2500 odd elephants in the range occupy the most fragmented elephant habitat of the country that has been degraded and fragmented due to mining, shifting cultivation and developmental activities.

Jharkhand has two distinct elephant populations, viz. Palamau and Singhbhum and about 700 elephants. The Palamau population occupies the Betla National Park, Palamau Tiger Reserve and adjoining areas. The Singbhum population occupies the available forest area of Dalma Wildlife Sanctuary and the forests of Saranda, Porhat, Kolhan, Saraikala (formerly North Chaibasa) and Dhalbhum Forest Divisions (Tiwari et al. 2005; Elephant Corridors of Central India, In: Right of Passage: Elephant Corridors of India. WTI)

The elephant movement reported between Dalma Wildlife Sanctuary and Saraikala Forest Division which has been threatened by habitat degradation, heavy traffic movement on NH-

33, the construction of Subarnarekha canal and the Tatanagar-Chandil railway along with various stone crushing units and other anthrpogenic activities. Second corridor is between Dalma Wildlife Sanctuary / Chandil RF and Matha Range of Purulia Forest Division (West Bengal). And, the third one is between Mosabani Range of Dhalbhum Forest division and Chakulia Range through degraded forestland and agricultural fields and extends to Gidhni Range of Jhargram (West Bengal). The detailed map of these three elephant corridors is shown in **Figure-8.1** and Image of Elephant in **Plate-8.8** (Reference: Tiwari et al. 2005; Elephant Corridors of Central India, In: Right of Passage: Elephant Corridors of India. WTI). Further, to strengthen the conservation of the Singhbhum elephant habitats, which lack a Protected Area, the Project Elephant, Ministry of Environment and Forest has declared 4529 km^2 of the elephant habitat as Elephant Reserve-I.

Elephants from Mosabani also move to the Sarali and Tungru Reserve Forest of Elephant herds move from Dalma Wildlife Sanctuary of Jharkhand to Midnapore East and West Forest Divisions, Bankura North and South divisions, Rupnarayan Planning and Survey division, Panchet soil conservation Division, Puruliya and Kangsabati Soil Conservation Division II as well.

The elephant corridors of Central India, Mahilog Range and Kalimati Reserve forest Baghmundi and Chandil Reserve Forest and Matha Protected Forest, Baghmundi is given in Figures-8.2 to 8.4.

Plate-8.7: Sign Boards for Mahilong to KalimatiElephand Corridor, Baghmundi and Jaldha Boarder posts.

Figure-8.2: Elephants corridors of central India [Reference :Tiwarietal 2005, Right of Passage: Elephant Corridors of India. WTI]

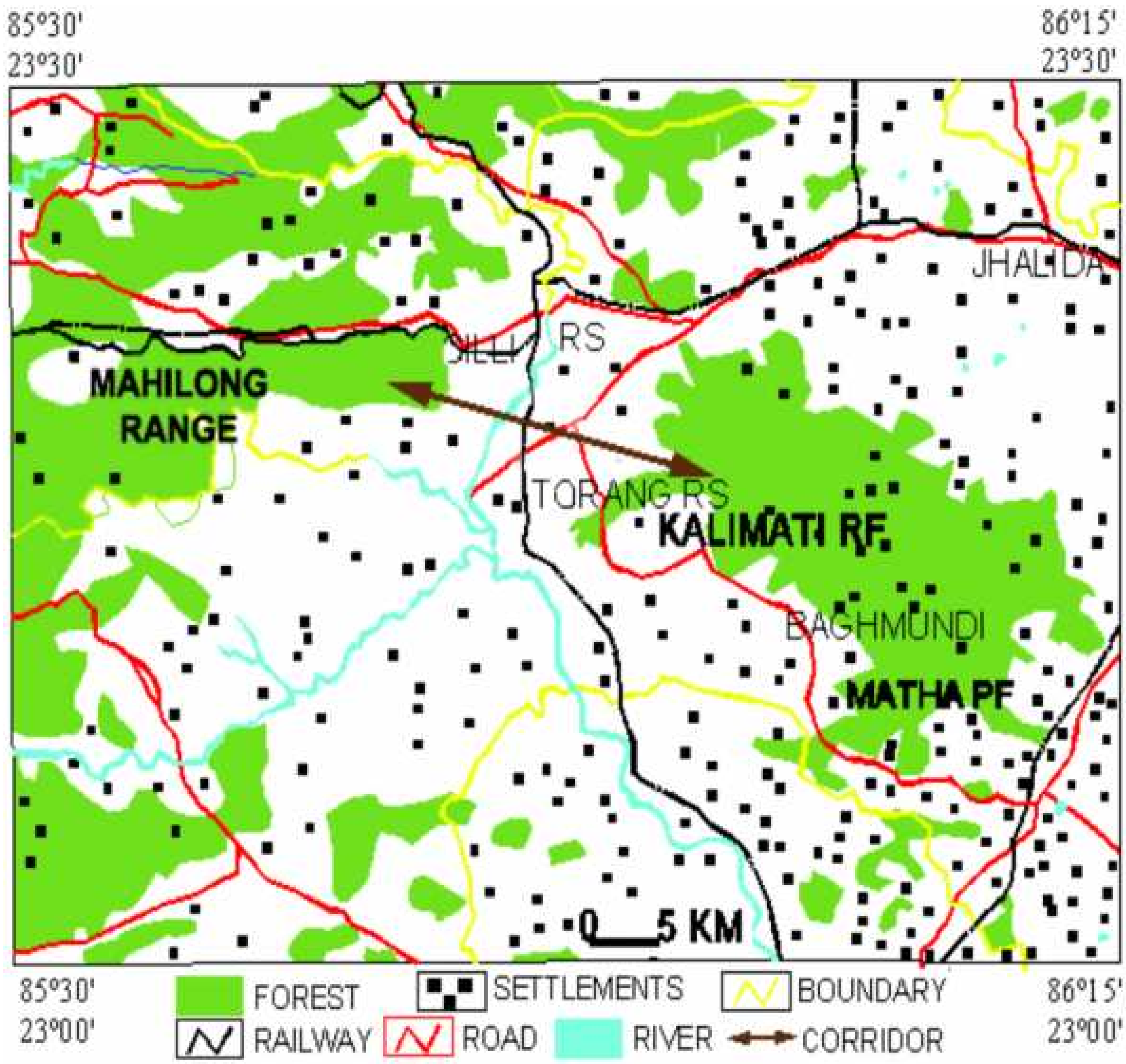


Figure-8.3: Elephant Corridors between Mahilong Range and Kalimati RF Bagmundi[Reference: Tiwari et al. 2005; Elephant Corridors of Central India, In: Right of Passage: Elephant Corridors of India. WTI]

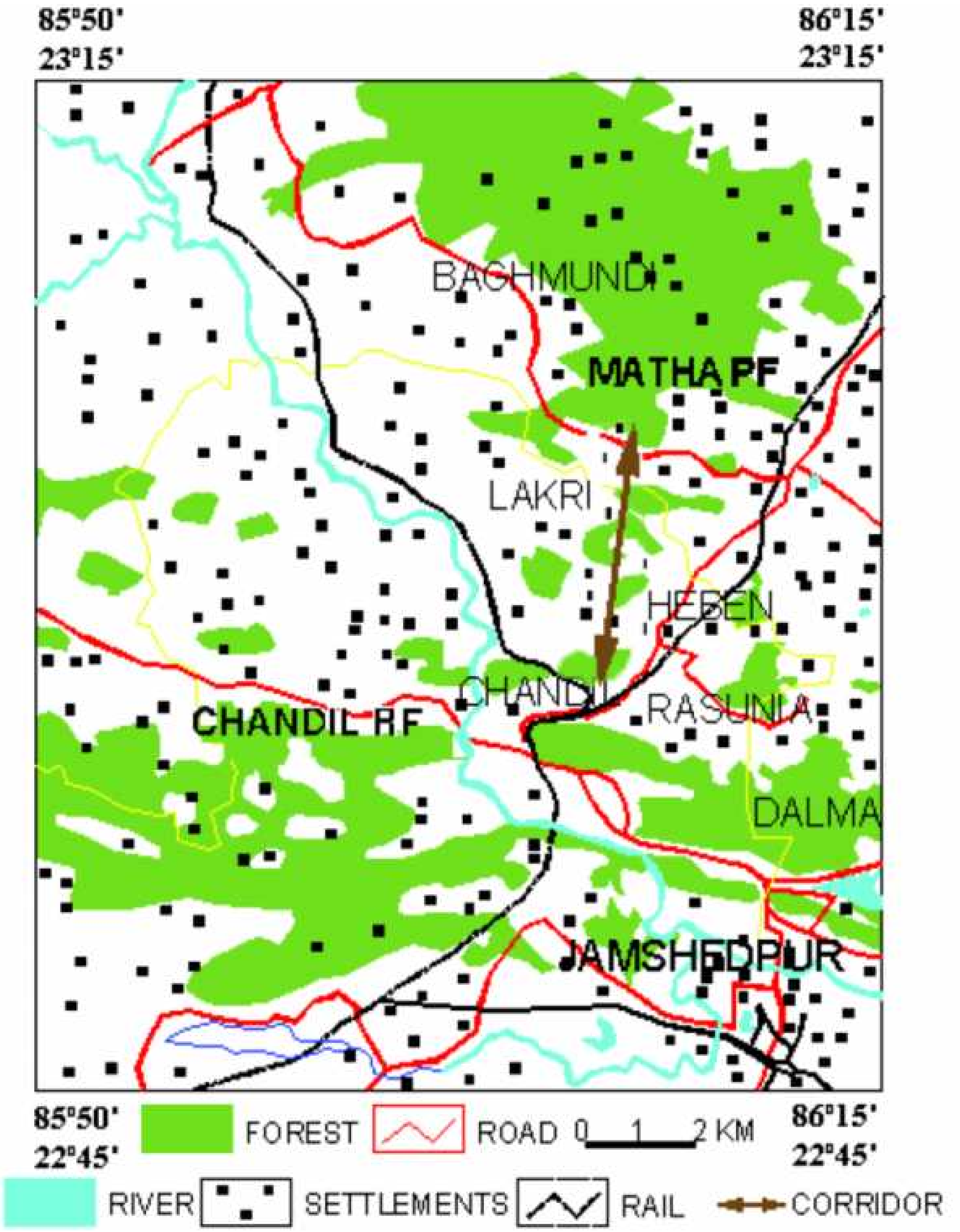


Figure-8.4: Elephants Corridors between Chandil RF / Dalma andMatha PF Bagmundi
[Reference: Tiwari et al. 2005; Elephant Corridors of Central India, In: Right of Passage: Elephant Corridors of India. WTI]

CHAPTER-9

AQUATIC ECOLOGY

9.1 AQUATIC ECOLOGY

Ecology is the scientific study of the interactions of organisms with themselves and the abiotic and biotic factors of the surrounding environments. Therefore, any change in the natural environment can alter the habitat fragmentation, which leads to change/loss of biodiversity as the species specific interaction and their food chain link gets widely impacted in response to the stress generated from the change in physical, chemical and biological environment due to erection of barriers (diversion structures, weirs, barrages, dams etc.) or blockage of the flowing water of river/stream.Thus, in order to predict the likely impacts of proposed Turga PumpedStorage Project on the Turga nallah, the hydro-biological characteristics like physical, chemical, biological, fishes and fisheries characteristics of this river water, the present study has been undertaken.

9.2 SAMPLING SITES

A total of 5 sampling sites listed as below were covered as a part of the survey:

- S1 (Turga upperdam site),
- S2 (downstream of upper dam site),
- S3 (upstream lower dam site),
- S4 (reservoir lower dam site)
- S5 (downstream lower dam site)

The above sites extend from 255 m to 405 m along the elevational gradient.The study was carried out during post-monsoon, summer and monsoon seasons (2013-14). In order to assess the river ecology, hydrobiological samples were retrieved from the different sites mentioned in **Table-9.1** and images are shown in **Plates-9.1 to 9.6.**

Table-9.1: Description of study sites selected on Turga Nalla

Sampling sites	**Location**	**Description**
Upper Dam Site (Proposed project)		
Site I **(S1)**	Upper Dam Axis site - Turga nallah	Mixed Jungle forest with Sal and Palaash plantation
Site II **(S2)**	D/s of proposed Upper dam Axis site	Mixed Jungle forest with Sal and Palaash plantation
Lower Dam Site (Existing one)		
Site III **(S3)**	u/s Lower Dam site	Darelehar :- Middle reach of Turga nalla
Site IV **(S4)**	Gossaidih / Pathardih	Lower dam reservoir and Turga nalla
Site V **(S5)**	Bhagmundi / Sarakdih	D/s flow of Turga nalla water course from Pathardih

9.3 METHODOLOGY ADOPTED FOR AQUATIC ECOLOGICAL SURVEY

The river /stream morphology is determined to ascertain the type of habitats, substratum and covers (aquatic vegetation, substratum, large woody debris, Particulate as clay, silt, sand, gravel, pebble, cobble, boulder, bedrock etc.), bank conditions, flow pattern, and type of valleys following flood prone area and riparian covers etc has been assessed based on the criteria described by Rosgen (1996) and habitat inventory described by Armontrout (1998), Myers and Swanson (1992) and Rosgen (1996). Stream order classification was based on Horton's (1954) approach as modified by Strahler (1954, 1957). In this system all ultimate headwaters are called first order streams. Stream formed by union of two such streams are designated second order and whenever two streams of a particular order join they form next order and so on. Habitat structures were observed in the river stretches from downstream to upstream at a fixed point including longitudinal survey of submergence, dam site and influence zones of toe dam projects with onsite visual estimation.

Phytoplankton and Zooplanktons were collected by filtering 50 liters of water at each site using a sieve of 25μ mesh size. The residue left in the sieve was collected in a 50 ml vial. Phytoplankton samples were preserved using Lugol's solution. No preservative were added in zooplankton samples. Benthos samples were collected from each site by scraping the boulder surfaces of known quadrat area (5cm x 5 cm). These samples were then preserved and analyzed in the same way as described for the planktons.

The macro-invertebrates were obtained with the help of a square feet Surber's sampler. The substrate, mainly stones are disturbed and immediately transferred to a bucket kept under water and later rinsed thoroughly to dislodge all the attached macro-invertebrates. To count the organisms the procedure described by Pennak (1953) and Edmondson (1959) are followed. Three replicates were obtained from each sites for each biotic communities. These replicates were pooled for further analysis.

Further analysis was conducted in laboratory. The volume of zooplankton, phytoplankton, and benthos were made up to 100 ml. The total density of zooplankton and phytoplankton were calculated using 'Drop-count' method (Adoni, 1983).

Density of Plankton (Phytoplankton/ zooplankton)

$$\text{Density} = A^*(1/L)^*(n/v)$$

Where, A = average number of organisms per drop
L = original sample volume
n = total volume of concentrated sample
v = volume of one drop

Density of Benthos (cells/ cm2) = A* (V/ v) *(1/ S)
Where, A = average number of organisms per drop
V= volume of scrapping (ml)
v = volume of one drop (ml)
S = area of scrapping (sq.cm)

Density of Macro-invertebrates

The samples retrieved from the sampling site were brought to the laboratory all individuals were counted. The final density of macro-invertebrate was expressed in the individuals per m^2.

The relative abundance of algal species was calculated as:

(Number of cells of a species / Total number of cells counted) x 100.

Identification of planktonic and benthic algae was carried out on the collected specimens – organisms of planktons, periphytons, benthoses etc by using standard keys formulated by different workers such as Pennak (1953), Edmondson (1959), Ward and Whipple (1959), Needham and Needham (1962), Trivedy and Goel (1984), Sarod and Kamat (1983, 1984), Hustedt and Jensen (1985), Battish (1992), Edington and Holdren (1995) and APHA (1992, 1998), and Lange- Bertalot & Krammer (2000, 2001 & 2002). The density of the plankton and benthic samples was estimated by using drop count method (Bhatt et al., 2005) and standards methods of APHA (1992, 1998). Fishes occurrence were determined by visual method and by collecting samples using different fishing gears like cast net, scoop net, hand net, hook-line, pot and open local devices methods. Fishes were identified up to the species level with the help of keys of Jayaram (1981), Menon (1987) and Talwar and Jhingran (1997). IUCN Red Data List (2008) was compared to assess threatened, endangered and vulnerable species in the study area. Conservation Assessment Management Plan of Biodiversity Conservation Prioritization Project Workshop (CAMP-BCPP, 1997) was followed to understand the threats and conservation status of Indian fish species.

9.4 AQUATIC MICRO FLORA AND FAUNA

The composition of phytoplankton and zooplankton of a particular aquatic ecosystem are indicators of environmental stress. The phytoplanktons constitute bulk of primary producers and are the base of food chains in any water body. The phytoplanktonic community of water body during the present study was represented by five groups namely Chlorophyceae, Bacillariophyceae, Desmidiaceae, Euglenophyceae and Myxophyceae. As evident from the study, Chlorophyceae dominated over Bacillariophyceae followed by Myxophyceae. The occurrence of various genera at various sampling sites in the study area arelisted in **Tables-9.1 to 9.5**.

9.5 COMMUNITY STRUCTURE

9.5.1 Zooplanktons

Zooplanktons are represented by Protozoan, Rotifera, Cladocera, Copepoda and Ostracoda. Among them, commonly occurring zooplankters were Nebalia, Amoeba, Phacus and Diffulugia belonging to phylum Protozoa **(Refer Table-9.1).** Rotifera was frequently represented by *Brachionus* spp., *Keratella tropica, Lecane luna, and Filinia longiseta*. Among Cladocera frequently represented forms were *Ceriodaphnia cornuta, Daphnia carinata, Moina macroscopa and Chydorus ovalis*. Commonly found Calanoids were Diaptomus sp, *Mesocyclops hyalinus* and nauplii were very frequently represented in zooplankton samples. However, all these forms were poorly represented in water bodies under taken during present study.

Table-9.1: Zooplanktons present in the study area

S.No.	Zooplankton Taxon	S.No.	Zooplankton Taxon
A.	**Protozoa**	**C.**	**Copepoda**
1.	Arcella *vulggaris*	1	Cyclops spp
2.	Diffuzia sp.	2	Mesocyclops *hyalinus*
3.	Paramecium sp.	3	Mesocyclops Hyalimus
4.	Vorticella sp.	4	Diaptomus sp.
5.	*Actinopherium sp*	5	Cypris sp.
6.	Amoeba sp.	6	*Nauplius* sp.
7.	*Nebalia sp*		**Cladocerans**
		1	Daphinia *corinata*
B.	**Rotifera**	2	Ceriodiaphnia cornusa
1.	*Asplanchnopus brightwelli*	3	Daphinia lumphasia
2	*Brachionus* sp.	4	Moina *macroscopica*
3	B. *rubens*	5	*Chydorus ovulis*
4	B.*bidens*	6	*Alona macrocopa*
5	B. *caudatus*	7	*Bosmina loniotris*
6.	Filinia *longiseta*		**Coelentrata**
7.	Keratella *tropica*	1	*Hydra viridissima* Pallas
8.	Lecane *luna*		**Ostracoda**
9.	Monostylla *bulla*	1	Heterocypris sp.
10.	Polyarthra *vulgaris*		**Insects**
11.	Euchlanis sp.	1	Water mites
12.	Rotaria sp.	2	Arachnids water spiders

Zooplankton community was dominated mainly by rotifers accounting for more than 75%, followed by Cladocera during both the seasons. Cladocerans were found dominant in the reservoir of lower dam. Rotifers comprised of *Brachionus diversicornis*, *Brachionus patulus*, *Brachionus* sp., *Keratella* sp. and *Platyias* spp. They were common at all sites except Site S4 (reservoir) where only *Keratella* sp. and *Platyias* spp. were recorded. Cladocera was represented by *Daphnia* spp. *Moina* spp., *Diaphonosoma* sp. and a few unidentified species. Copepoda included *Cyclops* sp. *Eucyclops* sp. *Cyclopodi* sp. and *Nauplli* sp. Most of the zooplanktonic communities are observed in all three seasons in the lower dam reservoir water. However, these species could not show any presence at other sites during non-monsoon period.

9.5.2 Algae (Filaments)

Filamentous algae

Algae in planktonic and benthic forms comprises filamentous (cyanophyceae- blue green algae and chlorophyceae- green algae) and non filamentous (Bacillariophyceae- diatoms) algae. During post monsoon seasons filamentous algae comprised of 11 species, of which 4 belong to Cyanophyta and 7 to Chlorophyta. Number of taxa ranged from 2 to 6 in planktonic community and 5 to 9 in benthic community (Refer **Table-9.2**). *Spirogyra* sp. and *Zygnenma* sp. were relatively most common species in the planktonic and benthic forms. Cyanophyta was dominant at site S4 in planktonic form where *Microcystis aeruginosa* accounted for 83.3% of the total filamentous algae. In the chlorophyceae *Coelastrum microporum* and *Oocystis solitaria* dominated planktonic community at a few sites while *Spirogyra* sp. dominated benthic community at sites S2 and S3. Periphyton communities (phytobenthos) showed poor growth at Site S4 (reservoir) and S5 (downstream reservoir). *Synechocystis crassa* was observed at site S2 only in the planktonic form.

During summer season, study site S1, S2 and S5 remained dry as the Turgna nalla is a seasonal nalla and water flow is observed during monsoon season only. Water flow at S3 site during summers happened to be an overflow or discharge from the other existing project reservoir diverted to Turga nalla in the middle reach area. Therefore, presence of plankton and phytobenthos was at site S3 also along with S4 lower dam reservoir (Refer **Table-9.2**).

A total of 8 species among blue green algae and 12 species from green algae were observed. Among blue green algae *Oscillatoria* sp and *Microcystis* spp are dominant communities whereas in green algae *Botrycoccus* and *spirogyra* are dominant communities. In reservoir water, *Cholorococum, Cosmarium, Pediastrum* and *Oocystis* are found dominant.

Table-9.2: Filamentous algal communities present in the study area of Turga project

Taxa	Phytoplanktons					Phytobenthos				
	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5
Post-Monsoon Season										
Cyanophyta										
Anacystis sp.	0.0	0.0	11.1	0.0	33.3	0.0	1.5	2.9	0.0	0.0

Taxa	**Phytoplanktons**					**Phytobenthos**				
	S1	**S2**	**S3**	**S4**	**S5**	**S1**	**S2**	**S3**	**S4**	**S5**
Gomphosphaeria aponina	0.0	0.0	0.0	16.7	0.0	25.0	0.0	0.0	0.0	0.0
Microcystis aeruginosa	0.0	0.0	11.1	83.3	0.0	0.0	1.5	0.0	0.0	0.0
Synechocystis crassa	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chlorophyta										
Botryococcus sp.	0.0	0.0	11.1	0.0	0.0	12.5	4.6	2.9	0.0	0.0
Coelastrum microporum	50.0	0.0	0.0	0.0	33.3	25.0	7.7	5.9	0.0	0.0
Oocystis solitaria	0.0	16.7	0.0	0.0	0.0	0.0	4.6	2.9	0.0	0.0
Sorastrum sp.	0.0	16.7	0.0	0.0	33.3	0.0	12.3	8.8	0.0	0.0
Sceredesmus sp.	0.0	0.0	33.3	0.0	0.0	0.0	13.9	0.0	0.0	0.0
Spirogyra sp.	50.0	33.3	22.2	0.0	0.0	25.0	35.4	41.2	0.0	0.0
Zygnenma sp.	0.0	16.7	11.1	0.0	0.0	12.5	18.5	35.3	0.0	0.0
Summer Season	**S1**	**S2**	**S3**	**S4**	**S5**	**S1**	**S2**	**S3**	**S4**	**S5**
Cyanophyta										
Anacystis sp.	0.0	0.0	6.5	3.0	0.0	0.0	0.0	1.5	1.4	0.0
Gomphosphaeria aponina	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.8	0.0
Microcystis aeruginosa	0.0	0.0	6.5	7.0	0.0	0.0	0.0	6.2	5.7	0.0
Chroococcus sp.	0.0	0.0	3.4	1.5	0.0	0.0	0.0	3.7	1.9	0.0
Oscillatoria sp.	0.0	0.0	10.2	5.5	0.0	0.0	0.0	14.2	5.7	0.0
Gloeocapsa sp.	0.0	0.0	3.4	5.5	0.0	0.0	0.0	6.2	4.6	0.0
Coelastrum sp.	0.0	0.0	0.0	1.2	0.0	0.0	0.0	2.8	0.0	0.0
Coeolosphaerium dubium	0.0	0.0	3.3	0.0	0.0	0.0	0.0	3.7	0.0	0.0
Chlorophyta										
Botryococcus sp.	0.0	0.0	8.0	1.7	0.0	0.0	0.0	3.7	1.4	0.0
Coelastrum microporum	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0
Oocystis solitaria	0.0	0.0	0.0	7.0	0.0	0.0	0.0	0.0	7.0	0.0
Oedogonium sp.	0.0	0.0	2.3	0.0	0.0	0.0	0.0	1.5	0.0	0.0
Scenedesmus sp.	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	1.4	0.0
Spirogyra sp.	0.0	0.0	7.3	6.1	0.0	0.0	0.0	9.1	4.7	0.0
Zygnenma sp.	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pediastrum sp.	0.0	0.0	0.0	3.8	0.0	0.0	0.0	1.5	7.0	0.0
Chlorella sp.	0.0	0.0	5.0	6.1	0.0	0.0	0.0	3.7	7.0	0.0
Cosmarium bioculatum	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	4.6	0.0
Chlorococcum sp.	0.0	0.0	2.0	4.0	0.0	0.0	0.0	1.5	4.6	0.0
Ulothrix sp.	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	1.4	0.0
Monsoon Season	**S1**	**S2**	**S3**	**S4**	**S5**	**S1**	**S2**	**S3**	**S4**	**S5**
Cyanophyceae (BGA)										
Anacystis sp.	7.7	0.0	8.3	12.5	5.0	0.0	0.0	25.0	0.0	8.3
Chroococcus sp.	0.0	8.0	5.6	3.1	0.0	13.2	0.0	0.0	9.4	0.0
Coelastrum sp.	0.0	0.0	0.0	9.4	0.0	0.0	4.0	0.0	12.5	0.0
Coeolosphaerium dubium	15.4	0.0	2.8	0.0	5.0	0.0	0.0	16.7	0.0	16.7
Gloeocapsa sp.	0.0	0.0	5.6	9.4	0.0	10.5	0.0	0.0	9.4	0.0
Gomphospheria aponina	0.0	16.0	0.0	6.3	0.0	2.6	0.0	0.0	0.0	25.0
Oscillatoria sp.	0.0	0.0	16.7	9.4	5.0	0.0	12.0	0.0	9.4	0.0
Synechococcus elongatus	0.0	8.0	11.1	3.1	0.0	7.9	0.0	8.3	0.0	0.0
Chlorophyceae										
Botryococcus sp.	7.7	0.0	0.0	3.1	0.0	10.5	0.0	0.0	15.6	0.0
Chlorella sp.	0.0	8.0	8.3	0.0	10.0	0.0	12.0	0.0	0.0	16.7
Chlorella vulgaris	3.9	0.0	0.0	9.4	0.0	10.5	0.0	16.7	0.0	0.0

Taxa	Phytoplanktons					Phytobenthos				
	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5
Chlorococcum sp.	0.0	0.0	8.3	0.0	10.0	13.2	4.0	0.0	0.0	8.3
Coelastrum sp.	7.7	4.0	0.0	6.3	15.0	0.0	0.0	25.0	12.5	0.0
Cosmarium bioculatum	0.0	8.0	0.0	3.1	0.0	7.9	20.0	0.0	0.0	0.0
Micractinum sp.	7.7	0.0	0.0	6.3	0.0	0.0	20.0	8.3	0.0	8.3
Oedogonium sp.	0.0	20.0	8.3	0.0	15.0	13.2	8.0	0.0	12.5	0.0
Pediastrum sp.	7.7	0.0	11.1	6.3	0.0	0.0	4.0	0.0	0.0	0.0
Sphaerocystis sp.	0.0	4.0	0.0	6.3	5.0	5.3	0.0	0.0	6.3	0.0
Spirogyra sp.	23.1	8.0	5.6	0.0	10.0	0.0	4.0	0.0	3.1	0.0
Ulothrix sp.	11.5	0.0	0.0	6.3	0.0	2.6	4.0	0.0	0.0	16.7
Zygnema sp.	7.7	16.0	8.3	0.0	20.0	2.6	8.0	0.0	9.4	0.0

S1 = Turga UpperDam site, S2 = downstream of Upper dam site, S3: upstream lower Dam site- middle reach, S4: Reservoir Lower Dam Site and S5: downstream Lower Dam site

The diversity of filamentous algae increased considerably in monsoon season. In monsoon season a total of 21 species were recorded from various sites in both communities, of which 8 belonged to Cyanophyta and remaining 13 to Chlorophyta. In the planktonic community *Anacystis* sp., *Chroococcus* sp., *Coelastrum* sp., *Zygnema* sp. and *Spirogyra* sp. Were the most common species. *Spirogyra* sp., *Oedogonium* sp., *Oscillatoria* sp., *Anacystis* sp. and *Coelastrum* sp. were abundant taxa at sites S1, S2, S3, S4 and S5, respectively, each accounted for more than 10%. In phytobnthos, none of the taxa represented more than three sites as compared to planktonic community. *Chlorococcum* sp. and *Oedogonium* sp., *Cosmarium bioculatum* and *Micractinum* sp., *Coelastrum* sp., *Botryococcus* sp. and *Gomphospheria aponina* were abundant at sites S1, S2, S3, S4 and S5, respectively, each accounted for more than 10% of total species.

Non filamentous Algae -Diatoms

Non filamentous algae comprised mainly of diatoms. In post-monsoon season a total of 30 taxa belonging to 11 genera were recorded from the study area. Phytoplankton were recorded from sites S1, S2 and S3 comprised of only 9 taxa while phytobenthos were recorded from sites S1, S2 and S3 comprising of 27 taxa. Inphytoplankton, none of the species was common at all sites. A few species like *Achnanthidium exigua*, *Synedra ulna* and *Navicula minuta* dominated the sites S2 and S3, respectively. In Phytobenthos *Gomphonema nagpurensis*, *Cocconeis placentula* and *Synedra ulna* were relatively more common species and were found at 3 sites. These 3 species dominated site S1 accounting more than 20% of total density. Sites S2 and S3 were dominated by *Amphora montana*and *Gomphonema sphaerophorum*, and *Gomphonema parvulum*, respectively. The details are given in **Table-9.3.**

During summers, a total 24 taxa in both communities-plankton and periphytons/ phytobenthos, were observed (Refer **Table-9.3**). Among them *Fragillaria*, *Achanthidium*, and *Cyclotella* are found dominant species followed by *Nitzchia, Amphora, Gomphonema* and *Synedra* spp. Site S1, S2, and S3 are devoid of any growth of algal matter that is due to dry season and absence of water flow in the stream.

In monsoon season, diatoms were represented by a total of 62 taxa in both communities, of which phytoplankton included 60 and phytobenthos comprised of 61 Taxa. Two species namely *Pleurosigma* sp. and *Achnanthidium biasolettiana* were absent in planktonic communities while *Achnanthidium kryophila* was absent in benthic communities of the study area. In the planktonic communities, none of the taxa (except *Achnanthes minutissima*) was common occurring at all sites. A few taxa like *Synedra ulna*, *Fragilaria vaucherae*, *Achnanthes minutissima*, *Planothidium lanceolata* and *Achnanthes microcephala* were abundant at sites S1, S2, S3, S4 and S5, respectively accounting more than 10% of the total density at each site (Refer **Table-9.3**). Likewise plankton, none of the benthic species (except *Achnanthes minutissima*) was common at all sites. Also, none of the benthic taxon was abundant at sites S1, S2 and S4 accounting more than 10% of the total density. *Achnanthes minutissima* dominated site S3 while *Achnanthidium kolbei*, *Achnanthes minutissima* and *Amphora montana*were abundant at site S5. A few taxa common in both communities were *Achnanthes minutissima*, *Achnanthes microcephala* and *Synedra ulna*.

Table-9.3: Diatom communities present in Turga River in the Project Influence Area

Taxa			**Phytoplankton**					**Phytobenthos**		
	S1	**S2**	**S3**	**S4**	**S5**	**S1**	**S2**	**S3**	**S4**	**S5**
Post-monsoon Season										
Achnanthidium exigua	33.4	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Achnanthidium lanceolata	0.0	0.0	18.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Amphora montana	0.0	0.0	0.0	0.0	0.0	0.0	11.1	1.1	0.0	0.0
Amphora pediculus	0.0	0.0	9.1	0.0	0.0	0.0	0.0	3.3	0.0	0.0
Cocconeis placentula	16.7	33.3	0.0	0.0	0.0	24.6	8.7	3.3	0.0	0.0
C. placentula var. euglypta	0.0	0.0	18.2	0.0	0.0	0.0	6.5	2.2	0.0	0.0
Cyclotella meneghiniana	0.0	0.0	9.1	0.0	0.0	0.0	0.0	3.3	0.0	0.0
Gomphonema lanceolatum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0
Gomphonema nagpurensis	0.0	0.0	0.0	0.0	0.0	18.0	3.2	2.2	0.0	0.0
Gomphonema parvulum	0.0	0.0	0.0	0.0	0.0	0.0	8.7	13.2	0.0	0.0
Gomphonema sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.3	0.0	0.0
G. sphaerophorum	0.0	0.0	0.0	0.0	0.0	6.5	12.1	0.0	0.0	0.0
Melosira varians	0.0	0.0	9.1	0.0	0.0	0.0	6.5	2.2	0.0	0.0
Gyrosigma sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0

Taxa	Phytoplankton					Phytobenthos				
	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5
Hanztschia amphioxys	0.0	0.0	0.0	0.0	0.0	0.0	3.2	2.2	0.0	0.0
Navicula cryptocephala	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0
Navicula disjuncta	0.0	0.0	0.0	0.0	0.0	13.2	0.0	9.2	0.0	0.0
Navicula frustulum	0.0	0.0	0.0	0.0	0.0	0.0	8.7	2.2	0.0	0.0
Navicula halophila	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0
Navicula minuta	16.6	0.0	27.2	0.0	0.0	6.5	0.0	0.0	0.0	0.0
Navicula palea	0.0	0.0	0.0	0.0	0.0	0.0	3.2	1.1	0.0	0.0
Navicula viridula	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0
Nitzschia comutata	0.0	0.0	0.0	0.0	0.0	0.0	6.5	2.2	0.0	0.0
Nitzschia filiformis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0
Nitzschia fonticola	0.0	0.0	0.0	0.0	0.0	0.0	6.5	2.2	0.0	0.0
Nitzschia subtilis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0
Nitzschia thermalis	0.0	0.0	0.0	0.0	0.0	0.0	3.2	2.2	0.0	0.0
Synedra tabulata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0	0.0
Synedra sp.	0.0	0.0	9.1	0.0	0.0	13.2	8.7	4.4	0.0	0.0
Synedra ulna	33.3	0.0	0.0	0.0	0.0	18.0	3.2	4.4	0.0	0.0
Summer Season										
Achnanthidium exigua	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	1.6	0.0
Achnanthidium kryophila	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	3.3	0.0
Achnanthes lanceolata	0.0	0.0	4.1	0.0	0.0	0.0	0.0	0.0	1.7	0.0
Achnanthes minutissima	0.0	0.0	2.5	2.3	0.0	0.0	0.0	1.8	3.3	0.0
Amphora ovalis	0.0	0.0	2.0	2.3	0.0	0.0	0.0	1.5	0.9	0.0
Amphora sp	0.0	0.0	1.1	2.1	0.0	0.0	0.0	0.0	1.1	0.0
Cocconeis placentula	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	4.7	0.0
Cyclotella meneghiniana	0.0	0.0	0.0	10.7	0.0	0.0	0.0	1.7	3.3	0.0
Gomphonema lanceolatum	0.0	0.0	1.6	0.0	0.0	0.0	0.0	1.2	1.7	0.0
G. ventricosum	0.0	0.0	1.0	3.7	0.0	0.0	0.0	3.3	1.2	0.0
G. parvulum	0.0	0.0	1.4	1.3	0.0	0.0	0.0	0.0	0.9	0.0
Gomphonema sp.	0.0	0.0	0.3	2.1	0.0	0.0	0.0	3.3	4.7	0.0
G. sphaerophorum	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0
Melosira varians	0.0	0.0	1.6	0.0	0.0	0.0	0.0	1.1	1.6	0.0
Hanztschia amphioxys	0.0	0.0	0.4	0.0	0.0	0.0	0.0	1.1	1.9	0.0
Navicula cryptocephala	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	1.6	0.0
Navicula sp.	0.0	0.0	3.3	6.7	0.0	0.0	0.0	1.8	1.6	0.0
Nitzschia amphibia	0.0	0.0	2.3	0.0	0.0	0.0	0.0	1.7	0.0	0.0
Nitzschia thermalis	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.6	0.0
Nitzschia sp.	0.0	0.0	1.4	2.0	0.0	0.0	0.0	2.0	0.0	0.0
Synedra sp.	0.0	0.0	2.6	0.0	0.0	0.0	0.0	2.3	0.0	0.0
Synedra ulna	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	2.2	0.0
Cymbella affinis	0.0	0.0	2.2	2.3	0.0	0.0	0.0	1.6	0.6	0.0
Diatoma vulgare	0.0	0.0	1.6	0.0	0.0	0.0	0.0	1.7	0.0	0.0
Epithemia sp.	0.0	0.0	1.9	0.0	0.0	0.0	0.0	1.7	0.0	0.0
Fragilaria vaucherae	0.0	0.0	1.6	1.2	0.0	0.0	0.0	6.9	1.7	0.0
Monsoon season										
Achnanthidium austriaca	0.0	0.0	4.4	0.0	0.0	0.0	4.9	0.0	1.8	2.2

Taxa			Phytoplankton					Phytobenthos		
	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5
A.biasolettiana	0.0	0.0	0.0	0.0	0.0	0.0	1.1	6.1	0.0	0.0
Achnanthidium bottnica	0.0	0.0	8.6	0.0	0.0	0.0	1.6	0.0	1.8	0.0
Achnanthidium exigua	0.0	0.0	0.0	3.2	0.0	0.0	1.6	0.0	0.0	8.7
Achnanthidium exilis	4.6	0.0	0.0	0.0	0.0	3.1	0.0	6.1	0.0	0.0
Achnanthidium hungarica	0.0	10.4	0.0	0.0	0.0	0.0	2.8	0.0	0.0	0.0
Achnanthidium kolbei	0.0	0.0	0.0	3.2	0.0	0.0	1.1	0.0	0.0	13.0
Achnanthidium kryophila	0.0	0.0	0.0	0.0	14.8	0.0	0.0	0.0	0.0	0.0
Achnanthes lanceolata	0.0	6.5	0.0	3.2	0.0	0.0	6.5	0.0	0.0	4.4
Achnanthes microcephala	9.3	0.0	10.8	0.0	25.9	3.6	5.4	0.0	5.5	0.0
Achnanthes minutissima	3.7	2.6	10.8	4.8	11.1	8.8	6.0	12.1	6.1	10.9
Amphora montana	0.0	7.8	0.0	0.0	3.7	0.0	1.1	0.0	0.0	15.2
Amphora ovalis	0.0	3.9	0.0	0.0	0.0	0.0	1.1	3.0	1.8	0.0
Amphora sp.	0.9	0.0	2.2	0.0	3.7	0.6	2.2	0.0	0.0	0.0
Cocconeis placentula	2.8	0.0	0.0	4.8	0.0	0.0	1.6	0.0	1.2	2.2
C. placentula var. euglypta	1.9	1.3	0.0	0.0	0.0	0.0	0.5	0.0	2.4	0.0
C.placentula var. lineata	0.0	0.0	4.4	0.0	0.0	1.3	1.6	3.0	0.0	0.0
Cymbella aequalis	2.8	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	6.5
Cymbella affinis	4.6	0.0	4.4	0.0	0.0	0.0	3.3	0.0	1.2	0.0
Cymbella amphicephala	0.0	3.9	0.0	3.2	0.0	0.0	1.1	0.0	0.0	0.0
Cymbella pusila	0.0	6.5	0.0	0.0	0.0	1.3	0.0	0.0	1.8	4.4
Cymbella ventricosa	0.9	0.0	0.0	0.0	0.0	0.0	1.1	0.0	1.2	0.0
Cymbella sp.	0.0	0.0	4.4	0.0	0.0	0.0	0.0	3.0	1.2	0.0
Diatoma vulgare	0.0	5.2	0.0	0.0	0.0	0.6	0.5	0.0	1.8	0.0
D. vulgaris var. vulgaris	0.9	0.0	2.2	0.0	0.0	0.6	0.0	0.0	1.2	0.0
Epithemia sorex	2.8	0.0	0.0	0.0	0.0	0.6	1.1	0.0	0.6	0.0
Epithemia sp.	3.7	0.0	0.0	3.2	0.0	0.0	0.0	0.0	1.2	0.0
Fragilaria intermedia	0.0	2.6	0.0	0.0	0.0	7.5	8.7	0.0	3.1	6.5
Fragilaria sp.	0.0	2.6	0.0	3.2	0.0	3.1	3.8	0.0	3.7	2.2
Fragilaria vaucherae	0.0	11.6	0.0	0.0	0.0	1.3	2.2	0.0	1.8	0.0
Gomphonema intricatum	4.6	0.0	6.5	0.0	0.0	0.0	1.6	0.0	3.1	0.0
Gomphonema lanceolatum	0.0	2.6	0.0	0.0	0.0	1.3	0.0	6.1	0.0	0.0
Gomphonema longiceps	4.6	0.0	4.4	0.0	0.0	0.0	1.1	0.0	2.4	0.0
Gomphonema olivaceoides	0.0	5.2	0.0	6.4	0.0	2.5	0.0	3.0	0.0	0.0
Gomphonema olivaceum	0.0	0.0	8.6	0.0	3.7	1.3	2.2	0.0	1.8	0.0
Gomphonema parvulum	3.7	0.0	0.0	7.9	0.0	6.9	2.8	0.0	1.2	0.0
G. parvulum var. exilissimum	1.9	0.0	0.0	0.0	7.5	0.0	1.1	0.0	2.4	6.5
G. parvulum var. micropus	0.0	3.9	0.0	0.0	0.0	2.5	0.0	6.1	0.0	0.0
Gomphonema sp.	3.7	0.0	2.2	3.2	0.0	6.9	1.6	0.0	1.2	8.7
Gomphonema ventricosum	2.8	0.0	0.0	0.0	0.0	0.6	3.8	0.0	1.8	0.0
Gomphonema affine	1.9	0.0	0.0	1.6	0.0	0.6	1.1	0.0	0.0	0.0

Taxa			Phytoplankton					Phytobenthos		
	S1	S2	S3	S4	S5	S1	S2	S3	S4	S5
Hantzschia amphioxys	0.0	1.3	0.0	0.0	0.0	1.3	0.5	0.0	2.4	0.0
Melosira varians	0.9	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0
Navicula cryptocephala	0.0	2.6	0.0	0.0	0.0	3.6	0.0	0.0	1.8	0.0
Navicula erifuga	2.8	0.0	0.0	0.0	14.8	0.0	1.1	0.0	3.7	0.0
Navicula palacea	0.0	3.9	0.0	3.2	0.0	1.3	0.0	3.0	0.0	0.0
Navicula rhyncocephala	4.6	0.0	8.6	0.0	0.0	5.0	1.6	0.0	1.8	2.2
Navicula rostellata	2.8	0.0	0.0	3.2	0.0	0.0	0.0	0.0	1.2	0.0
Navicula sp.	0.0	6.5	0.0	0.0	11.1	1.9	1.1	12.1	3.1	0.0
Navicula veneta	1.9	0.0	0.0	6.4	0.0	0.0	0.0	3.0	2.4	0.0
Nitzschia acicularis	0.0	1.3	4.4	0.0	0.0	1.3	2.2	0.0	0.0	0.0
Nitzschia amphibia	4.6	0.0	0.0	0.0	0.0	0.6	0.0	3.0	1.2	0.0
Nitzschia communis	0.0	2.6	0.0	4.8	0.0	1.3	3.3	0.0	0.0	0.0
Nitzschia palea	0.0	1.3	0.0	0.0	0.0	0.0	0.0	6.1	2.4	0.0
Nitzschia sp.	0.0	1.3	0.0	7.9	0.0	0.0	1.6	0.0	0.0	0.0
Nitzschia umbonata	1.9	0.0	4.4	0.0	0.0	0.0	0.0	0.0	1.8	0.0
Pleurosigma sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.5	9.1	1.2	0.0
Planothidium lanceolata	2.7	0.0	0.0	15.5	0.0	6.9	1.6	0.0	8.5	0.0
Surirella ovata	0.0	0.0	0.0	1.6	3.7	0.0	0.5	0.0	1.2	0.0
Surirella sp.	0.0	0.0	2.2	0.0	0.0	0.6	1.1	0.0	2.4	0.0
Synedra acus	4.6	1.3	0.0	0.0	0.0	9.4	3.8	12.1	1.2	0.0
Synedra sp.	0.0	0.0	6.5	0.0	0.0	6.9	2.7	0.0	3.7	6.5
Synedra ulna	11.1	1.3	0.0	9.5	0.0	4.4	2.2	0.0	6.7	0.0

S1 = Turga Dam site upper, S2 = downstream of Upper dam site, S3: upstream lower Dam site & d/s upper dam site-middle reaches, S4: Reservoir Lower Dam Site and S5: downstream Lower Dam site

9.5.3 Macro-invertebrates

Macro-invertebrates (nymph) are widely used in water quality monitoring surveys as they are considered as the ideal bio indicators. The macro invertebrate community in Turga river in proposed project area was reflective of the moderate water quality. The density of macro-invertebrates in Turga river ranged from 1222 – 2055 individuals/m^2 in post-monsoon season (Refer **Table-9.4**). A total of 10 genera/species belonging to 9 families were recorded from Turga river. Species belonging to Chironomidae family was predominant in the term of density, indicating the deteriorated water quality. During study period benthos were found at site S3 and S4 whereas other sites were devoid of any benthic life forms due to dry season. In monsoon season density of macro-invertebrate ranged from 0 to 799 indiv./m^2 with maximum at site S1 (upstream of upper dam). The density was considerably low as compared to post-monsoon season except at Site S1, where macro-invertebrate fauna was absent in post-monsoon season. The nymphs were absent from the reservoir, which can be attributed to the suitable substrate. The macro-invertebrate comprised of a total of 10 genera belonging to 9 families. Out of total 13 genera in both seasons, 7 genera were common. The taxa like *Ephemerella excrucians*, *Simulium pictipes* and *Odontomyia* were recorded in post-monsoon season while *Caenis latipennis*, *Copelatus* and *Ochrotrichia* were specific in monsoon season. The majority of the species intolerant of water pollution, indicating the clean and non-polluted status of water of Turga nalla. However, they were absent in reservoir, which was dominated by gastropods (Refer **Table-9.4**).

Table-9.4: Macro-invertebrates observed in the project influenced area

Post-monsoon	**Taxa**	**(S1)**	**(S2)**	**(S3)**	**(S4)**	**(S5)**
Family						
Heptageniidae	*Cinygmula*	0	11	0	0	0
Baetidae	*Baetis*	0	44	11	0	0
Ephemerellidae	*Ephemerella excrucians*	0	11	178	0	0
Leptophlebiidae	*Paraleptophlebia*	0	11	44	0	0
Perlidae	*Acroneuria*	0	0	11	0	0
Hydropsychidae	*Hydropsyche*	0	56	111	0	0
Chironomidae	*Chironomus*	0	0	22	26	40
	Ablabesmyia	0	1078	1667	136	138
Simuliidae	*Simulium pictipes*	0	0	11	0	0
Stratiomyidae	*Odontomyia*	0	11	0	0	0
Density (indiv./m^2)		**0**	**1222**	**2055**	**162**	**178**
Summer Season						
Heptageniidae	*Cinygmula*	0	0	4	0	0
Baetidae	*Baetis*	0	0	11	0	0
Ephemerellidae	*Ephemerella excrucians*	0	0	18	0	0
Leptophlebiidae	*Paraleptophlebia*	0	0	4	0	0
Perlidae	*Acroneuria*	0	0	0	0	0
Hydropsychidae	*Hydropsyche*	0	0	0	0	0
Chironomidae	*Chironomus*	0	0	36	16	0
	Ablabesmyia	0	0	62	24	0
Simuliidae	*Simulium pictipes*	0	0	8	0	0
Stratiomyidae	*Odontomyia*	0	0	0	0	0
Density (indiv./m^2)		**0**	**0**	**143**	**40**	**0**
Monsoon Season						
Heptageniidae	Cinygmula	44	0	11	0	0
Baetidae	Baetis	0	11	33	0	0
Caenidae	Caenis latipennis	0	0	78	0	0
Leptophlebiidae	Paraleptophlebia	0	22	89	0	0
Perlidae	Acroneuria	0	11	0	0	0
Dytiscidae	Copelatus	0	44	0	0	0
Hydroptilidae	Ochrotrichia	100	33	0	0	0
Hydropsychidae	Hydropsyche	78	156	22	0	0
Chironomidae	Chironomus	44	26	8	12	36
	Ablabesmyia	533	78	44	4	22
Density (indiv./m^2)		799	355	277	16	58

S1 = Turga upper Dam site, S2 = downstream of Upper dam site, S3: upstream lower Dam site- middle reaches Turga nalla, S4: Reservoir Lower Dam Site and S5: downstream Lower Dam site

9.5.6 Biotic Communities

In post-monsoon season Zooplanktons density ranged from 0- 47 individuals/ litre. Rotifers and Protozoans were the most dominant genera among the zooplankton (Refer **Table-9.5**). In monsoon season it slightly increased to 12 to 53 individuals/ litre. Density of Phytoplankton ranged from 9- 76 and 66 – 850 cells/l in post-monsoon and monsoon seasons, respectively (Table-9.5). During summerseason, most of the communities are absent at Site S1, S2, and S3. However, presence of different communities was observed at site S3 and S4 (reservoir water) due to availability of water. Diatoms were the major constituent accounting for about 38.7-39.8%, whereas other algae account for about 61.3-60.3% of the total biotic communities at S3 and S4 sampling sites. The Phytoplanktonic community was comprised of Cyanophyta, Chlorophyta and Bacillariophyceae (diatoms). Cyanophyta and Chlorophyta formed major part of phytoplankton in post-monsoon season whereas bacillariophyceae showed slightly higher density in monsoon season. Phytobenthic density ranged from 120 to 1280 cells/cm^2 and 205 to 4592 cells/cm^2, in post-monsoon and monsoon seasons, respectively.

Diatoms accounted for 10 - 75 % part of phytobenthic community, while, other algae formed by Cyanophyta and Chlorophyta accounted for 25 – 90 % part in both seasons. Phytobenthos were not collected from the sites S4 and S5 due to lack of suitable substrate. No diatom taxa were recorded from the sites S4 and S5 in planktonic forms during post-monsoon season (Refer **Table-9.5**). The density of macro-invertebrates in Turga river ranged from 1222 – 2055 individuals/m^2 and 0 to 799 individuals/m^2 in post-monsoon and monsoon seasons, respectively.

Table-9.5: Densities and %age composition of different biotic communities in Turga nallah

Sites	**S1**			**S2**			**S3**			**S4**			**S5**		
Parameters/Sites	**PM**	**SS**	**MS**	**PM**	**SS**	**MS**	**PM**	**SS**	**MS**	**PM**	**SS**	**MS**	**PM**	**SS**	**MS**
Zooplankton Density (indiv/ litre)	0	0	44	47	0	53	22	12	22	10	76	29	0	0	12
Phytoplankton Density (cells / litre)	9	0	850	39	0	367	76	93	135	50	1236	157	29	0	67
Bacillariophyceae Density (%)	0	0	54	10	0	52.5	33.3	38.7	51.5	0	39.8	63.5	0	0	59.2
Other Algae (%)	100	0	46	90	0	47.6	66.7	61.3	48.5	100	60.3	36.5	100	0	40.9
Phytobenthos Density (cells/ cm^2)	120	0	1392	657	0	4592	1280	876	233	NC	396	3180	NC	0	205
Macro invertebrate Density (indiv/m^2)	0	0	799	2055	0	277	1222	143	355	-	40	0	-	0	0

Note:- S1 = Turga Dam site upper, S2 = donstream of Upper dam site, S3: upstream lower Dam site, S4: Reservoir Lower Dam Site and S5: downstream Lower Dam site; PM = post-monsoon; SS=Summer Season; M S= monsoon season

9.5.7 Macrophytes

Limited number of macrophyte species were observed at various sampling sites. Occurrence of few species like *Hydrilla, Potamogeton, Polygonum* sp., *Saccharum* sp., and members of poaceae family among grasses were found in the region occurring in the pools and along banks as riparian cover of Lower Dam Reservoir and buffer zone of Turga Nalla. However, no dominant species among macrophyte community was found in the Turga Nalla. This is due to seasonal flow followed by dry season with no flows. The macrophytes species has been found present and some are shown in the Table-9.6 and **Plates 9.1 to 9.6**.

Table-9.6: Riparian and aquatic macrophyte in the Study Area

Family	**Species**
Alismataceae	*Limnophyton sp; Sagittaria sagittifolia*
Amaryllidaceae	*Crinum defixum*
Aponogetonaceae	*Aponogeton natans*
Convolvulaceae	*Ipomoea aquatic*
Hydrocharitaceae	*Hydrilla verticillata; Vallisneria spiralis*
Potamogetonaceae	*Potamogeton perfoliatus; P. natans*
Menyanthaceae	*Nymphoides cristata*
Cyperaceae	*Cyperus exaltatus, C.rotundus; Eleocharis geniculata; Schoenoplectus littoralis*
Poaceae	*Aristida adscensionis; Cenchrus biflorus; Saccharum spontaneum; Sporobolus diander*
Polygonaceae	*Polygonum glabrum*
Salvadoraceae	*Salvadora Oleoides*
Solanaceae	*Datura inoxia*

Turga Nalla flows to Lower dam near village Gossiadih / Pathardih

Lower Dam view and Turga Nalla

Panoramic view of Turga nalla falls and its water flow to Lower Dam

Plate-9.1: Lower Dam Site of Turga Pumped Storage Project

Turga Nalla at submergence end point of Lower Dam –Fall Habitat

Turga Nalla u/s lower dam and d/s upper dam with fall habitat

Plate-9.2: Turga Stream geomorphology and its water fall habitats

Turga Nalla V notch d/s of Upper Dam, Purulia Range Beat Bhagmundi

Plate-9.3: Demarcation of V-Notch site near proposed Upper Dam Axis in Ayodhya Hills

U/s view of Turga Nalla at Upper Dam site –Submergence area

Existing V notch on Turga Nalla near Upper Dam Axis Site

D/s view of Turga Nalla near Upper Dam Site

Plate-9.4: Images taken during Summer Season at proposed Upper Dam Site of Turga Project

Plate-9.5 : D/s of Existing Irrigation Dam, Pathardih

Plate-9.6: Turga nalla morphology d/s of Bhagmundi

9.6 FISHERIES

The fisheries survey was carried out in Turga nallah and its surroundings in view of the environmental impacts of a proposed Turga Pumped Storage Project. Turga is a rainfed river, originating from Ayodhya hills. The Turga nalla flows from north to south, confluences with Kistobazar nalla, which in turn joins west – east flowing Sobha river and finally confluences with Subernrekha river.

Information on the fish and fishery resources from Turga nalla and its surrounding areas was gathered with the help of primary survey and secondary information (Bhatt et al. 2001). Fish were landed with the help of local fishermen from the Turga nalla, reservoir of Lower dam and downstream of reservoir during post-monsoon and monsoon seasons. In addition, local people and fishermen were interviewed to assess the presence of fish species in the area. The Bengali vernacular name of fish species given by respondents were further confirmed from the various sources.

9.6.1 Species Composition

Fish fauna of Turga nalla and its influence area comprises of about 21 species under 11 families (**Table-9.7**), however, as per local information, there are 25 fish species present in the area as listed in **Table-9.8**.

Turga is a small river with shallow bottom, therefore, hardly harbours small species like *Barilius bendelisis*, *Chela cachius*, *Puntius* spp. and *Nemacheilus* spp. Some of the species like *Labeo rohita*, *L. calbasu*, *Catla catla*, *Cirrhinus mrigala*, *Anabas testudineus*, *Badis badis*, etc have been introduced in the reservoir of lower dam (irrigation project). In addition, species like *Puntius* spp. and *Macrognathus aral* (**Plates 9.7 to 9.12**) also inhabit the reservoir. Other species listed in **Tables 9.7** and **9.8** have been reported from the influence area like Kistobazar nalla and Lower dam reservoir

Table-9.7: Fish species composition in Turga Nalla and its influence area

S. No.	Scientific Name	Vernacular Name	Distribution	IUCN Status
	Cyprinidae			
1	*Labeo rohita*	Rohu	Lower Dam Reservoir	LC
2	*Labeo calbasu*	Rohu	Lower Dam Reservoir	LC
3	*Cirrhinus mrigala*	Mrigal	Lower Dam Reservoir	LC
4	*Gibelion catla*	Catla	Lower Dam Reservoir	LC
5	*Puntius sophor*	Puthi	LD-Reservoir/Turga R	LC
6	*Puntius chola*	Puthi	LD-Reservoir/Turga R	LC
7	*Puntius ticto*	Puthi	LD-Reservoir/Turga R	LC
8	*Garra spp.*	Garra fish	LD-Reservoir	LC
9	*Barilius bendelisis*	Korong	Turga Influence area	LC

S. No.	Scientific Name	Vernacular Name	Distribution	IUCN Status
10	*Chela cachius*	-	Influence Area	LC
	Ambassidae			
11	*Chanda / Parambassis ranga*	Glassy fish	Lower dam reservoir	LC
	Balitoridae			
12	*Nemacheilus sp.*	-	Influence area	-
13	*Nemacheilus montanus*	-	Influence area	-
	Cobitidae			
14	*Lepidocephalus guntea*	-	Influence area	LC
	Cichlidae			
15	*Oreochromis mossambicus*	Cichlids	Lower dam reservoir	LC
	Channidae			
16	*Channa punctatus* (Bloch,1793)	Snake head	Lower dam reservoir	LC
	Gobiidae			
17	*Glossogobius giuris*	-	Lower dam reservoir	
	Anabantidae			
18	*Anabas testudineus*	Koi	Reservoir	DD
	Notopteridae			
19	*Notopterus notopterus*	Pupda	Lower dam reservoir	LC
	Nandidae			
20	*Badis badis*	Dum	Reservoir	LC
	Mastacembelidae			
21	*Macrognathus aral*	Bam	Reservoir	

LC = least concerned, DD = data deficient

Table-9.8: Fish Species trophic structure in the study area

S. No.	Fish species /Family	Local Name	Trophic Level®	Threat Status†
	Cyprinidae			
1	*Gibelion catla/* Catla catla (Hamilton,1822)	Catla*	PL	Vu
2	*Cirrhinus mrigala*Ham.-Buch, 1822	Murgol*	BE	LRnt
3	*Cyprinus carpio (Linnaeus, 1758)*	Common Carp*	OM	Vu
4	*Labeo rohu* (Hamilton)	Rohu*	BE	LRlc
5	*Puntius sarana sarana* (Ham-Buch)	Putti*	PL	Vu
6	*Puntius ticto* (Ham.-Buch,1822)	Putty	PL	LRnt
7	*Puntius chola*Ham. - Swamp Barb	Putty	PL	LRnt
8	*Puntius conchonius*	Putty	PL	LRnt
9	Salmostoma bacaila*Ham- Buch, 1822*	Chalya	OM	DD
10	*Salmostoma phulo Ham.*	Chela*		
11	*Chela fasciata / Chela cachius*	Chela*		
12	*Barilius* sp	-*	-	-
13	*Barilius bendelisis*	-*		
	Balitoridae			
14	*Nemacheilus jonatus*	Loach*		
15	*N. montanus*	Loach*		

S. No.	Fish species /Family	Local Name	Trophic Level®	Threat Status†
	Cobitidae			
16	*Lepidocephalus guntea*	Loach*		
	Cichlidae			
17	*Oreochromis mossambicus (Peters, 1852)*	Cichlids		
	Channidae			
18	*Channa marulius* (Hamilton,1822)	Murrel*	CA	VU
19	*Channa punctatus* (Bloch,1793)	Snake head	CA	LRnt
20	*Channa striatus* (Bloch,1793)	Kabra*	CA	LRnt
	Gobiidae			
21	*Glossogobius giuris*(Ham-Buch)	-		
	Ambissidae			
22	*Chanda ranga/ Parambassis ranga*	Indian Glassy fish	CA	LRlc
	Bagridae			
23	*Spearota seengala* (Sykes,1839)	Singhara*	CA	LRnt
	Notopteridae			
24	*Notopterus notopterus* (Pallas,1769)	Pupda*	CA	EN
	Mastacembelidae			
25	*Mastacembalus armatus* (Lacepede)	Bam-eel*	BE	VU

*Note: Reported from secondary information and from locals. Abbr: EN, endangered; VU, vulnerable; DD, data deficient; LRnt , lower risk near threatened; Lr lc, low risk least concern; as per CAMPA, PL, planktivores; BE, benthic feeder; OM, omnivore; CA, carnivore; P, pelagic; G, general; B, benthic.

During post monsoon season, a total of 6 species were observed from different sites. *Puntius* sophore, *Puntius ticto* and *Macrognathus aral* or bam eel were landed from the downstream of the reservoir with the help of local fishermen. *Chela cachius* and *Barilius bendelisis* were found to inhabit Turga nalla and Kistobazar nallah in the catchment. *Puntius ticto* was recorded from the reservoir.

In summerseason, maximum number of catch belonged to *Oreochromus mosambicus*, followed by Puntius sp –small barbs and other trash fishes like Indian Glassy fish (**Tables-9.7 and 9.8**&**Plates-9.7 to 9.12**). A total of 11 fish species were collected from the Study Area as well Lower dam reservoir.

In monsoon season a total of 5 species were observed from the downstream of reservoir, Turga nalla and reservoir. Fish fauna of middle stretch comprised of *Garra* species, *Macrognathus aral* and *Puntius* sophore. Turga nallah harboured *Nemacheilus montanus* and *Puntius* sp. Other species listed in **Tables-9.7 and 9.8** were reported to inhabit reservoir and other wetland of Baghmundi division.

Trophic Structure

The common fish species which are present as *Puntius* spp, *Notopterus* sp.,*Labeo*sp., and *Channa* spp.reported during the study period. The information of fishes was also collected from the published secondary data and from interaction made with local people during field survey. The list of fish species with trophic structure and status is given in the **Table-9.8**. However, the Turga nalla has low diversity due to seasonal flow pattern.

Fish Migration

None of fish species described above performs seasonal migration. Large size fish like *Labeo* spp., *Gibelion* sp., and *Cirrhinus* sp. inhabit reservoir of lower dam, these species have been introduced for the development of fishery. Due to low flow in the feeding tributaries, they do not ascend.

Fisheries Status

Fish resources in Purulia is associated to the livelihood of the people, however, in absence of large rivers in the influence area of Turga Pumped Storage Project, the fishery activities were not prominent. During the field investigation, local fishermen using different gears were found to land fish from the outlet of reservoir of lower dam during post-monsoon, summer and monsoon seasons, respectively. The catch size ranges from 0.4 to 1.2 kg for two hours fishing. Fishermen used cast net to land fish. Organized fishing was observed in the surrounding areas. As per the Fisheries Department (http://purulia.nic.in/distAdmin/departments/fisheries/BlockListFCS.html) at least two societies known as Baghmundi Thana FCS Ltd exist in the Baghmundi division. Under these societies, many fishermen are registered. In addition, Paddy fishery in the Baghmundi area was also observed during the field studies.

Fisherman Community near Lower Dam site

Fisherman using local gears for fishing in Lower Dam Site

Fisherman angling fishes at Lower Dam Side, Gossiadih

Plate-9.7: Fishing gears used by Fishermen for fishing at Lower dam reservoir

Fisherman throwing cast net for fish catch in a village pond near Bhagmundi

Fishermen using local gears for fishing in the Lower dam, Pathardih

Fisherman using hook and rods for fishing at lower dam site, Pathardih

Plate-9.8: Fishing gears used by Fishermen for fishing at Lower dam reservoir & surrounding area water bodies

Channa punctatus

Glossogobius giuris

Pseudambassis ranga

Plate-9.9: Fish catch at Lower dam reservoir, Turga Project

Oreochromis mossambicus

Oreochromis mossambicus

Puntius sarana

Plate-9.10: Fish catch at Lower dam reservoir, Turga Project

Puntiius sp

Glossogobius giuris

Notopterus notopterus

Plate-9.11: Fish catch at Lower dam reservoir, Turga Project

Oreochromis mossambicus

Earthworms: used as fishing bait

Mollscans

Plate-9.12: Fish catch at Lower dam reservoir, Turga Project

CHAPTER-10

PREDICTION OF IMPACTS

10.1 GENERAL

Based on the project details and the baseline environmental status, potential impacts as a result of the construction and operation of the proposed Turga Pumped Storage Project have been identified. 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, otherwise qualitative assessment has been undertaken. The present Chapter covers the anticipated positive as well as negative impacts likely to accrue as a result of construction and operation of the proposed project. The construction and operation phases comprise 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 various project activities and associated potential environmental impacts on various environmental parameters have been identified and summarized in a matrix and the same is outlined in Table-10.1.

Table-10.1: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**									
1.	Site preparation including tree cutting	√				√	√	√	√	
2.	Earthwork and excavation including blasting and drilling	√	√		√	√	√	√	√	
3.	Construction of Upper and Lower dam across river Turga	√		√		√	√	√	√	
4.	Construction of under-ground structure	√	√			√	√		√	
5.	Construction of power house	√	√			√	√		√	
6.	Construction of new roads and widening of existing roads	√				√	√	√	√	

S. No.	Project Activities	Soil & Land	Geology	Hydrology	Water quality	Air quality	Noise	Flora/ Fauna	Employment	Socio-Culture
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 Hydrologic Regime
- Impacts on Sedimentation
- Impacts on Water Quality
- Impacts on Air Environment
- Impacts on Noise Environment
- Impacts on Land Environment
- Impacts on Biological Environment
- Impacts on Socio-Economic Environment

10.2 IMPACTS ON HYDROLOGIC REGIME

The proposed Turga Pumped Storage Project would require filling up of Upper reservoir up to FRL, which would then be used for peaking power. The filling up of reservoir for peaking power operations can lead to drying up of river downstream of dam site. The impact is most severe in lean season. This can lead to significant adverse impacts on downstream riverine ecology. To mitigate the adverse impacts, Environmental flows shall be released for maintaining the aquatic ecology and water quality of river.

As per the norms of Ministry of Environment, Forests & Climate change, the recommended Environmental Flows to be released are as follows:

- **Monsoon Season- May to September** - 30% of the average flows during 90 % dependable year.
- **Non-monsoon Non lean Season- October & April** - 25% of the average flows during 90% dependable year.
- **Lean Season- November to March** - 20% of the average flows during 90% dependable year.

The proposed Turga Pumped Storage Project envisages construction of a Upper Dam and Lower Main and Lower Saddle dam at the existing Irrigation Dam site. The water of Turga nala will be used to fill up the dead storage of Upper reservoir, which has been estimated as 5.9 Mm^3. The gross storage capacity (Dead storage+ Live storage) of Lower Reservoir at FRL will be 18.0 Mm^3.

The water availability in 90% Dependable year (1975) for Upper and Lower Reservoirs is 2.93 Mm^3 and 4.47 Mm^3. Considering inflow for average year, for one unit operation the shortest period will be seventeen(17) months from the starting of impounding activity, if the impounding starts from the beginning of the monsoon season (June) and the longest period will be twenty-four(24) months, if impounding starts from July/August/September/October. It can be said that two (2) monsoon seasons to two (2) years are necessary for one (1) unit operation if the average inflow data is used.

The shortest period for four (4) units operation if the impounding starts from July/ August/September will be thirty eight (38) months, and the longest period for the same will be forty six (46) months if the impounding starts from October/November. It can be state that three and half monsoon seasons are necessary for four (4) units operation.

Once the Upper reservoir is filled up, the same can be used to generate hydropower, which will be stored in the Lower Reservoir and pumped back to Upper Reservoir. This cycle will be repeated on a daily basis. To avoid drying of Turga nala during Upper and Lower Reservoir filling period, suitable arrangements will be kept for environment flow release. The time required for filling up of reservoir impounding is given in Table-10.2.

Table-10.2: Time required for Reservoir Impounding

Year	One unit under operation	Four units under operation
Average Year	17-24 months	38-46 months
Wet Year	13 months	26 months
Dry year	36 months	60 months

The details are given in following paragraphs.

Necessary storage capacity for generating four (4) units

Required live storage capacity

$$Ve' = 197 \times 4 \times 5 \times 60 \times 60 = 14.184 \times 10^6\ m^3 \text{ (At upper and lower reservoirs)}$$

The least necessary storage capacity

$$V(1) = Vd\ (upper) + Vd\ (lower) + Ve' = (5.876 + 3.773 + 14.184) \times 10^6\ m^3$$

$$= 23.833 \times 10^6\ m^3$$

The required periods of reservoir impounding for commencement of the project have been calculated under following conditions.

- Irrigation and other water demand, e.g., from Public Health Engineering Department, etc. required at the downstream of the lower reservoir would be supplied from other water resource during the reservoir impounding of the project.
- Irrigation and other water which must be kept at the upper reservoir would be stored after full (four (4) units) operation of the project

Following three (3) scenarios under difference hydrological conditions (average, wet and dry) are considered to estimate the required period for plant operation.

a) Average Year

By using monthly average inflows to both reservoirs from 1958 to 2012, the required period of reservoir impounding for one (1) unit operation and four (4) units operation were calculated.

The shortest period and the longest period for first unit operation are to start impounding from the beginning of the monsoon season (June), which takes seventeen (17) months, and from July or August or September or October, which takes twenty-four (24) months.

It can be said that two (2) monsoon seasons to two (2) years are necessary for one (1) unit operation if the average inflow data is used.

The shortest period and the longest period for four (4) units operation are to start impounding from July or August or September, which takes thirty-eight (38) months, and from October or November, which takes forty-six (46) months.

It can be said that three and half (3.5) monsoon seasons are necessary for four (4) units operation if the average inflow data is used.

Wet Year

By using monthly inflows to both reservoirs from 1958 to 2012, the shortest required period of reservoir impounding for one (1) unit operation and four (4) units operation were calculated.

The shortest periods for first unit operation and four (4) units operation are to start impounding from August 1995 to August 1996, which takes thirteen (13) months, and from August 1995 to September 1997, which takes twenty-six (26) months.

It can be said that only one (1) year plus one (1) month are enough for one (1) unit operation if the reservoir impounding fortunately starts in the wettest year (the heaviest rainy monsoon year), and two (2) monsoon seasons plus two (2) months are enough for four (4) units operation if impounding fortunately starts at the beginning of successive three (3) wet years.

Dry Year

By using monthly inflows to both reservoirs from 1958 to 2012, the longest required periods of reservoir impounding for one (1) unit operation and four (4) units operation are calculated.

The shortest period for first unit operation and four (4) units operation are to start impounding from August 1975 to July 1978, which takes thirty-six (36) months, and from August 1975 to July 1980, which takes sixty (60) months.

It can be said that three (3) years are necessary for one (1) unit operation and five (5) years are necessary for four (4) units operation if impounding unfortunately starts at the beginning of successive dry years.

The reservoir filling will lead to drying of river Turga. This will lead to adverse impacts on downstream ecology.

Consideration of Environmental Flows

In this study, the impounding schedule is estimated based on the condition that environmental flow can be supplied from other water resources and inflow to upper and low dams can be fully utilized for pumped storage project.

Here, the worst case, that other water resources are not available at all, is examined by estimating how the impounding period becomes longer than the original.

Environmental Flows

Minimum environmental flow release would be 20% of average of four months of lean period and 25% of flow during non-lean non-monsoon period corresponding to 90% dependable year. The cumulative flow releases including spillage during monsoon period shall be 30% of the cumulative inflows during the monsoon period corresponding to 90% dependable year.

Since there is no flow in lean period in this area, the Environmental Flows during monsoon period and non-monsoon period for the Upper Dam are 0.79 (2.63 × 30%) MCM and 0.07 (0.29 × 25%) MCM respectively, and those for the Lower Dam are 1.20 (4.01 × 30%) MCM and 0.11 (0.44 × 25%) MCM respectively. The details are given in Tables-5.3 and 5.4 of this Report.

For Turga Pumped Storage project, the Environmental Flows for Upper and Lower Reservoir are given in Tables-10.3 and 10.4 respectively.

Table-10.3: Recommended Environmental Flows for Upper Reservoir

Month/Season	Flow in 90% DY 1975 (MCM)	Percentage of inflow as Environmental Flow	Environmental Release (MCM)
June	0.11	30%	0.03
July	0.38	30%	0.011
August	0.02	30%	0.006
September	1.55	30%	0.47
October	0.56	30%	0.17
Monsoon (Total)- **(A)**	2.63	30%	0.786
Non-Monsoon (Total)- **(B)**	0.29	25%	0.0725
Annual (A+B)	**2.92 MCM**		**0.8585, say 0.86 MCM**

Table-10.4: Recommended Environmental Flows for Lower Reservoir

Month/Season	Flow in 90% DY 1975 (MCM)	Percentage of inflow as Environmental Flow	Environmental Release (MCM)
June	0.17	30%	0.05
July	0.58	30%	0.17
August	0.04	30%	0.01
September	2.37	30%	0.71
October	0.86	30%	0.26
Monsoon (Total)- **(A)**	4.01	30%	1.20
Non-Monsoon (Total)- **(B)**	0.44	25%	0.11
Annual (A+B)	**4.45 MCM**		**1.31 MCM**

It is considered to release the environmental flow from very beginning of the filling of both the dams, so that environmental and ecological aspects can be sustained. The existing irrigation and drinking water requirements during filling period of reservoirs shall be met by diverting water from other sources e.g., Bamni nala.

Impounding Schedule for Average Year (considering Environmental Flows)

By using monthly average inflows to both reservoirs from 1958 to 2012, the required period of reservoir impounding for one (1) unit operation and four (4) units operation are calculated.

The shortest and the longest periods for first unit operation are to start impounding from August, which takes twenty-five (25) months meaning eight (8) months longer that the original, and from October, which takes thirty-four (34) months meaning ten (10) months longer than the original.

The shortest period and the longest period for four (4) units operation are to start impounding from July or August or September or October, which takes forty-nine (49) months meaning eleven (11) months longer than the original, and from December, which takes fifty-five (55) months meaning nine (9) months longer than the original.

Impounding Schedule for Wet Year (considering Environmental Flows)

The required period of reservoir impounding for one (1) unit operation and four (4) units operation are calculated taking into account environmental flow release against the shortest periods of the original, which start from August 1995, without consideration of environmental flow release.

The start months for first unit operation and four (4) units operation change from thirteen (13) months later to twenty-three (23) months later, which means ten (10) months longer, and from twenty-six (26) months later to thirty-seven (37) months later, which means eleven (11) months longer.

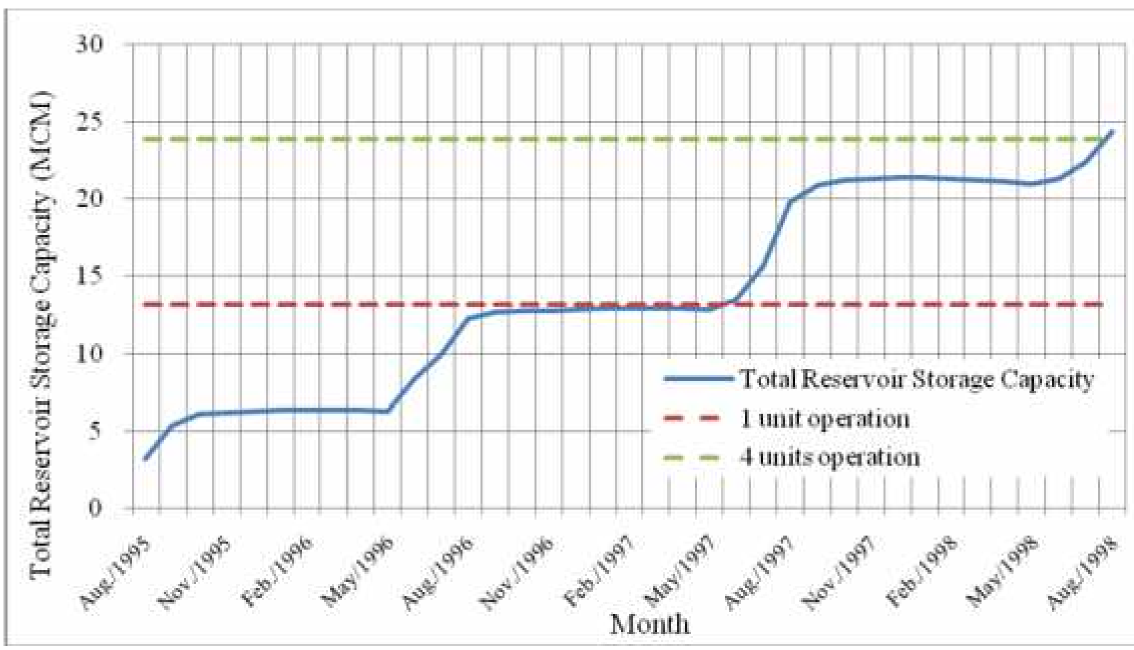


Figure-10.1: Impounding Schedule for Wet Years (with Environmental Flows)

Recommendation

To shorten the reservoir impounding period for the plant operation, it is recommended to consider partial reservoir impounding during the construction works of the dams during the detailed study. As a matter of course, the related rules and regulations to partial impounding must be preserved.

It might be possible to start reservoir impounding during the construction works of embankment at the upper and lower dams under following conditions from technical aspect.

- Construction works of spillway portion of dam is completed
- Construction works of embankment portion reaches to a certain elevation, which can keep a certain overflow depth to discharge a flood
- Reservoir water elevation even during a certain flood would not be permitted to exceed the height of embankment at any time

10.3 IMPACTS OF SEDIMENTATION

In the absence of sediment observed data at the site or nearby, the sediment rate 1045 cum/sq.km./year (1.045 mm/year) has been adopted based on the average sediment rate of Indo-Gangetic Plains-II. The New zero elevation for upper dam after feasible service time (i.e. 70 years) has been computed as 408.2m which is much Lower than the MDDL 448 m by Empirical area reduction method.

The sedimentation studies for Lower Turga Dam could not be carried out by empirical area reduction method due to incomplete reservoir elevation area-capacity of the reservoir which could not be obtained below FRL and the concerned values have been linearly interpolated between 255m to 274.625m. Since the size of the catchment is small, the new zero elevation after feasible service time(i.e. 70 years) has been computed by area increment method as 255.42m which is much below the MDDL. 280m.

10.4 IMPACTS ON WATER ENVIRONMENT

a) Construction phase

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

- Sewage from labour camps/colonies
- Effluent from crushers
- Pollution due to muck disposal
- Effluents from batching plants
- Effluent from Fabrication Units and Workshops

i) Sewage from labour camps/colonies

The project construction is likely to last for a period of 63 months. The peak labour strength likely to be employed during project construction phase is about 800 workers and 200 technical staff. The total increase in population is expected to be about 4,000.

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, also leads to mushrooming of various allied activities to meet the demands of the migrant labour population in the project area.

The domestic water requirement has been estimated as 135 lpcd. Thus, total water requirements work out to 0.54 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 0.43 mld.

It is recommended to commission sewage treatment plant for treatment of sewage generated from labour camps, prior to disposal of sewage.

ii) 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. 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 ton of material crushed. The effluent from the crusher would contain high-suspended solids. 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 Turga.

The effluent from crusher will have suspended solids level of 3000-4000 mg/l. It is recommended to treat the effluent from crushers in settling tank before disposal so as to ameliorate even the marginal impacts likely to accrue on this account.

iii) Pollution due to muck disposal

The major impact on the water quality arises when the muck is disposed along the river bank. The muck will essentially come from the road-building activity, tunneling and other excavation works. The unsorted waste going into the river channel will greatly contribute to the turbidity of water continuously for long time periods. The high turbidity is known to reduce the photosynthetic efficiency of primary producers in the river and as a result, the biological productivity will be greatly reduced. Therefore, the prolonged turbid conditions would have negative impact on the aquatic life. Therefore, muck disposal has to be done in line with the Muck Disposal Plan given in EMP to avoid any negative impact.

iv) 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. It is proposed to treat the effluent before disposal to ameliorate even the marginal impacts likely to accrue on this account.

v) 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 level. It is proposed to treat the effluent in oil & Grease separate unit from fabrication units and workshops prior to disposal.

b) Operation phase

The major sources of water pollution during project operation phase include:

- Effluent from project colony
- Impacts on reservoir water quality

i) 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 existing colony of Purulia Pumped Storage Project (PPSP), with sewage treatment plant and other infrastructure facilities. Hence, problems of water pollution due to disposal of sewage are not anticipated.

ii) Impacts on reservoir water quality

The flooding of previously forest land in the submergence area will increase the availability of nutrients resulting from decomposition of vegetative matter. Phytoplankton productivity can supersaturate the euphotic zone with oxygen before contributing to the accommodation of organic matter in the sediments. Enrichment of impounded water with organic and inorganic nutrients will be the main water quality problem immediately on commencement of the operation. However, this phenomenon is likely to last for a short duration of few years from the filling up of the reservoir. In the proposed project, most of the land coming under reservoir submergence has tree cover. These trees shall be cleared before filling up of the reservoir after initial years of filling will have a diurnal variation of water level from FRL to MDDL in the upper reservoir. Significant variation in water level on a daily basis is also expected in the Lower Reservoir. Thus, due to significant diurnal variations in water level in Upper and Lower reservoirs, re-aeration from natural atmosphere shall take place, which will maintain Dissolved Oxygen in the water body. Thus, in the proposed project, no significant reduction in DO level in water of Upper and Lower Reservoir is anticipated.

10.5 IMPACTS ON AIR ENVIRONMENT

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

- Pollution due to fuel combustion in various equipment
- Emission from various crushers
- Fugitive emissions from various sources.
- Pollution due to increased vehicular movement
- Dust emissions from muck disposal

i) Pollution due to fuel combustion in various equipment

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

ii) Emissions 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 ton 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. It is proposed to treat the effluent from crushers in settling tank before disposal so as to ameliorate even the marginal impacts likely to accrue on this account.

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.

iii) Pollution due to increased vehicular movement

During construction phase, increase in number of vehicles is anticipated for transportation of construction material. The increase in number of vehicles is expected to be a maximum of 20/hour. The impacts on ambient air quality due to increase in vehicular movement is given in Table-10.5.

Table-10.5: Increase in pollutants due to vehicular movement

Distance	PM («g/m^3)	NOx («g/m^3)
100	34.73	0.63
150	30.39	0.55
200	27.01	0.49
250	24.31	0.44
300	20.26	0.36
350	16.21	0.29
400	9.72	0.18
450	8.10	0.15
500	7.37	0.13

It can be concluded from Table-10.5, that no major impacts on ambient air quality is anticipated due to increase in a vehicular movement during construction phase.

iv) Dust emissions 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.

10.6 IMPACTS ON NOISE ENVIRONMENT

a) 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.

i) Impacts due to operation of construction equipment

The noise level due to operation of various construction equipment is given in Table-10.6.

Table-10.6: 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-10.7.

Table-10.7: Increase in noise levels due to operation of various construction equipment

Increase in noise levels due to operation of various construction equipment

Distance (m)	Ambient noise levels dB(A)	Increase in noise level due to construction activities dB(A)	Increase in ambient noise level due to construction activities dB(A)
100	36	45	34
200	36	39	29
500	36	31	25
1000	36	25	25
1500	36	21	24
2000	36	19	24
2500	36	17	24
3000	36	15	24

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-10.8.

Table-10.8: 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 air absorption, rain, atmospheric inhomogeneties and 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.

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 no vehicular movement near the dam site. During construction phase, increase in vehicular movement is expected to increase up to a maximum of 20 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-10.9.

Table-10.9:Increase in noise levels due to increased vehicular movement

Distance (m)	Ambient noise level dB(A)	Increase in noise level due to increased vehicular movement dB(A)	Noise levels due to increased vehicular movement dB(A)	Increase in ambient noise level due to increased vehicular movement dB(A)
10	40	66	66	26
20	40	61	61	21
50	40	55	55	15
100	40	51	51	11

Distance (m)	Ambient noise level dB(A)	Increase in noise level due to increased vehicular movement dB(A)	Noise levels due to increased vehicular movement dB(A)	Increase in ambient noise level due to increased vehicular movement dB(A)
200	40	46	47	7
500	40	40	43	3
1000	40	36	41	1

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 on wildlife.

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-10.10.

Table-10.10: 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

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-10.11.

Table-10.11: 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-10.10) 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.

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. Recommended details of maximum charge /delay to minimise noise due to blasting is given in Table-10.12.

Table-10.12: Noise generation due to blasting with maximum charge/delay

No. of holes	Maximum charge/delay (kg)	Total charge (kg)	Distance (m)	Noise level dB (A)
42	1	42	250	76-85
44	1	44	250	76-86
46	1	46	250	74-85
48	1	48	400	70-75

With the above specifications, noise level due to blasting operations is expected to be of the order of 75-86 dB (A). Since, the nearest settlement is 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 expected to be attenuated by at least 10-20 dB (A). Hence, noise level due to blasting is not expected to cause any significant adverse impact.

10.7 IMPACTS ON LAND ENVIRONMENT

a) Construction phase

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

- Quarrying operations
- Operation of construction equipment
- Soil erosion
- Muck disposal
- Acquisition of land
- Changes in landuse and drainage pattern
- River Bank Stability

Quarrying operations

The estimated requirements of construction material for the project are listed in Table-10.13.

The quantum of construction material available in various quarries is given in Table-10.14.

Table-10.13: Quantities of Construction Material Required

S. No.	Structure	Core Material (Lac m^3)	Filter Material (Lac m^3)	Rockfill Material (Lac m^3)	Fine Aggregate (Lac m^3)	Coarse Aggregate (Lac m^3)
1	Upper Dam	5.50	2.23	28.80	0.21	0.42
2	Lower Dam	-	-	-	3.78	7.55
3	Lower Saddle Dam	2.90	1.40	14.97	-	-
4	Power House and T.H.	-	-	-	0.25	0.50
5	Waterway	-	-	-	0.36	0.72
	Total	**8.4**	**3.63**	**43.77**	**4.60**	**9.19**

Table-10.14: Quantities of Construction Material Available

S. No.	Description	Name of Quarry	Quantity (lakh m^3)
1	Clay	• Jilingtadh • Hathinada • Purana tarpania	1.37 5.85 2.27
		• Kudna • Turga Lower Reservoir • Gosaidih • Drift Area & Bagmundi BA	1.49 0.18 0.73 1.03
2	Rockfill & Filter	• Kudna • Dulgubera	220 10
3	Coarse Aggregate & Fine Aggregate	• Turga • Dulgubera • Malti • Kudna • Hadhadinala	22 10 50 220 75

The quarrying activities could lead to following impacts:

- Creating the pits or quarries requires the removal of virtually all natural vegetation, top soil and subsoil to reach the aggregate underneath. Thus, vegetal cover is lost from quarrying sites.
- Quarrying can disrupt the existing movement of surface water and alter the natural drainage pattern. Engineering activities associated with quarrying can directly change the course of surface water. Pits or depressions created by quarrying can intercept surface water flow.
- Blasting during quarrying is another key adverse impact. Blasting may occur daily or as infrequently. Blasting noise generally increases with the amount of explosive, with specific atmospheric conditions, and with proximity to a blast. The area in front of a blast commonly receives more noise than area behind the blast.
- Earth-moving equipment along with increased vehicular movement are the pother source of noise in quarrying activities. The impacts of noise are highly dependent on the sound source, the topography, land use, ground cover of the surrounding site, and climatic conditions. Topographic barriers or vegetated areas can shield or absorb noise.
- Opening of the quarries will cause visual impacts because they remove some part of the hills. Quarrying operations are semi-mechanized in nature and is normally done by cutting a face of the hill. A permanent scar is likely to be left, once quarrying activities are over.
- With the passage of time, the rock from the exposed face of the quarry under the action of wind and other erosion forces, get slowly weathered and after some time, they become a potential source of landslide.

Thus, it is necessary to implement appropriate slope stabilization measures to prevent the possibility of soil erosion and landslides in the quarry sites.

ii) Operation of construction equipment

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

Various criteria for selection of these sites would be:

- Proximity to the site of use
- Sensitivity of forests in the nearby areas
- Proximity from habitations
- Proximity to drinking water source

Efforts must be made to locate equipments in such a way that the adverse impacts on environment are minimal, i.e. to locate the construction equipment, so that impacts on human and faunal population are minimal.

iii) Soil erosion

The runoff from the construction sites will have a natural tendency to flow towards river Turga. For some distance downstream of major construction sites, such as upper and lower dam, power house, etc. there is a possibility of increased sediment levels which will lead to reduction in light penetration, which in turn could reduces the photosynthetic activity to some extent of the aquatic plants as it depends directly on sunlight. This change is likely to have an adverse impact on the primary biological productivity of the affected stretch of river Turga. However, runoff from construction sites, entering small streams would have significant adverse impact on their water quality. The runoff would increase the turbidity levels with corresponding adverse impacts on photosynthetic action and biological productivity. The impacts on these streams and rivulets thus, would be significant. Adequate measures need to be implemented as a part of EMP to ameliorate this adverse impact to the extent possible.

iv) Muck disposal

The total quantity of muck expected to be generated has been estimated to be of the order of 32 lakh m^3. Considering, 25% swelling factor, the total muck to be handled is 40 lakh m^3. About 5o% material shall be used as construction material Thus, 20 lakh m^3 of muck is planned to be disposed. The component wise detail of muck to be generated and identified zones for accommodating the muck generated is given in Table-10.15.

Table-10.15: Component wise details of muck to be generated

S. No.	Description of Items	Unit	Quantity
a	**DIVERSION CHANNEL(730m long)**		
1	Open Excavation (Soil)	m^3	4200
2	Open Excavation (Rock)	m^3	420
b	**COFFER DAM**		
1	Open Excavation (Soil)	m^3	47530

S. No.	Description of Items	Unit	Quantity
2	Open Excavation (Rock)	m^3	7130
B-LOWER CONCRETE DAM (872 m long & 64m high)			
1	Open Excavation (Soil)	m^3	309773
2	Open Excavation (Rock)	m^3	132760
C-LOWER SADDLE DAM (595 m long & 50 m high)			
1	Open Excavation (Soil)	m^3	75680
2	Open Excavation (Rock)	m^3	88060
E-UPPER ROCKFILL DAM (732 m long & 63.5 m high)			
1	Open Excavation (Soil)	m^3	93400
2	Open Excavation (Rock)	m^3	304852
F-UPPER DAM SPILLWAY			
1	Open Excavation (Soil)	m^3	1350
2	Open Excavation (Rock)	m^3	5008
G-DIVERSION TUNNEL CUM BOTTOM OUTLET			
1	Open Excavation (Soil)	m^3	500
2	Open Excavation (Rock)	m^3	1000
INTAKE			
Inlet Structure			
1	Open Excavation (Soil)	m^3	365580
2	Open Excavation (Rock)	m^3	243720
head race &Penstock including Intake Gate Shaft			
Head race &Penstock			
1	Inclined Shaft Excavation	m^3	32,560
2	Tunnel Excavation (including Upper Penstock)	m^3	140,320
Intake Gate Shaft			
1	Open Excavation (Soil)	m^3	1070
2	Open Excavation (Rock)	m^3	710
INTAKE GATE SHAFT (Underground)			
1	Excavation	m^3	12560
WORK ADIT to HRT			
1	Open Excavation (Soil)	m^3	1150
2	Open Excavation (Rock)	m^3	4590
	Tunnel Excavation	m^3	49070
Work Adit to Lower Penstock			
1	Underground Excavation	m^3	27160
TailRace			
Tail race Tunnel			
1	Tunnel Excavation	m^3	112870
Tailrace gate shaft (Tunnel)			
1	Gate Shaft Excavation	m^3	9610
Work Adit toTRT			
1	Tunnel Excavation	m^3	28380
TailRace Outlet			
outlet Structure			
1	Open Excavation (Soil)	m^3	408640

S. No.	Description of Items	Unit	Quantity
2	Open Excavation (Rock)	m^3	272430
POWER HOUSE			
1	Cavern Excavation	m^3	171010
2	Busbar Excavation	m^3	3580
DRAFT TUNNEL			
1	Tunnel Excavation	m^3	3160
Transformer Cavern			
1	Cavern Excavation	m^3	38180
2	Draft Gate shaft Excavation	m^3	3480
MAT			
1	Open Excavation (Soil)	m^3	6410
2	Open Excavation (Rock)	m^3	25640
3	Tunnel Excavation (UG)	m^3	46460
Top Heading Tunnel to Powerhouse			
1	Tunnel Excavation	m^3	2380
Cable Tunnel & Ventilation Tunnel			
1	Inclined Shaft Excavation	m^3	5720
2	Tunnel Excavation	m^3	1770
Switchyard			
1	Common Excavation	m^3	42540
2	Rock Excavation	m^3	63460
3	Excavation for Foundation	m^3	7370
TOTAL MUCK GENERATED			**3203243**
SWELL Factor @ 25%			4004054
Quantity to be used as Construction material @ 50%			2002027
Quantity to be disposed off			**2002027**
	Say		**20 lacs cum**

The total volume to be disposed is 20 lakh m^3. The muck will be disposed in 3 muck disposal sites, as outlined in Table-10.16. The area of muck disposal sites is 11.04 ha. The capacity of of muck disposal sites 11.04 lakh m^3. The remaining muck (8.96 lakh m^3) will be disposed in Kudna and Dulgubera Quarry areas, which have a total capacity of 9.7 lakh m^3.

Table-10.16: Muck Disposal Area and Capacities

Zone No.	Area (ha)
USP-1	2.20
USP-2	4.32
LSP-2	4.52
Kudna Quarry Area	9.80
Dulgubera Quarry Area	3.25
Total	**24.09**

Muck, if not securely transported and dumped at pre-designated sites, can have serious environmental impacts, such as:

- 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.

The muck disposal sites will be suitably stabilized on completion of the muck disposal. The details of stabilization of muck disposal sites are outlined in Environmental Management Plan covered in Volume-III of this Report.

v) Acquisition of land

The total land required for the project is 292.0 ha. The details are given in Table-10.17. As per the present status, about 234 ha of land is Forest land and the remaining (58 ha) is non-forest government land and /or Private Land. Out of 58 ha of non-forest government land and /or Private Land, 34 ha of land will be transferred from I&W Dte., Govt. of West Bengal to Turga PSP. The remaining 24 ha of land to be arranged temporarily on leased basis.

Table-10.17: Land requirement for proposed project

S. No.	Component	Area (ha)
1.	Upper Reservoir submergence at FRL	87.1
2.	Lower Reservoir submergence at FRL	49.0
3.	Dam site and other structure	13.9
4.	Quarry Site	32.0
5.	Construction facility	15.0
6.	Clay core Area	20.0
7.	Roads	10.0
8.	Stockpile area for construction material, etc.	30.0
9.	Other miscellaneous requirement	35.0
	Total	**292.0**

vi) Impacts due to roads

The project site is located on the west of Purulia district in the state of West Bengal. Access road networks to Purulia are available from all the major cities in the state. Materials required for project construction such as steel and cement have to be transported from the point of source to the site. Similarly construction equipment and machinery are also to be brought to the construction site.

Regarding embankment materials, geotechnical investigation on the prospective borrow areas carried out by CSMRS have confirmed the availability of required quantity and suitable quality within short distance in the project area. On the other hand, natural fine & coarse aggregates required for concrete will be made available from the Quarry areas, located in the close vicinity of the Project Area.

The project can also be approached from Kolkata by an alternate route via Bishnupur, Bankura, Purulia and Balrampur. The distance along this route is 405 km. The other route via. Jamshedpur and Chandil, though longer is considered more suitable for transportation of equipment and materials, as it is along a national highway for major portion of its length.

From Purulia, the district headquarter town, the project site is about 70km away, 30 km from Purulia to Balrampur along NH 32 plus 40 km from Balrampur to site via. Pathardih.

The project area can be reached by road via National Highway No. 6 upto Boharagora, through NH-31 upto Chandil and by NH-32 to Balarampur (Barabhum). The distance from Kolkata to Balarampur by road is around 410 kms. The National High ways are of class 70 R as per IRC (Indian Road Congress) Standard and are capable to carry 70 Tons throughout the country. IRC standard further specified that upto 100 ton can be transported by trailors with multiple wheels

The existing available road from Balarampur to Bagmundi (26km) is of District Board Specification and conforms to State Highway Standard. The balance road stretch of road (approx 1 km) needs to be strengthened.

The largest consignment in the project will be the runner (Dimension tentatively: 6.7 m x 6.7 m x 6.0 m). The existing National Highway and State Highway can accommodate transportation of the consignment easily. However, the balance road of approx. 1 km stretch needs to be strengthened as per Code.

The construction of roads can lead to the following impacts:

- 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

vii) Changes in landuse and drainage pattern

The total land to be acquired for the project is about 292 ha, of which about 136.1 ha of land shall come under submergence at Full Reservoir Level (FRL) of Upper (87.1 ha) and Lower Reservoir (49.0 ha). Thus, land, which at present, is under forests will get converted into a water body (reservoir).

About 155.9 ha shall be acquired for other project appurtenances including dam, water conductor system, switch yard, roads and other project appurtenances. Thus, the pre-project landuse will be converted in to a built-up area.

About 10 ha of land will get converted into roads, i.e., a built-up area. The area to be utilized for muck disposal or for quarrying will be permanently disturbed and will be stabilized or reclaimed, so that it does not lead environmental hazards at a later date.

The labour camps, contractor’s working space will be used temporarily and shall be properly reclaimed on completion of construction activities.

10.8 IMPACTS ON BIOLOGICAL ENVIRONMENT

a) Construction phase

10.8.1 Impacts on Terrestrial flora

i) Increased human interferences

The direct impact of construction activity of any water resource project in a Mountainous terrain is generally limited in the vicinity of the construction sites only. As mentioned earlier, a large population (4,000) including technical staff, workers and other group of people are likely to congregate in the area during the project construction phase. 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 to them. The quantum of wood to be consumed during construction phase, by the labour population is given as below:

*	Average fuel wood consumption	: 20 kg pcd
*	Average population size over Project construction phase	: 3200
*	Average consumption per day	: 640 quintals/day
*	For a construction period of 63 months	: 1,226,400 quintals or 1,66,560 m^3.

* One tree produces about 2.5 m^3 of wood, thus, about 66,600 trees will be required to meet the fuel wood requirements of the labour population, over a construction phase of 63 months.

Hence to minimize impacts, community kitchens using LPG as fuel have been recommended. The details are covered in Environmental Management Plan covered in Volume-III of this Report.

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. Since, labour camps are proposed to be constructed by the contractor along with necessary facilities, such impacts are not envisaged. The details are covered in Environmental Management Plan covered in Volume-II of this Report.

During construction of various components of the project, e.g., submergence area in Upper and Lower Reservoirs, road, upper dam, dam axis, muck disposal, etc., trees will have to be cleared. The tree felling or clearing shall be done by the Forest Department.

Impacts due to Vehicular movement and blasting

Dust is expected to be generated during blasting, vehicle movement for transportation of construction material or construction waste. The dust particles shall settle on the foliage of trees and plants, thereby reduction in amount of sunlight falling on tree foliage. This will reduce the photosynthetic activity. Based on experience in similar settings, the impact is expected to be localized upto a maximum of 50 to 100 m from the source.

Diversion of forest land

During project construction phase, land will be required for location of construction equipment, storage of construction material, muck disposal, widening of existing roads and construction of new project roads. The total land required for the project is 292 ha of which 234 ha is forest land.

As a part of field studies, ecological survey was conducted at various locations in the Study Area. The details of floral species at various sampling sites on land to be acquired are given in Tables-10.19 and 10.20.

Table-10.19: Details of floral species at various sampling sites

Site	No. of tree species	Density (No./ha)	Dominant tree species
Lower dam (Saddle Area, Lower dam site Bagmundi)	3	330	*Butea monosperma, Phoenix sylvestris, Diospyros melanoxylon*
At Upper Dam axis site and its upstream (Tar pania)	16	410	*Shorea robusta, Semecarpus anacardium, Syzygium cumini, Terminalia tomentosa*
Downstream of Upper dam axis site (d/s of Tar pania, middle reach between lower dam to upper dam of Turga Nala)	14	230	*Shorea robusta, Terminalia chebula, Mangifera indica, Wendlandia exserta*

Table-10.20: Details of floral species at various sampling sites

Site	Shrubs	Herbs
Lower dam (Saddle Area, Lower dam site Bagmundi)	*Chromolaena odoratum, Lantana indica, Ipomoea carnea,*	*Melilotus indica, Chrysopogon aciculatus, Mazus delavayi*
At Upper Dam axis site and its upstream (Tar pania)	*Clerodendrum viscosum, Chromolaena odoratum, Cassia tora, Woodfordia fruticosa*	*Oplismenus composites, Desmodium diffusum, Elephantopus scaber Urena lobata, Phyllanthus urinaria*
Downstream of Upper dam axis site (d/s of Tar pania, middle reach between lower dam to upper dam of Turga Nala)	*Clerodendrum viscosum, Lantana indica, Chromolaena odoratum, Combretum decandrum, Strobilanthes pectinatus*	*Desmodium diffusum, Hedyotis thomsoni, Digitaria pedicillaris, Elephantopus scaber*

It can be seen from Table-10.19 that *Butea monosperma, Phoenix sylvestris, Diospyros melanoxylon Shorea robusta, Semecarpus anacardium, Syzygium cumini, Terminalia tomentosa* were the dominant tree species. The tree density in the submergence, dam and power house sites ranged from 230 to 410 per ha. The number of tree species observed at various sites ranged from 3 to 16. Normally in a dense forest, tree density is of the order of 1000-1200 trees/ha. Thus, in forest land to be acquired for the project, the tree density is low.

As per Table-10.20, Amongst shrubs, *Chromolaena odoratum, Lantana indica, Ipomoea carnea, Clerodendrum viscosum, Cassia tora, Woodfordia fruticosa, Combretum decandrum, Strobilanthes pectinatus* were the dominant species.

The dominant herbaceous species (Refer Table-10.20) at various sampling sites were *Melilotus indica, Chrysopogon aciculatus, Mazus delavayi, Oplismenus composites, Desmodium diffusum, Elephantopus scaber Urena lobata, Phyllanthus urinaria.* Thus, no endemic or RET species are reported in the land to be acquired for the project.

Endemic Species

As per Chatterjee (1940) endemic plant taxa from different districts of West Bengal includes species namely *Cadenthera ulginosa* var. *birbhumensis, Cuscuta sharmanum, Hydrocotyle himalaica, Hypericum assamacum* and *Dalbergia duarensis*. Besides these newly described endemic species, some endemic species viz., *Acer osmastonii, Begonia rubella, Calamus inermis, Cymbidium eburnum,* etc. are reported from the extreme Northern boundary of West Bengal. Since entire Purulia district constitute the western undulating uplands and plateau, there is no possibility that these plants may occur in the project area. Thus, no impacts on endemic species is envisaged.

Threatened Flora

The project area is largely a degraded ecosystem due to high human pressure, large scale lopping and removal of fodder and timber species for preparation of agricultural fields, grazing, construction of road, etc. As per Red Data Book of India, no rare and endangered species are reported from the project area. However, Nayar and Sastry (1987-1990) have discussed some rare and endangered plant species viz., *Acer osmastonii, Begonia rubella, B. satrapsis, Calamus inermis, Codonopsis affinis, Cymbidium eburnum, Phoenix rupicola*, etc. from northern part of West Bengal includes Darjeeling, Kurseong, Sewak and Jalpaiguri area. Since these species are distributed above 600 m elevation in northern and southern wet part of West Bengal, hence these species are not observed in the proposed project.

10.8.2 Impacts on Terrestrial fauna

a) Construction phase

Impacts on wildlife

The total land required for the project is 292 ha of which about 136.1 ha comes under submergence, (including river bed). The balance land is required for other project appurtenances. The project area does not lie in path of wildlife movement. Thus, creation of a reservoir due to the proposed project is not expected to cause any significant adverse impact on wildlife movement. The project area and its surroundings are not reported to serve as habitat for wildlife nor do they lie on any known migratory route. Thus, no impacts are anticipated on this account.

Mammalian fauna of the study area comprises of more than 25 species that come from 16 families. The commonly reported species include Jungle Cat, Wild Boar, Grey Mongoose, Brush-tailed Porcupine, Indian Hare, Pangolin, Tree Shrew etc. Most of the species belong to Schedule II, III and IV as per the categorization of Indian wildlife Protection Act. As per IUCN classification, mammal species belonged mainly to Least Concerned category.

Asian Elephant is found in lower reaches and is not reported from the project or its surrounding area.

A total number of 66 species of birds were encountered during field studies. The species belonging to families Anatidae, Ardeidae, Charadridae, Rallidae, Phalacrocoracidae etc were common in lower region in open places and wetland while members of Picidae, Megailaimidae, Strigidae, etc were inhabitants of woody forests in the catchment. Dominant bird species observed during the survey are Blue jay, dove, myna, house crow, house sparrow, lapwing, little egret and grey wagtail etc.

About 66% of the total species found in the study area of proposed project were widespread residents while sparse residents were represented by 3.5%. Widespread resident birds were followed by widespread winter visitor, represented by 17.4% of the total species. Among Summer visitor species like Common Sandpiper (*Actitis hypoleucos*), Green Sandpiper (*Tringa ochropus*), Little Cormorant (*Phalacrocorax niger*), Indian Golden Oriole (*Oriolus kundoo*), Red-breasted Flycatcher (*Ficedula parva*) and Grey-backed Shrike (*Lanius tephronotus*). Most common species recorded from the different sites of study area were *Francolinus pondicerianus*, *Megalaima haemacephala*, *Psittacula eupatria*, *Centropus sinensis*, *Dicrurus macrocercus*, *Dendrocitta vagabunda*, *Chloropsis cochinchinensis*, *Sturnus pagodarum*, *Phylloscopus fuligiventer* and *Turdoides striatus*. Mopst of the avi-faunal species belonged to Least Concerned Cateegory as per IUCN classification.

The agriculture fields in the study area provides ideal habitat for many snakes and reptiles. Reptiles such as cobra, and python were found occasionally in the dense vegetation areas as narrated by local people. Monitor Lizard was observed along the roadside during the survey. Out of Seven species of reptiles recorded, three species of lizard i.e *Hemidactylis* sp (House lizard) and *Calotes* sp (Garden lizard) are common in occurrence. Majority of the species are categorized as ‘Least Concerned’ as per IUCN criterion. Cobra is protected under schedule II of Indian Wildlife Protection Act (1972). None of the reptile species is present in the IUCN Red List of threatened animals (2014).

Thus, considering the fact that most of the faunal species belonged to least concerned category as per IUCN classification or category III and IV as per Indian Wildlife Protection Act (1972). Thus, significant adverse impacts on fauna is not anticipated.

Impacts due to construction activities

During construction period, 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 the construction phase, accessibility to area will lead to influx of workers and the people associated with the allied activities from outside will also increase. Increase in human interference could have an impact on terrestrial ecosystem. The other major impact could be the blasting to be carried out during construction phase. This impact needs to be mitigated by adopting controlled blasting and strict surveillance regime and the same is proposed to be used in the project. This will reduce the noise level and vibrations due to blasting to a great extent.

Likewise, siting of construction equipment, godowns, stores, labour camps, etc. may generally disturb the fauna in the area. Thus, impacts on this account are not expected to be significant. 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. The same have been suggested as a part of the Environmental Management Plan (EMP).

Impacts on avi-fauna due to construction of reservoir

The project area and its surroundings are quite rich in avi-fauna. The construction of Upper and Lower dams, a total reservoir area of about 136.1 ha will be created, with quiescent/tranquil conditions. The reservoir banks will have wet environment throughout the year which can lead to proliferation of vegetation e.g. grass, etc. along the reservoir banks. Such conditions are generally ideal for various kinds of birds, especially, water birds. This is expected to increase the avi-faunal population of the area.

b) Operation phase

i) 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. The increased accessibility to the area can lead to increased human interferences. However, considering, the manpower requirement in project operation phase, increase in human population is not expected to be significant. The manpower in project operation phase will be living in project colony, with all the modern amenities. Thus, pressure due to this project personnel on the forests of the area is not expected to be significant.

10.8.3 Aquatic Flora

a) Construction phase

During construction phase wastewater mostly from domestic source will be discharged mostly from various camps of workers actively engaged in the project area. Around 0.54 mld of water is required for the workers during the peak construction phase out of which 80% (i.e. about 0.43 mld) will be discharged back as wastes, more or less as a point sources from various congregation sites where workers will reside. Appropriate sewage treatment measures will be commissioned so as to avoid adverse impacts on riverine ecology.

b) Operation phase

The completion of the proposed Turga Pumped Storage Project would bring about significant changes in the riverine ecology during initial phases of reservoir impoundment, as it can lead to drying of river Turga downstream of Upper and Lower Reservoirs. It is proposed to release Environmental flows as per the norms of Ministry of Environment, Forests & Climate Change (MOEF&CC) to mitigate the adverse impacts on rivering ecology during reservoir impoundment.

On completion of reservoir filling, during project operation phase, the water stored in the upper Reservoir will be used for peaking power generation. The water will be stored in the Lower Reservoir and pumped back to Upper reservoir during non-peak hours. Thus, water flowing in river Turga will be allowed to be released during project operation phase.

The construction of upper and lower reservoir will transform a river from 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 perish as a result of increase in depth.

10.8.4 Impacts on Aquatic Fauna

Construction phase

Impacts due to extraction of construction material

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

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

The cumulative impact of all the above operations is increase in turbidity levels. Good dredging practices can however, minimize turbidity. The dredging and deposition of dredged material may affect the survival and propagation of benthic organisms. The macro-benthic life which remains attached to the stones, boulders etc. gets dislodged and is carried away downstream by turbulent flow. The areas from where construction material is excavated, benthic fauna gets destroyed. In due course of time, however, the area gets recolonized, with fresh benthic fauna. The density and diversity of benthic fauna, will however, be less as compared with the pre-dredging levels.

Impacts due to human activities

Accumulation of labour force in the project area might result in enhancement in indiscriminate fishing including use of explosives. The use of explosive material to kill fishes in the river in the project area would result in complete loss of fishes and other aquatic life making a river stretch completely barren. Indiscriminate fishing will reduce fish stock availability for commercial and sport fishermen. These aspects have been adequately covered in the Environmental Management Plan (EMP) outlined Volume-III of this Report.

(b) Operation Phase

Impacts on Fisheries

During post monsoon season, a total of 6 species i.e. *Puntius* sophore, *Puntius ticto, Macrognathus aral, Chela cachius, Barilius bendelisis and Puntius ticto* were observed.

In summer season, maximum number of catch belonged to *Oreochromus mosambicus*, followed by Puntius sp –small barbs and other trash fishes like Indian Glassy fish. A total of 11 fish species were collected from the Study Area as well Lower dam reservoir.

In monsoon season a total of 5 species were observed from the downstream of reservoir, Turga nalla and reservoir. Fish fauna of middle stretch comprised of *Garra* species, *Macrognathus aral* and *Puntius* sophore. Turga nallah harboured *Nemacheilus montanus* and *Puntius* sp. The species were reported from the lower reservoir.

The Turga nalla has low diversity due to seasonal flow pattern. The area at Upper dam site is devoid of fish species that is related to habitat structures, and seasonal flow though water at downstream area till the Turga gets some overflow water from the other existing Purulia Pumped Storage Project and flows in to the Lower Dam reservoir at Gossaidih /Pathardih, which supports comparatively better diversity. In project operation phase, due to presence of water, fish species reported in Lower Reservoir are expected to be observed in Upper Reservoir. The list of these species is given in Table-10.21.

Table-10.21: List Fish species likely to develop in reservoirs of Upper and Lower Dams in project operation phase

S. No.	Scientific Name	Vernacular Name	IUCN Status
	Cyprinidae		
1	*Labeo rohita*	Rohu	Least Concerned
2	*Labeo calbasu*	Rohu	Least Concerned
3	*Cirrhinus mrigala*	Mrigal	Least Concerned
4	*Gibelion catla*	Catla	Least Concerned
5	*Puntius sophor*	Puthi	Least Concerned
6	*Puntius chola*	Puthi	Least Concerned
7	*Puntius ticto*	Puthi	Least Concerned
8	*Garra spp.*	Garra fish	Least Concerned
	Ambassidae		
9	*Chanda / Parambassis ranga*	Glassy fish	Least Concerned
	Cichlidae		
10	*Oreochromis mossambicus*	Cichlids	Least Concerned
	Channidae		

S. No.	Scientific Name	Vernacular Name	IUCN Status
11	*Channa punctatus* (Bloch,1793)	Snake head	Least Concerned
	Gobiidae		
12	*Glossogobius giuris*	-	Least Concerned
	Notopteridae		
13	*Notopterus notopterus*	Pupda	Least Concerned

Impacts on Migratory Fish Species

Migratory fish species are not reported in river Turga, as it is seasonal in nature. Thus, no impact on migratory fish species is expected due to the proposed project.

SPE(C)
PL f/ch (2F1)
Sh/ail

No. J-12011/13/2013-IA-I
Ministry of Environment & Forests
Government of India
(IA-I Division)

Paryavaran Bhawan
CGO Complex, Lodi Road
New Delhi – 110 003

Date: 4th November, 2013

To

① CE-in-Charge/PSPD
07/11/13
② SPE(C)
11.11.13

The Chief Engineer
M/s. West Bengal State Electricity Company Ltd
Plannin Investigation & Design Department
Vidyut Bhavan
5th Floor, Block-DJ, Sector-II
Salt Lake
Kolkata- 700 091

Subject: Turga Pumped Storage (1000 MW) project in Purulia District of West Bengal by M/s. West Bengal State Electricity Distribution Company Ltd – TOR – regarding.

Sir,

This is with reference to your letter no. PIDD/Environment/Turga PSP/61/18 dated 10.4.2013 on the above mentioned subject.

2. The said proposal has been examined by the Expert Appraisal Committee (EAC) for River Valley & Hydroelectric Projects in its meeting held on 23-24th September, 2013. The comments and observations of EAC may be seen in the Minutes of the said meetings, which are available on the website of this Ministry.

3. It is noted that the project envisages construction of a 79 m (from bed level) high rock-fill upper dam with central impervious clay core and a 69 m (from bed level) high earthen dam with central impervious clay core constructed by raising existing irrigation dam across River Turga to generate 1000 MW of hydropower. The total land requirement for the project is 292 ha. Out of this 200.31 ha is forest land. The total submergence area is about 136.61 ha. The catchment area of upper dam site is 4.2 Sq. Km and 13.72 Sq. Km at lower dam site. An underground powerhouse is proposed 4 units of 250 MW each. Total cost of the project is about Rs. 2585.16 Crores.

4. Based on the recommendations of the EAC, the Ministry of Environment & Forests hereby accords clearance for pre-construction activities at the proposed site as per the provisions of the Environmental Impact Assessment Notification, 2006 and its subsequent amendment, 2009 along with the following additional Terms of Reference (TOR) for preparation of EIA/EMP report. The EIA/EMP report should contain the information in accordance with provisions & stipulations as given in the **Annexure-I**. While preparing the EIA/EMP report prevailing norms shall be strictly followed specially with respect to environmental flows and muck disposal sites and management plans. The additional TORs prescribed are as follows:

i. A table of 10 daily water discharge in 90% dependable year showing the intercepted discharge at the dam, the environmental and other flow releases downstream of the dam and spill are to be provided in hydrology chapter of the EIA.

ii. A site-specific study to be carried-out for establishing the proper environmental flow release during monsoon, non-monsoon/non-lean and lean months. Environmental flow must mimic the pre-dam flow pattern of the river for sustaining the aquatic bio-diversity together with downstream user need and accordingly, water withdrawal for power generation is to be regulated. Minimum environmental flow release would be 20% of average of four months of lean period and 25% of flows during non-lean non-monsoon period corresponding to 90% Dependable year. The cumulative flow releases including spillage during monsoon period should be about 30% of the cumulative inflows during the monsoon period corresponding to 90% dependable year.

iii. Biodiversity study is to be carried-out by associating a reputed organization to be recommended either by WII, Dehradun or by ICFRE, Dehradun.

iv. Cumulative impact of upstream/downstream projects is to be taken into account, if any.

v. A detailed study needs to be undertaken and detailed Biodiversity Conservation & Management Plan should be made in EMP.

vi. **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. Provision for early warning systems should be provided.

vii. The Resettlement & Rehabilitation plan should as per the latest norms and R&R Plan, 2007 should be followed. The committee also suggested that the project proponent should also keep in mind the land reforms act of Government of India, if it is enacted in R&R Plan. Empowerment of local community in the project activities should be ensured.

5. The Consultant engaged/ to be 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. This is a prerequisite for consultants to be engaged.

6. The Consultants shall include a "Certificate" in EIA/EMP report regarding portion of EIA/EMP prepared by them and data provided by other organization(s)/laboratories status of approval of such laboratories.

7. The draft EIA/EMP report prepared as per the above Terms of References should be submitted to the State Pollution Control Board/Committee concerned for conducting Public Hearing /Consultation as per the provisions stipulated in EIA Notification of 2006.

8. All issues discussed in the Public Hearing/Consultations should be addressed and incorporated in the EIA/EMP Report. Final EIA/EMP report should be submitted to the Ministry for Environmental Clearance only after incorporating these issues.

9. The TOR will remain valid for a period of 3 years from the date of issue of this letter for submission of EIA/EMP report along with public consultation.

10. In case of any change in the Scope of the Project such as capacity enhancement, shifting of dam site/powerhouse and change in submergence etc., fresh scoping clearance has to be obtained by the project proponent.

11. Information pertaining to Corporate Environmental Responsibility and Environmental Policy shall be provided in the EIA/EMP Report as per this Ministry's circular dated 19.5.2012.

12. The Project Proponent shall also follow the instructions contained in MoEF's letter No. J-11013/41/2006-IA-II (I) dated 4.8.2009 and OM No.J-11013/1/2013-IA-I dated 28.5.2013 for preparing and submission of EIA/EMP reports.

13. This has approval of the Competent Authority.

Yours faithfully,

(B. B. Barman)
Director

Copy to:

1. Secretary, Ministry of Power, Shram Shakti Bhawan, Rafi Marg, New Delhi- 1.
2. The Advisor (Power), Planning Commission, Yojna Bhawan, New Delhi-110001.
3. The Principal Secretary, Department of Power & Non Conventional Energy Sources Government of West Bengal, New Secretariat Buildings, 7th Floor, 1, K.S. Roy Road Kolkata - 700 001
4. The Secretary, Department of Environment, Government of West Bengal, FD-415/A, Sector-III, Poura Bhavan, 4th Floor, Bidhannagar, Kolkata – 700 106.
5. The Chief Engineer, Project Appraisal Directorate, Central Electricity Authority, Sewa Bhawan, R. K. Puram, New Delhi- 110066
6. The CCF, Regional Office (EZ), Ministry of Environment & Forests, A/3, Chandersekharpur, Bhubaneswar – 751 023
7. The Member Secretary, West Bengal Pollution Control Board Paribesh Bhavan, 10A, Block-L.A., Sector III, Salt Lake City, Calcutta - 700 098
8. EI Division, Ministry of Environment & Forests, New Delhi-110 003
9. NIC Cell – request to upload on the MoEF website
10. PS to JS (MS)/ Director (BB)/ PVS Rao (Sci. B)
11. Guard File.

(B. B. Barman)
Director

Annexure-II

Monthly Inflows at Turga Upper Dam (C.A. 8.29 Sq. Km)							MCM	
Year	June	July	Aug	Sep	Oct	Monsoon Total	Non Monsoon	Annual
1958	0.11	1.17	0.79	1.70	0.63	4.40	0.48	4.88
1959	0.10	1.15	0.78	1.20	0.78	4.00	0.44	4.44
1960	0.01	0.67	1.63	1.20	0.54	4.05	0.45	4.50
1961	0.57	0.01	0.94	1.75	0.87	4.14	0.46	4.60
1962	0.12	0.80	1.08	1.44	0.62	4.06	0.45	4.50
1963	0.14	0.93	1.45	1.15	0.63	4.29	0.47	4.77
1964	0.26	1.34	1.55	1.25	0.57	4.97	0.55	5.52
1965	0.13	1.39	1.32	0.67	0.33	3.85	0.42	4.27
1966	0.44	0.00	0.88	0.65	0.37	2.34	0.26	2.59
1967	0.00	0.00	1.74	3.10	0.87	5.71	0.63	6.34
1968	0.33	1.48	1.94	0.46	0.27	4.47	0.49	4.96
1969	0.00	0.53	0.60	1.14	0.40	2.66	0.29	2.95
1970	0.16	1.08	0.96	1.94	0.69	4.82	0.53	5.35
1971	0.50	1.20	2.30	0.77	0.39	5.16	0.57	5.73
1972	0.00	0.38	1.67	0.84	0.43	3.32	0.37	3.68
1973	0.08	0.99	1.05	1.35	0.67	4.14	0.46	4.60
1974	0.00	1.95	1.06	1.20	0.42	4.63	0.51	5.14
1975	0.11	0.38	0.02	1.55	0.56	2.63	0.29	2.92
1976	0.00	0.32	0.01	1.29	0.44	2.06	0.23	2.29
1977	0.36	0.78	0.54	0.86	0.36	2.90	0.32	3.22
1978	0.39	0.40	1.19	1.61	0.68	4.28	0.47	4.75
1979	0.18	0.63	0.69	0.63	0.34	2.47	0.27	2.74
1980	0.12	1.38	0.75	0.99	0.51	3.75	0.41	4.16
1981	0.14	1.22	1.24	1.09	0.38	4.08	0.45	4.53
1982	0.16	0.41	1.01	0.65	0.43	2.65	0.29	2.94
1983	0.06	0.71	0.82	1.63	0.68	3.89	0.43	4.32
1984	1.35	0.38	1.88	0.87	0.43	4.91	0.54	5.45
1985	0.18	1.36	1.49	1.60	0.82	5.45	0.60	6.05
1986	0.27	0.61	1.60	1.45	0.61	4.55	0.50	5.05
1987	0.06	1.28	1.45	1.24	0.45	4.48	0.49	4.97
1988	0.92	0.31	0.60	1.07	0.39	3.28	0.36	3.64
1989	0.51	0.79	1.46	1.07	0.42	4.24	0.47	4.71
1990	0.54	2.13	0.69	1.45	0.58	5.39	0.59	5.98
1991	0.00	0.90	1.74	0.89	0.35	3.88	0.43	4.31
1992	0.12	0.68	1.05	1.92	0.62	4.39	0.48	4.88
1993	0.42	0.37	0.57	1.73	0.69	3.78	0.42	4.19
1994	0.92	1.40	1.15	0.87	0.48	4.83	0.53	5.36
1995	0.26	0.88	2.09	1.69	0.66	5.59	0.62	6.21
1996	1.06	0.91	1.41	0.69	0.30	4.37	0.48	4.85
1997	0.32	1.24	2.47	1.05	0.43	5.50	0.61	6.11
1998	0.23	0.74	1.04	1.11	0.48	3.60	0.40	4.00
1999	0.41	1.15	1.62	1.41	0.58	5.17	0.57	5.74
2000	0.14	0.52	0.72	0.95	0.42	2.75	0.30	3.05
2001	0.66	0.99	0.87	0.66	0.30	3.47	0.38	3.85
2002	0.71	0.17	1.34	0.83	0.47	3.52	0.39	3.91
2003	0.00	0.49	1.28	0.75	0.56	3.08	0.34	3.42
2004	0.00	0.43	1.66	0.75	0.42	3.27	0.36	3.63
2005	0.03	0.79	0.70	0.82	0.41	2.75	0.30	3.06
2006	0.19	0.80	0.87	1.07	0.40	3.34	0.37	3.70
2007	0.09	1.80	1.44	1.44	0.48	5.25	0.58	5.82
2008	0.90	1.76	1.09	0.84	0.32	4.91	0.54	5.45
2009	0.00	0.95	1.13	1.56	0.55	4.19	0.46	4.65
2010	0.05	0.26	0.40	0.97	0.39	2.06	0.23	2.29
2011	1.07	0.52	2.59	1.26	0.48	5.92	0.65	6.58
2012	0.28	1.46	1.53	1.78	0.55	5.61	0.62	6.22
Average	**0.29**	**0.86**	**1.20**	**1.20**	**0.51**	**4.06**	**0.45**	**4.51**

Annexure-III

Monthly Inflows at Turga Lower Dam (C.A. 12.66 Sq. Km) MCM								
Year	**June**	**July**	**Aug**	**Sep**	**Oct**	**Monsoon Total**	**Non Monsoon Total**	**Annual**
1958	0.16	1.79	1.21	2.59	0.96	6.71	0.74	7.45
1959	0.16	1.76	1.19	1.83	1.18	6.11	0.67	6.78
1960	0.01	1.03	2.49	1.83	0.82	6.18	0.68	6.86
1961	0.88	0.02	1.43	2.67	1.32	6.32	0.70	7.02
1962	0.19	1.23	1.65	2.19	0.94	6.20	0.68	6.88
1963	0.21	1.42	2.21	1.76	0.96	6.56	0.72	7.28
1964	0.40	2.05	2.36	1.91	0.86	7.59	0.83	8.43
1965	0.20	2.12	2.02	1.03	0.51	5.88	0.65	6.52
1966	0.66	0.00	1.34	0.99	0.57	3.57	0.39	3.96
1967	0.00	0.00	2.66	4.73	1.32	8.72	0.96	9.68
1968	0.51	2.26	2.96	0.70	0.41	6.82	0.75	7.57
1969	0.00	0.80	0.91	1.74	0.60	4.06	0.45	4.51
1970	0.25	1.64	1.46	2.96	1.05	7.36	0.81	8.17
1971	0.77	1.84	3.51	1.18	0.59	7.88	0.87	8.74
1972	0.00	0.58	2.55	1.29	0.66	5.07	0.56	5.63
1973	0.12	1.51	1.61	2.06	1.02	6.33	0.70	7.02
1974	0.00	2.97	1.62	1.83	0.65	7.07	0.78	7.84
1975	0.17	0.58	0.04	2.37	0.86	4.01	0.44	4.45
1976	0.00	0.49	0.02	1.96	0.67	3.15	0.35	3.50
1977	0.56	1.19	0.82	1.31	0.56	4.43	0.49	4.92
1978	0.59	0.61	1.82	2.46	1.05	6.53	0.72	7.25
1979	0.28	0.96	1.06	0.96	0.52	3.77	0.41	4.18
1980	0.18	2.11	1.14	1.51	0.78	5.73	0.63	6.35
1981	0.22	1.87	1.90	1.67	0.58	6.23	0.69	6.92
1982	0.24	0.62	1.54	0.99	0.65	4.05	0.44	4.49
1983	0.09	1.08	1.26	2.48	1.03	5.95	0.65	6.60
1984	2.06	0.58	2.87	1.33	0.66	7.50	0.83	8.33
1985	0.27	2.07	2.27	2.45	1.26	8.32	0.92	9.23
1986	0.42	0.93	2.44	2.21	0.94	6.95	0.76	7.71
1987	0.10	1.96	2.21	1.90	0.68	6.84	0.75	7.60
1988	1.40	0.47	0.92	1.63	0.59	5.01	0.55	5.56
1989	0.78	1.20	2.22	1.63	0.64	6.47	0.71	7.19
1990	0.82	3.25	1.06	2.21	0.89	8.23	0.91	9.14
1991	0.00	1.37	2.65	1.37	0.54	5.93	0.65	6.58
1992	0.19	1.04	1.60	2.94	0.95	6.71	0.74	7.45
1993	0.65	0.56	0.87	2.64	1.05	5.77	0.63	6.41
1994	1.40	2.14	1.76	1.33	0.73	7.37	0.81	8.18
1995	0.40	1.35	3.19	2.59	1.01	8.54	0.94	9.48
1996	1.61	1.40	2.16	1.05	0.45	6.67	0.73	7.40
1997	0.48	1.89	3.78	1.60	0.66	8.40	0.92	9.33
1998	0.35	1.14	1.58	1.70	0.73	5.50	0.60	6.10
1999	0.62	1.75	2.47	2.16	0.89	7.89	0.87	8.76
2000	0.21	0.80	1.10	1.45	0.64	4.19	0.46	4.65
2001	1.01	1.51	1.32	1.00	0.45	5.30	0.58	5.88
2002	1.09	0.26	2.05	1.27	0.71	5.38	0.59	5.97
2003	0.00	0.75	1.96	1.15	0.85	4.71	0.52	5.23
2004	0.00	0.66	2.54	1.14	0.65	4.99	0.55	5.54
2005	0.05	1.21	1.06	1.25	0.63	4.20	0.46	4.67
2006	0.30	1.22	1.33	1.63	0.61	5.10	0.56	5.66
2007	0.13	2.75	2.20	2.20	0.73	8.01	0.88	8.90
2008	1.38	2.68	1.67	1.28	0.49	7.49	0.82	8.32
2009	0.00	1.45	1.73	2.38	0.84	6.40	0.70	7.11
2010	0.08	0.40	0.61	1.48	0.59	3.15	0.35	3.50
2011	1.63	0.80	3.96	1.92	0.73	9.05	1.00	10.04
2012	0.43	2.23	2.34	2.72	0.84	8.56	0.94	9.50
Average	**0.45**	**1.32**	**1.83**	**1.83**	**0.77**	**6.20**	**0.68**	**6.88**

Annexure-IV

TURGA DAM PROJECT (WEST BENGAL)

(A) Physiographic parameters

Table -1

Parameter	Value	
A	12.66	km^2
L	7.90	km
Lc	3.50	km
S	43.41	m/km
H	319	m

(B) Time of concentration tc

By Kirpich Formula

tc = 0.000324*L^0.77*S^-0.385
= **1.12** hour

By California Formula

tc = (0.87L^3/H)^0.385
= **0.52** hour

By Bhatnagar Formula

tc = (L^3/H)^0.345
= **1.16** hour

As time of concentration is about 1.1 hour, Rational Formula has been used.

(C) PMP computations

1 day SPS = 565 mm

(As per latest PMP atlas Mahanadi & adjoining river basin)

MAF = 1.3

1 day PMP = 735 mm

24 hour PMP =785 mm

One hour PMP depth considering 12 hour storm (785X0.695X0.225) = 122.75 mm/hour

(As per tables 3-36 & 3-38 of latest PMP atlas Mahanadi & adjoining river basins)

(D) Flood Estimation by Rational formula

Q = 0.278CIA

Where,

C is runoff coefficient taken as 1

I is rainfall intensity (mm/h)

A is the catchment area in sqkm

Loss rate 1.5 mm/hour (from FER subzone 1(g))

i) **Flood estimation for Lower Turga project**

Net Rain fall intensity	=	121.25 mm/h
A	=	12.66 sqkm
Q	=	426.74 Cumec
Base flow	=	0.63 Cumec
Total Discharge	=	**427.37** Cumec

ii) **Flood estimation for Upper Turga project**

Net Rain fall intensity	=	121.25 mm/h
A	=	8.29 sqkm
Q	=	279.44 Cumec
Base flow	=	0.42 Cumec
Total Discharge	=	**279.86** Cumec

वाप्कोस लिमिटेड
WAPCOS LIMITED
(भारत सरकार का उपक्रम)
जल संसाधन, नदी विकास व गंगा संरक्षण मंत्रालय
(A Government of India Undertaking)
Ministry of Water Resources, River Development & Ganga Rejuvenation

Date: 27.11.2015

UNDERTAKING

As per MoEF Office Memorandum no. J-11013/41/2006/-IA-III, dated 5th October, 2011, M/s. WAPCOS Limited, Gurgaon, Haryana herewith declares ownership of the contents (information and data) of the EIA Study for Turga Pumped Storage Project, West Bengal.

27/11/15

(Authorised Signatory)

डॉ. अमन शर्मा/ Dr. Aman Sharma
वरि. महा प्रबंधक (गंगा संरक्षण एवं पर्यावरण)
Sr. General Manager (Ganga Rejuvenation & Envt.)
वाप्कोस लिमिटेड / WAPCOS LIMITED
(भारत सरकार का उपक्रम/A Govt. of India Undertaking)
76-सी, सैक्टर -18, गुड़गाँव -122015 (हरि.)
76 - C, Sector - 18, Gurgaon -122015 (Hr.)

76-C, Institutional Area, Sector - 18, Gurgaon - 122 015 (Haryana), INDIA
Tel. : +91-124-2399421 (16 Lines) Fax : +91-124-2397392
E-mail : ho@wapcos.gov.in ; mail@wapcos.gov.in Website : http://www.wapcos.gov.in
CIN NO. U74899DL1969G01005070

Accreditation Certificate of the EIA consultant as per the office memorandum issues by MOEF, GOI

NABET

National Accreditation Board
for Education and Training

NABET/EIA/RA068/085

Oct 09, 2015

Chairman cum Managing Director
WAPCOS Limited (A Government of India Undertaking)
Plot-76-C, Sector-18, Gurgaon – 122015, Haryana
(Kind Attention: Mr. R.K. Gupta)

Dear Sir,

Sub: Re-Accreditation

This has reference to your application to QCI-NABET for re-accreditation (RA) as EIA Consultant Organization and the assessment carried for same in your organization from Apr. 07-09, 2015.

We are pleased to inform you that based on the document and office assessments during RA, the Accreditation Committee has approved renewal of accreditation given to your organization for a period of three years from **Apt. 09, 2015 to Apr. 08, 2018** subject to coverage of balance Functional areas and specific response to NCs/Obs./Alerts issued, if applicable (Refer Annexure III) with the following details:

1. Annexure I - Scope of accreditation
2. Annexure II - List of experts with approved sectors/ functional areas
3. Annexure III - Non-Conformances/ Observations/ Alerts (NCs/ Obs./ Alerts)
4. Annexure IV - Observations on Quality Management System (QMS)
5. Annexure V - Terms and conditions of accreditation
6. Annexure VI - Result of assessment
7. Annexure VII - Guidelines for addressing Major Non-Conformances/ Observations/ Alerts
8. Annexure VIII - Format to be followed for mentioning the names of the experts involved in EIA reports prepared by **WAPCOS Limited.**

Result of RA including Non-Conformances/ Observations/ Alerts (NCs/ Obs./ Alerts) applicable to your organization as per RA are also posted on QCI website vide minutes of the Accreditation Committee meetings dated June 10, 2015. You are requested to take necessary actions to close the NCs/ Obs. as per guidelines and timeframe mentioned in Annexure VII of this letter. You are also advised to review eligibility of organization as per Version 3 of the Scheme (posted on NABET website) which has become effective from Sep 1, 2015 and meet its requirements by Dec. 31, 2015 positively.

You are required to make all payments to NABET as applicable, within one month from the date of invoice sent to you. Continuation of this accreditation of your organization is subject to the clearance of all dues by your organization, satisfactory compliance to Annexure III and V.

With best regards,

Yours sincerely,

(Abhay Sharma)
Assistant Director

Institution of Engineers Building, 2nd Floor, Bahadur Shah Zafar Marg, New Delhi - 110 002, India
Tel. : +91-11-2337 9321, 2337 8057 Fax : +91-11-2337 8678 e-mail : nabet@qcin.org Website : www.qcin.org

Scope of Accreditation

Annexure I

NAME OF THE CONSULTANT ORGANIZATION: WAPCOS Limited (A Government of India Undertaking)
Plot-76-C, Sector-18, Gurgaon – 122015, Haryana

Sl. No.	Sector number		Name of Sector	Category A/B
	As per MoEF Notification	As per NABET Scheme		
1.	1 (a) (i)	1	Mining of Minerals- Open cast only	A
2.	1 (c)	3	River Valley, Hydel, Drainage and Irrigation projects	A
3.	1 (d)	4	Thermal Power Plants	A
4.	7 (e)	33	Ports, harbours, jetties, marine terminals, break waters and dredging	A
5.	8 (a)	38	Building and large construction projects including shopping malls, multiplexes, commercial complexes, housing estates, hospitals, institutions	B
Total = 05 Sectors *Individual EIA Coordinators approved for different sectors are mentioned in Annexure II*				

The ACO has overall obtained more than 60 % marks and therefore qualifies for Cat. A.

(Abhay Sharma)
Assistant Director

Accreditation Certificate of the laboratory

NABL

National Accreditation Board for Testing and Calibration Laboratories

(An Autonomous Body under Department of Science & Technology, Govt. of India)

CERTIFICATE OF ACCREDITATION

SPECTRO ANALYTICAL LABS LTD.

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

E-41, Okhla Industrial Area, Phase-II, New Delhi

in the discipline of

CHEMICAL TESTING

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Certificate Number T-0249

Issue Date 03/02/2015

Valid Until 02/02/2017

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the additional requirements of NABL.

Signed for and on behalf of NABL

N. Venkateswaran	Anil Relia	Prof. Ashutosh Sharma
Program Manager	Director	Chairman

Accreditation Certificate of the laboratory

NABL

National Accreditation Board for Testing and Calibration Laboratories

Department of Science & Technology, India

CERTIFICATE OF ACCREDITATION

SPECTRO ANALYTICAL LABS LTD.

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

E-41, Okhla Industrial Area, Phase-II, New Delhi

in the discipline of

BIOLOGICAL TESTING

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Certificate Number T-1073

Issue Date 02/03/2014

Valid Until 01/03/2016

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the additional requirements of NABL.

Signed for and on behalf of NABL

Prachi Kukreti
Convenor

Anil Relia
Director

Dr T. Ramasami
Chairman

West Bengal State Electricity Distribution Company limited
(A West Bengal Government Enterprise)
Vidyut Bhavan (5th Floor), Block-DJ , Sector-II, Salt Lake ,Kolkata
West Bengal – 700091 (India)
Tel: 033-23345821/23197628
Fax.: 033-23345855

(April -2016)

WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED

(A Government of West Bengal Enterprise)

WBSEDCL

VOLUME- II: SIA REPORT

TURGA PUMPED STORAGE PROJECT

(Previously known as Purulia Pumped Storage Extension Project on TurgaNala)

(4 X 250 MW)

APRIL2016

CONTENTS

CHAPTER-5 PLAN FOR PROTECTION OF CULTURAL IDENTITY

CHAPTER-6 COST ESTIMATES

LIST OF FIGURES

CHAPTER-1

INTRODUCTION

1.1 INTRODUCTION

The Turga Pumped Storage Project on Turga nala is located in Purulia district of West Bengal. This is one of the four Pumped Storage Schemes initially identified by erstwhile WBSEB (now known as WBSEDCL). The Turga Pumped Storage Scheme envisages utilization of the waters of the river Turga in Ayodhya hills for peak power generation on a Pumped storage type development. The coordinates of Upper Dam site are 23°12'47"N and 86°04'20"E. Likewise, coordinates of the lower Dam site are 23°11'49''N and 86°04'13"E. The project site is approachable by a jeepable road taking off from Balrampur – Baghmundi state highway. The nearest rail head is located at Barabhum and nearest airport is located at Ranchi. The project location map is enclosed as Figure-1.1.

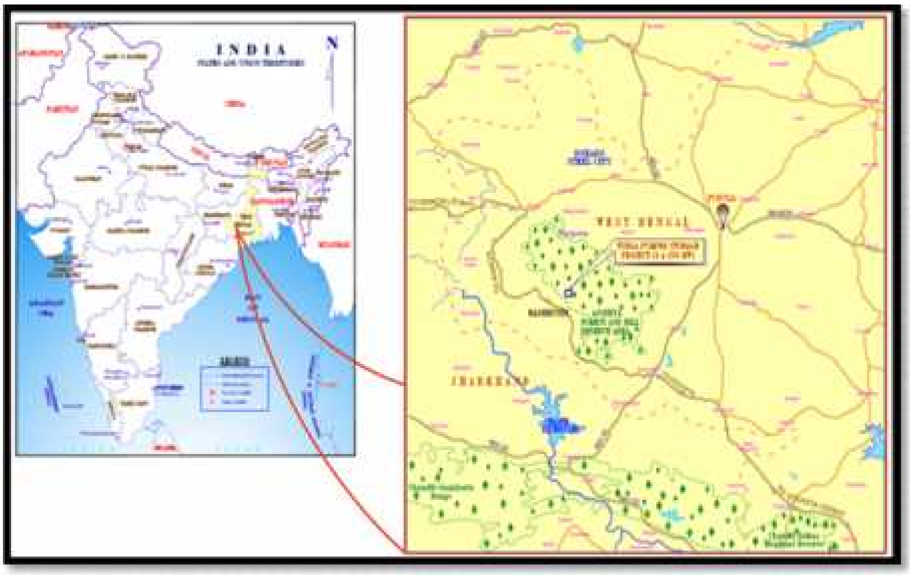


Figure-1.1 Project Location Map

1.2 PROJECT PROFILE

The Turga Pumped Storage Project envisages utilization of hydro potentiality of Ajodhya Plateau, an extension of Chhota Nagpur Plateau. The project envisages the construction of Upper Dam (C.A. 8.29 Sq. Km) across Turga Nala, a tributary of Subarnarekha river and a water conductor system with an underground Power House on the downstream of Upper Dam and a Lower Dam having intermediate catchment of 4.37 sq. km (total C.A. 12.66 sq. km).

The Project is a Close Loop type Pumped Storage Scheme. It comprises two reservoirs at two different levels (the difference of water levels of the reservoirs will represent the effective “head” of the Project) and water conductor system will connect the two reservoir through an underground power house. During peak hours power will be generated by depleting the water reserve of the upper reservoir which will pass through the waterway and the generator and turbines installed at the power house and will be stored in the Lower Reservoir. During off peak hours the excess power from thermal stations will be fed back to pump the water from Lower Reservoir to Upper reservoir through power house where generators and turbines will then act as motors and pumps respectively. The same cycle of operation will be repeated during peak and lean period.

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

1.3 SALIENT FEATURES

The salient features of Turga Pumped Storage Project are given in Table-1.1.

Table-1.1: Salient Features of Turga Pumped Storage Scheme

1. LOCATION	
Country **State** **District**	India West Bengal Purulia
River	Turga Nala a tributary of Subarnarekha River
Dam Axis (Upper)	Left Bank Latitude 23^{0}12’ 47.2” & Longitude 86^{0} 04’ 19.9” E 405064.831 , N 2567415.095(UTM) Right Bank Latitude 23^{0}12’ 46.2” & Longitude 86^{0} 03’54.16” E 404332.556 , N 2567391.165(UTM)
Dam Axis (Lower)	Left Bank Latitude 23^{0}11’ 48.8’’ & Longitude 86^{0} 04’ 12.5” E 404843.406 , N 2565619.006(UTM) Right Bank Latitude 23^{0}11’ 50.7’’ & Longitude 86^{0} 03’ 41.9” E 403973.742 , N 2565682.666(UTM)
Access to the Project	

Road	i) Kolkata to Chandil along NH 33 via Jamshedpur 380km ii) Chandil to Balrampur along NH 32 30km iii) Balrampur to Patherdhi along State-Highway 30km iv) Patherdhi to Project Site (Upper dam) 10km **Total 450 km**
Airport	Ranchi
Railhead (with unloading facilities)	Barabhum Railway Station (30km from project site) on the Howrah Purulia Broad Gauge Line of South **Eastern railway** 335km from Howrah via Adra 320 km from Howrah via Tatanagar
Port	Haldia, Kolkata
2. PROJECT	
Type	Pumped Storage Project (Closed Loop Type)
Power	1000MW
Installed Capacity	4 X 250 MW
Peak Operating duration	5 hours daily
3. HYDROLOGY	
Catchment Area	
Upper Dam	8.29 km^2
Lower Dam	12.66 km^2
Average Annual Rainfall in Basin	1334 mm
Average annual Run-off	
Upper Reservoir	4.51 Mm^3
Lower Reservoir	6.88 Mm^3
75% Dependable Run-off	
Upper Reservoir	3.68 Mm^3
Lower Reservoir	5.63 Mm^3
90% Dependable Run-off	
Upper Reservoir	2.93 Mm^3
Lower Reservoir	4.47 Mm^3
Maximum Design Flood (PMF)	
Upper Reservoir	280 m^3/s
Lower Reservoir	428 m^3/s
Annual Average Sediment Load	1045m^3 /Km^2/yr
4.0 CIVIL STRUCTURE	
4.1 UPPER RESERVOIR	
FRL	464.00 m
MDDL	441.40 m (With irrigation Storage depleted) 444.40 m(For Pumped storage Generation)
Pondage at FRL	21.6 Mm^3

Pondage at MDDL(at 441.40m) Pondage at MDDL(at 444.44m)	5.9 Mm^3 7.4 Mm^3
Live Pondage	14.2 Mm^3
4.2 LOWER RESERVOIR	
FRL	316.5 m
MDDL	280.4 m
Pondage at FRL	18 Mm^3
Pondage at MDDL	3.8 Mm^3
Live Pondage	14.2 Mm^3
4.3 UPPER DAM	
Type	Rock fill with Central impervious core
Top of Dam	EL 467.5 m
Accepted Foundation Elevation	EL 404 m
Length of Dam at top	732 m
Max. Height of Dam	63.5m
Top width of dam	10.00 m
4.4 SPILLWAY ARRANGEMENT	
Type	Over Flow Ogee Type on Left Bank(Concrete)
Crest Elevation	EL 464.0m at FRL
MWL	EL 466m
Design Flood	280 m^3 /s
No. of Bays	4 Bays , 13m wide each
No. of Piers	3 Piers, 2 m wide each
Waterway	58 m
4.5 DIVERSION CUM BOTTOM OUTLET ARRANGEMENTS	
Type	Tunnel on left bank
Diversion Flood	109 m^3/s
Length & Diameter	691m , 4m (Concrete Lined)

Invert Level of DT at Inlet	EL 410.0m
Invert Level of DT at Outlet	EL 408.0m
Bottom Outlet	
Length & Diameter	Same as Diversion Tunnel will act as Bottom Outlet
Invert of Bottom Outlet at Inlet	EL 423.5m
Invert of Bottom Outlet at Outlet	EL 408.0m
Deletion Time	27 hrs(Approx.)
4. 6 MAIN LOWER DAM	
Type	Concrete Gravity
Top of Dam	EL 320m
Foundation Elevation	EL 256 m
Length of Dam at top	872 m
Max. Height of Dam	64 m
No. of OF blocks	4 nos, 18m wide each
No. NoF Blocks	40 nos, 20m wide each
Top width of dam	10.00 m
4.7 LOWER SADDLE DAM	
Type	Rock fill with central impervious core
Top of Dam	EL 320.0 m

Foundation Elevation	EL 270 m
Length of Dam at top	595 m
Max. Height of Dam	50.0 m (from Bed level)
Top width of dam	10.00 m
4.8 SPILLWAY ARRANGEMENT	
Type	Over Flow Ogee Type
Crest Elevation	EL 316.5 m at FRL
MWL	EL 318.53m
Design Flood	428 m3 /s
No. of Bays	5 Bays , 15m wide each
No. of Piers	4 Piers, 3 m wide each
Total Waterway	87 m
4.9 DEPLETION SLUICE	
Location	In Block No. 38
Size	1.5m(W) X 2.0(H)
Crest Elevation	EL 270m
Gate Chamber	7.7m(L)X 6m(W)X 5m(H)
Depletion Time	97 hrs.
4.10 DIVERSION ARRANGEMENT	
Coffer Dam with overflow spillway	Rockfill with earthen Core

Bed Level	EL265m
FRL/MWL	EL280m/283.5m
Diversion Flood	167 m^3/s
Height of Coffer Dam	20m
Spillway Crest	EL 280m
Spillway crest Length	35m
4.11 Power Intake	
Type H x W x No. x Line	Horizontal Type with anti-vortex lubbers 12.0m x 13.0m x 3 nos x 2 lines
4.12 Headrace Tunnel (Intake Tunnel)	
D x L x line	D 9.0 m x L 618.11 m x 2 lines
4.13 Penstock (Steel Lining)	
D x L x line After Bifurcation	D 9.0 m x L 224.37m x 2 lines D 6.4 m- D 4.4 m x L 73.73 m x 4 lines
4.14 Tailrace Tunnel	
Tailrace Tunnel No1 Tailrace Tunnel No2	D 7.0 m x L 126.90 m x 1 line D 7.0 m x L 114.40 m x 1 line D 10.0 m x L 419.14 m x 1 line D 7.0 m x L 102.90 m x 1 line D 7.0 m x L 89.40 m x 1 line D 10.0 m x L 402.77 m x 1 line
4.15 Tailrace Outlet	
Type H x W x No. x Line	Horizontal Type with anti-vortex lubbers 12.0m x 13.0m x 3 nos x 2 lines
4.16 Powerhouse	
-Type -Four Fixed Speed Pump/Turbine units -One Variable Speed Pump/Turbine unit + Three Fixed Speed Pump/Turbine units	Type; Underground Bullet shape L 160.00m x B 25.00 m x H 53.00 m L 160.00 x B 25.00 m x H 55.00 m
4.17 Transformer Room	Type;
Type L x B x H	Underground Bullet shape L 139.17 m x B 16.00m x H 16.00m

4.18 Switch Yard	
Type W x B	Type; Open air Type W 165 m x B 50 m at EL 340 .00 m
5.0 Hydro-mechanical Equipment	
5.1 Intake Equipment	
Intake Trashrack Intake Maintenance Gate Intake Gate	3 sets x 2 lines, W 13.0m x H 12.0m Vertical lift fixed wheel type steel gate 2 sets W 7.0m x H 9.0m Vertical lift fixed wheel type steel gate2 sets W 7.0m x H 9.0m
5.2 Steel Penstock	
- Type of penstock - Type, number of bifurcation - Inside diameter Before bifurcation After bifurcation - Total length	Embedded type welded steel penstock Internal reinforced type bifurcation 2sets 9.0 m (main pipe) 6.4~4.4 m (branch pipe) 975.7 m/lane (824.2 m : main pipe) (75.7 m/75.7 m: branch pipe to unit No.1(3), No.2(4))
5.3 Steel Liner of Tailrace Tunnel	
- Number of lane - Type of steel liner - Type, number of junction - Inside diameter Before junction After junction - Total length	4 lanes Embedded type welded steel liner Internal reinforced type junction 2 sets 7.0 m (branch pipe) 10.0 m (main pipe) 213.8 m (No.1), 164.4 m (No.2)
5.4 Draft Equipment	
- Quantity - Type of gate - Clear span - Clear height	4 sets High pressure slide type steel gate (Bonneted gate) with transition pipe 5.60 m 5.60 m
5.5 Tailrace Equipment	
Tailrace Trashrack Tailrace Gate	3 sets x 2 lines, W 13.0m x H 12.0m Vertical lift slide type steel gate 2 sets W 8.00 m x H 10.00 m
5.6 Bottom Outlet Equipment of Lower Dam	
Bulkhead Gate Auxiliary Gate Main Gate	Slide Type Steel Gate (Stoplog) 1 set W2.49m x H3.34m High Pressure Slide Type Steel Gate 1 set W 1.50m x H 2.00m High Pressure Slide Type Steel Gate 1 set W 1.50m x H 2.00m
5.7 Bottom Outlet Equipment of Upper Dam	
Trashrack	Vertical Fixed Type Steel Trashrack 1 set

Stoplog Auxiliary Gate Main Gate	W 4.0 m x H 4.0 m Slide Type Steel Gate 1 set W 4.0 m x H 4.0 m High Pressure Slide Type Steel Gate 1 set W 1.45m x H 1.80m Jet Flow Gate 1 set W 1.80m x H 1.80m
6.0 Electromechanical Equipment	
6.1 Pump Turbine	
Type	Francis type, vertical shaft reversible pump-turbine
Number of unit	Four (4) units
Effective head at normal static head	146.4 m
Maximum Turbine Output at normal effective head	255,500kW , 280,600kW (10% Overload)
Maximum Pump Input	285,000 kW
Maximum Turbine Discharge	197.0 m^3/s
Maximum Pump Discharge	196.7 m^3/s
Revolving Speed	187.5 rpm
6.2 Generator-Motor	
Type	Three (3) phase, alternating current synchronous, generator-motor, vertical shaft, rotating field, enclosed housing, rim-duct air-cooled and semi-umbrella type
Number of unit	Four (4) units
Rated Capacity	Generator; 306MVA Motor (output); 255 MW
Power Factor	Generator; 0.90 (lagging) Motor; 0.95 (leading)
Rated Voltage	18.0kV
Rated Current	2,574A

Rated Frequency	50 Hz
Rated Revolving Speed	187.5 rpm
Over Load Capacity	110 % rated capacity
6.3 Main Power Transformer	
Type	Indoor, oil-immersed, 3 single phase transformers with on-load tap changer (OLTC) for pumping operation
Number of unit	4 units
Rated Capacity	330 MVA
Rated Voltage	Primary; 18 kV Secondary; 400 kV adjustable range of the secondary voltage: -5% to +10%(3kV/tap)
Connection	Primary: Delta Secondary: Wye
Neutral Grounding System for Secondary Winding	Solidly Grounded
Basic Impulse Insulation Level (BIL)	Primary: 95 kV Secondary: 1,425 kV Neutral Secondary: 38 kV r.m.s(power frequency)
6.4 Generator-Motor Circuit Breaker	
Type	Indoor, Metal-enclose, SF6 gas blast and single pressure type
Number of Unit	Four (4) units
Rated Voltage	24 kV
Rated Normal Current	11,000 A
Rated Short Circuit Breaking Current	80 kA
6.5 Gas Insulated Switchgear	
6.5.1 Circuit Breaker	
Type	400 kV Gas Insulated Switchgear (GIS)
Number of Feeder	Nine (9) feeders including two (2) feeders for future expansion of transmission lines
Rated Voltage	420 kV
Rated Normal Current	2,000 A
Rated Short Time (2 sec) withstand Current	50 kA
Rated Lighting Impulse withstand Voltage	1,425 kV
6.5.2 Rating Disconnecting Switch	
Rated Voltage	420 kV
Rated Normal Current	2,000 A
Rated Frequency	50 Hz

and /or Private Land, 34 ha of land will be transferred from I & W Directorate, Government of West Bengal to Turga Pumped Storage Project. Remaining 24 ha of land to be arranged temporarily on leased basis.

Appropriate compensation measures as per ownership status has been suggested as a part of the Environmental Management Plan.

1.5 OUTLINE OF THE REPORT

The document for the Comprehensive EIA study for the proposed Turga Pumped Storage Project has been presented in four volumes. The details are given as below:

- Volume-I presents the Environmental Impact Assessment (EIA) Study
- Volume-II covers the Social Impact Assessment (SIA) Study
- Volume-III outlines the Environmental Management Plan (EMP) Report.
- Volume-IV ourlines Public Hearing Proceeding Report

The present document (Volume-II) outlines the findings of the SIA study for the proposed Turga Pumped Storage project.

The contents of the document are organized as follows:

Chapter-1 The Chapter gives an overview of the Turga Pumped Storage Project.

Chapter-2 Delineates the profile of the villages the villages in the Study Area.

Chapter-3 Describes the anticipated positive and negative impacts likely to accrue as a result of the construction and operation of the proposed Turga Pumped Storage Project on socio-economic aspects of Environment.

Chapter-4 Presents the Local Area Development Plan for Turga Pumped Storage Project.

Chapter-5 Outlines the Plan to maintain cultural identity of the locals.

Chapter-6 Summarizes the cost required for implementation of Local Area Development Plan and Plan to maintain cultural identity of the locals

CHAPTER –2
SOCIO-ECONOMIC ASPECTS

2.1 GENERAL

The aim of the socio-economic study is to assess the overall impact on various facets of socio-economic environment due to establishment of the project and consequent land acquisition in the affected villages and its population in general and the project affected families (PAFs) in particular, whose livelihood would be affected. The baseline socio-economic scenario of the district and blocks in which the proposed project is located has been discussed. Thereafter the socio-economic status of the PAFs is described followed by the impacts of the proposed project on the socio-economic environment has to be elucidated.

The following sections highlight the overall socio-economic status prevailing in the affected villages as well as the study area.

The proposed project, because of its sheer size, will bring direct as well as indirect benefits to the population of District Purulia. As per the guidelines of the Ministry of Environment and Forest (MoEF), the study area was covered as a part of the socio-economic assessment. The Study Area is spread over in two blocks, namely, Bagmundi and Arsha. The Study Area comprises of about 69 villages, including project affected villages, in blocks Bagmundi (57 villages) and Arsha (12 villages).

2.2 POPULATION

The total population in the study area is of the order of 34316 persons as per Census of India 2011. The distribution of population and demographic profile in the study area villages is outlined in Table-2.1 and Figure-2.1.

Table-2.1: Demographic profile in Study Area Villages

S. No	Village Name	Total Population	Total Workers	Main Workers	Marginal Workers	Non Workers
	Block Bagmundi					
1	Jhabri	477	237	48	189	240
2	Karru	2588	1149	253	896	1439
3	Gandhudi	1295	353	30	323	942
4	Birgram	3722	1308	165	1143	2414
5	Sindri	4138	1700	1252	448	2438
6	Dabha	906	492	194	298	414
7	Tarang	1597	922	506	416	675
8	Nishchintpur	471	281	85	196	190
9	Uttamdi Alias Rengtudi	404	245	131	114	159
10	Bhursu	3096	1271	844	427	1825
11	Koreng	1407	608	216	392	799
12	Ukada	875	444	435	9	431
13	Burda	5159	2670	1265	1405	2489
14	Dungridi	194	106	53	53	88
15	Susnidi	127	74	32	42	53

S. No	Village Name	Total Population	Total Workers	Main Workers	Marginal Workers	Non Workers
16	Saramchaki	117	65	28	37	52
17	Babnijara	81	49	29	20	32
18	Pitidiri	567	274	82	192	293
19	Kushumtikri	132	78	1	77	54
20	Hesadi	729	411	143	268	318
21	Saharjuri	1038	581	96	485	457
22	Bongada	226	131	41	90	95
23	Sonahara	252	151	50	101	101
24	Kalha	422	168	98	70	254
25	Bhunighra	505	184	67	117	321
26	Telia Bhasa	367	211	4	207	156
27	Saldi	78	40	21	19	38
28	Bhitpani	240	133	0	133	107
29	Alkusi	67	22	13	9	45
30	Kurupahar	113	67	36	31	46
31	Baredi	1056	660	280	380	396
32	Khirabera	442	242	90	152	200
33	Dhundhikhap	304	174	52	122	130
34	Chorda	2568	1135	700	435	1433
35	Ghorabandha	3274	1886	928	958	1388
36	Ghaghra	126	30	1	29	96
37	Sarakdi	842	276	231	45	566
38	Chano	298	83	33	50	215
39	Pratappur	629	216	205	11	413
40	Patardi	1609	620	291	329	989
41	Gobindapur	3064	1317	726	591	1747
42	Madla	3070	1837	730	1107	1233
43	Shrabandi	1091	477	43	434	614
44	Tantan	451	169	128	41	282
45	Basudi	352	138	89	49	214
46	Matiala	180	76	57	19	104
47	Kudlung	889	514	161	353	375
48	Barria	3982	1349	133	1216	2633
49	Gosaidi	183	77	72	5	106
50	Baghmundi	4035	1400	680	720	2635
51	Ranga	726	210	94	116	516
52	Andhra Alias Hathinada	724	171	144	27	553
53	Ajodhya	1648	772	392	380	876
54	Kuchrirakha	237	133	57	76	104
55	Punia Shasan	430	232	90	142	198
56	Chhatni	823	454	5	449	369
57	Lahadungri	115	73	27	46	42
	Sub-total(A)	**64538**	**29146**	**12657**	**16489**	**35392**
	Block Arsha (B)					
58	Uparjari	3489	1923	1120	803	1566
59	Upargugui	2656	1410	496	914	1246
60	Bamni	225	138	121	17	87
61	Ghatiali	329	175	154	21	154
62	Kanriyardih	118	64	60	4	54
63	Parsiya	215	58	57	1	157

S. No	Village Name	Total Population	Total Workers	Main Workers	Marginal Workers	Non Workers
64	Sitarampur	310	88	85	3	222
65	Bhuiyandih	274	68	65	3	206
66	Gayalikocha	673	449	334	115	224
67	Puranaburudih	23	20	8	12	3
68	Tanasi	1046	542	190	352	504
69	Pattanr	612	235	201	34	377
	Sub-total(B)	**9970**	**5170**	**2891**	**2279**	**4800**
	Total (A+B)	**74508**	**34316**	**15548**	**18768**	**40192**

Source: Primary Census Abstract, 2011

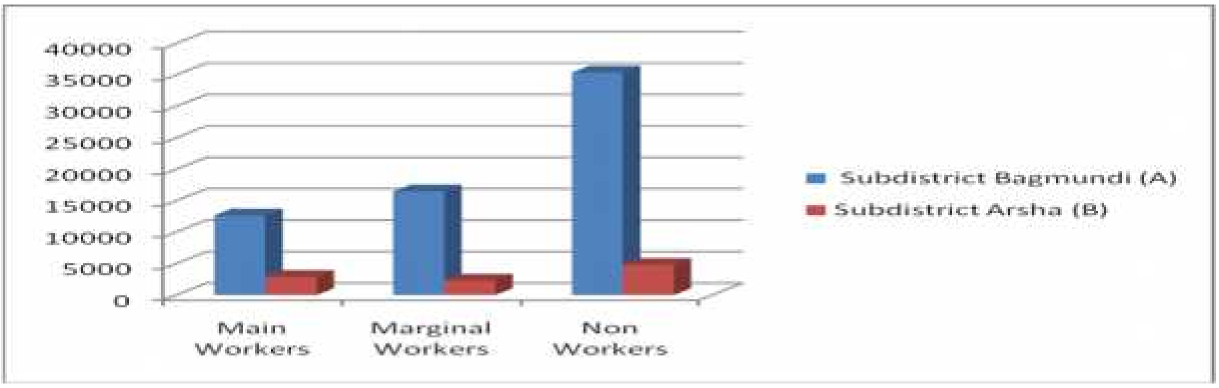


Figure-2.1: Demographic profile in the Study Area Villages

The male and female population in study area villages comprises about 51.12% and 48.88% of the total population respectively. The population comprising of infants and children below the age of 6 years constitute about 16.89% of the total population in the study area villages. The sex ratio study area villages is 956 females per 1000 males and thefamiliy size is around.

2.3 CASTE PROFILE

The distribution of population in study area villages on the basis of caste is summarized in Table-2.2 and depicted in Figure-2.2. It is observed that General Caste is dominant Caste in the study area villages accounting for 58.99% of the total population followed by Schedule tribe (28.61%) and Schedule Caste (12.39%).

Table-2.2: Caste profile in the Study Area Villages

S. No	Village Name	Total Population	Schedule Caste Population	Schedule Tribe Population	General Caste Population
	Block Bagmundi				
1	Jhabri	477	137	108	232
2	Karru	2588	141	126	2321
3	Gandhudi	1295	131	197	967
4	Birgram	3722	929	238	2555
5	Sindri	4138	286	185	3667
6	Dabha	906	196	109	601
7	Tarang	1597	199	44	1354

S. No	Village Name	Total Population	Schedule Caste Population	Schedule Tribe Population	General Caste Population
8	Nishchintpur	471	132	305	34
9	Uttamdi Alias Rengtudi	404	55	299	50
10	Bhursu	3096	599	195	2302
11	Koreng	1407	367	151	889
12	Ukada	875	9	75	791
13	Burda	5159	679	1372	3108
14	Dungridi	194	0	194	0
15	Susnidi	127	0	127	0
16	Saramchaki	117	0	117	0
17	Babnijara	81	0	81	0
18	Pitidiri	567	0	567	0
19	Kushumtikri	132	0	131	1
20	Hesadi	729	118	604	7
21	Saharjuri	1038	35	956	47
22	Bongada	226	2	224	0
23	Sonahara	252	0	252	0
24	Kalha	422	0	422	0
25	Bhunighra	505	0	498	7
26	Telia Bhasa	367	0	367	0
27	Saldi	78	0	78	0
28	Bhitpani	240	0	238	2
29	Alkusi	67	0	67	0
30	Kurupahar	113	0	113	0
31	Baredi	1056	63	417	576
32	Khirabera	442	0	0	442
33	Dhundhikhap	304	126	0	178
34	Chorda	2568	350	475	1743
35	Ghorabandha	3274	565	84	2625
36	Ghaghra	126	0	126	0
37	Sarakdi	842	8	0	834
38	Chano	298	0	33	265
39	Pratappur	629	60	62	507
40	Patardi	1609	199	17	1393
41	Gobindapur	3064	54	92	2918
42	Madla	3070	630	195	2245
43	Shrabandi	1091	201	0	890
44	Tantan	451	87	243	121
45	Basudi	352	0	92	260
46	Matiala	180	0	178	2
47	Kudlung	889	343	199	347
48	Barria	3982	599	738	2645
49	Gosaidi	183	5	134	44
50	Baghmundi	4035	576	513	2946
51	Ranga	726	8	714	4
52	Andhra Alias Hathinada	724	0	719	5
53	Ajodhya	1648	179	1237	232
54	Kuchrirakha	237	3	233	1
55	Punia Shasan	430	0	428	2
56	Chhatni	823	0	820	3

S. No	Village Name	Total Population	Schedule Caste Population	Schedule Tribe Population	General Caste Population
57	Lahadungri	115	0	115	0
	Sub-total(A)	**64538**	**8071**	**16304**	**40163**
	Block Arsha				
58	Uparjari	3489	261	878	2350
59	Upargugui	2656	276	982	1398
60	Bamni	225	0	225	0
61	Ghatiali	329	0	315	14
62	Kanriyardih	118	0	117	1
63	Parsiya	215	0	215	0
64	Sitarampur	310	298	10	2
65	Bhuiyandih	274	85	178	11
66	Gayalikocha	673	223	449	1
67	Puranaburudih	23	0	23	0
68	Tanasi	1046	15	1018	13
69	Pattanr	612	5	605	2
	Sub-total(B)	**9970**	**1163**	**5015**	**3792**
	Total (A+B)	**74508**	**9234**	**21319**	**43955**

Source: Primary Census Abstract, 2011

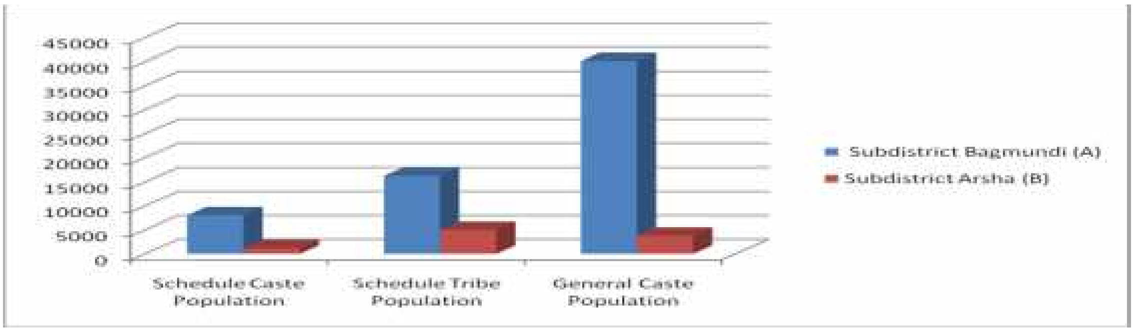


Figure-2.2: Caste profile in the Study Area Villages

2.4 LITERACY LEVELS

The details of literate and illiterate population amongst the total population of Study Area Villages are presented in Table-2.3 and Figure-2.3. It is observed that about 46.06% of the total population in the study area villages is literate, while about 53.94% population is illiterate. The male and female literacy rates are 58.43% and 33.1% respectively.

Table-2.3: Distribution of literate and illiterate population in the Study Area Villages

S. No	Village Name	Total Population	Population Literate	Male Literate	Female Literate	Population Illiterate	Male Illiterate	Female Illiterate
	Block Bagmundi							
1	Jhabri	477	205	141	64	272	109	163
2	Karru	2588	1174	818	356	1414	514	900
3	Gandhudi	1295	576	346	230	719	290	429
4	Birgram	3722	1726	1171	555	1996	723	1273
5	Sindri	4138	1950	1266	684	2188	814	1374
6	Dabha	906	413	244	169	493	203	290
7	Tarang	1597	864	569	295	733	238	495

S. No	Village Name	Total Population	Population Literate	Male Literate	Female Literate	Population Illiterate	Male Illiterate	Female Illiterate
8	Nishchintpur	471	189	130	59	282	97	185
9	Uttamdi Alias Rengtudi	404	215	145	70	189	76	113
10	Bhursu	3096	1203	799	404	1893	789	1104
11	Koreng	1407	823	515	308	584	246	338
12	Ukada	875	493	311	182	382	152	230
13	Burda	5159	2532	1631	901	2627	1071	1556
14	Dungridi	194	49	39	10	145	62	83
15	Susnidi	127	39	27	12	88	39	49
16	Saramchaki	117	51	34	17	66	18	48
17	Babnijara	81	19	13	6	62	28	34
18	Pitidiri	567	332	186	146	235	92	143
19	Kushumtikri	132	43	34	9	89	40	49
20	Hesadi	729	321	217	104	408	163	245
21	Saharjuri	1038	334	230	104	704	281	423
22	Bongada	226	63	44	19	163	57	106
23	Sonahara	252	75	44	31	177	73	104
24	Kalha	422	109	79	30	313	129	184
25	Bhunighra	505	215	142	73	290	123	167
26	Telia Bhasa	367	152	102	50	215	89	126
27	Saldi	78	14	9	5	64	32	32
28	Bhitpani	240	97	65	32	143	50	93
29	Alkusi	67	18	13	5	49	20	29
30	Kurupahar	113	25	23	2	88	39	49
31	Baredi	1056	420	269	151	636	264	372
32	Khirabera	442	171	106	65	271	112	159
33	Dhundhikhap	304	122	74	48	182	73	109
34	Chorda	2568	1416	896	520	1152	457	695
35	Ghorabandha	3274	1443	910	533	1831	749	1082
36	Ghaghra	126	70	36	34	56	23	33
37	Sarakdi	842	511	333	178	331	111	220
38	Chano	298	149	92	57	149	56	93
39	Pratappur	629	378	236	142	251	96	155
40	Patardi	1609	924	639	285	685	224	461
41	Gobindapur	3064	1743	1184	559	1321	415	906
42	Madla	3070	1420	886	534	1650	644	1006
43	Shrabandi	1091	649	402	247	442	157	285
44	Tantan	451	165	105	60	286	136	150
45	Basudi	352	199	129	70	153	47	106
46	Matiala	180	54	39	15	126	52	74
47	Kudlung	889	482	307	175	407	138	269
48	Barria	3982	1933	1234	699	2049	812	1237
49	Gosaidi	183	87	53	34	96	41	55
50	Baghmundi	4035	2340	1359	981	1695	736	959
51	Ranga	726	221	162	59	505	205	300
52	Andhra Alias Hathinada	724	264	165	99	460	186	274
53	Ajodhya	1648	686	490	196	962	400	562
54	Kuchrirakha	237	117	73	44	120	45	75
55	Punia Shasan	430	230	144	86	200	70	130
56	Chhatni	823	189	134	55	634	277	357
57	Lahadungri	115	49	31	18	66	24	42
	Sub-total(A)	**64538**	**30751**	**19875**	**10876**	**33787**	**13207**	**20580**
	Block Arsha							
58	Uparjari	3489	1411	949	462	2078	786	1292

S. No	Village Name	Total Population	Population Literate	Male Literate	Female Literate	Population Illiterate	Male Illiterate	Female Illiterate
59	Upargugui	2656	1233	814	419	1423	550	873
60	Bamni	225	65	39	26	160	64	96
61	Ghatiali	329	120	72	48	209	90	119
62	Kanriyardih	118	35	25	10	83	28	55
63	Parsiya	215	57	40	17	158	68	90
64	Sitarampur	310	155	110	45	155	56	99
65	Bhuiyandih	274	99	68	31	175	66	109
66	Gayalikocha	673	121	84	37	552	255	297
67	Puranaburudih	23	6	5	1	17	7	10
68	Tanasi	1046	201	143	58	845	379	466
69	Pattanr	612	63	33	30	549	278	271
	Sub-total(B)	**9970**	**3566**	**2382**	**1184**	**6404**	**2627**	**3777**
	Total (A+B)	**74508**	**34317**	**22257**	**12060**	**40191**	**15834**	**24357**

Source: Census of India 2011

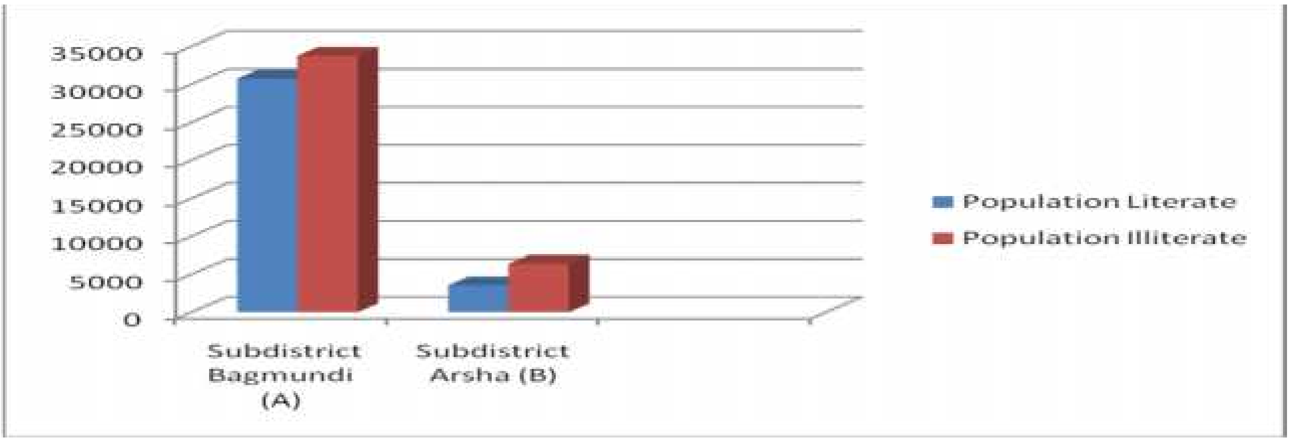


Figure -2.3: Literacy profile of the Study Area Villages

2.5 OCCUPATIONAL PROFILE

The details on occupational profile in the study area villages are given in Table-2.4. As per this table it is observed that 46.06% 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 53.94% of the total population. Amongst the working population, about 45.31% has been designated as Main workers while the remaining 54.69% are designated as Marginal workers.

Table-2.4: Occupational profile in the Study Area Villages

S.No	Village Name	Total Population	Total Workers	Main Workers	Marginal Workers	Non Workers
	Block Bagmundi					
1	Jhabri	477	237	48	189	240
2	Karru	2588	1149	253	896	1439
3	Gandhudi	1295	353	30	323	942
4	Birgram	3722	1308	165	1143	2414
5	Sindri	4138	1700	1252	448	2438

S.No	Village Name	Total Population	Total Workers	Main Workers	Marginal Workers	Non Workers
6	Dabha	906	492	194	298	414
7	Tarang	1597	922	506	416	675
8	Nishchintpur	471	281	85	196	190
9	Uttamdi Alias Rengtudi	404	245	131	114	159
10	Bhursu	3096	1271	844	427	1825
11	Koreng	1407	608	216	392	799
12	Ukada	875	444	435	9	431
13	Burda	5159	2670	1265	1405	2489
14	Dungridi	194	106	53	53	88
15	Susnidi	127	74	32	42	53
16	Saramchaki	117	65	28	37	52
17	Babnijara	81	49	29	20	32
18	Pitidiri	567	274	82	192	293
19	Kushumtikri	132	78	1	77	54
20	Hesadi	729	411	143	268	318
21	Saharjuri	1038	581	96	485	457
22	Bongada	226	131	41	90	95
23	Sonahara	252	151	50	101	101
24	Kalha	422	168	98	70	254
25	Bhunighra	505	184	67	117	321
26	Telia Bhasa	367	211	4	207	156
27	Saldi	78	40	21	19	38
28	Bhitpani	240	133	0	133	107
29	Alkusi	67	22	13	9	45
30	Kurupahar	113	67	36	31	46
31	Baredi	1056	660	280	380	396
32	Khirabera	442	242	90	152	200
33	Dhundhikhap	304	174	52	122	130
34	Chorda	2568	1135	700	435	1433
35	Ghorabandha	3274	1886	928	958	1388
36	Ghaghra	126	30	1	29	96
37	Sarakdi	842	276	231	45	566
38	Chano	298	83	33	50	215
39	Pratappur	629	216	205	11	413
40	Patardi	1609	620	291	329	989
41	Gobindapur	3064	1317	726	591	1747
42	Madla	3070	1837	730	1107	1233
43	Shrabandi	1091	477	43	434	614
44	Tantan	451	169	128	41	282
45	Basudi	352	138	89	49	214
46	Matiala	180	76	57	19	104
47	Kudlung	889	514	161	353	375
48	Barria	3982	1349	133	1216	2633
49	Gosaidi	183	77	72	5	106
50	Baghmundi	4035	1400	680	720	2635
51	Ranga	726	210	94	116	516
52	Andhra Alias Hathinada	724	171	144	27	553
53	Ajodhya	1648	772	392	380	876
54	Kuchrirakha	237	133	57	76	104
55	Punia Shasan	430	232	90	142	198

S.No	Village Name	Total Population	Total Workers	Main Workers	Marginal Workers	Non Workers
56	Chhatni	823	454	5	449	369
57	Lahadungri	115	73	27	46	42
	Sub-total(A)	**64538**	**29146**	**12657**	**16489**	**35392**
	Block Arsha					
58	Uparjari	3489	1923	1120	803	1566
59	Upargugui	2656	1410	496	914	1246
60	Bamni	225	138	121	17	87
61	Ghatiali	329	175	154	21	154
62	Kanriyardih	118	64	60	4	54
63	Parsiya	215	58	57	1	157
64	Sitarampur	310	88	85	3	222
65	Bhuiyandih	274	68	65	3	206
66	Gayalikocha	673	449	334	115	224
67	Puranaburudih	23	20	8	12	3
68	Tanasi	1046	542	190	352	504
69	Pattanr	612	235	201	34	377
	Sub-total(B)	**9970**	**5170**	**2891**	**2279**	**4800**
	Total (A+B)	**74508**	**34316**	**15548**	**18768**	**40192**

Source: Census of India 2011

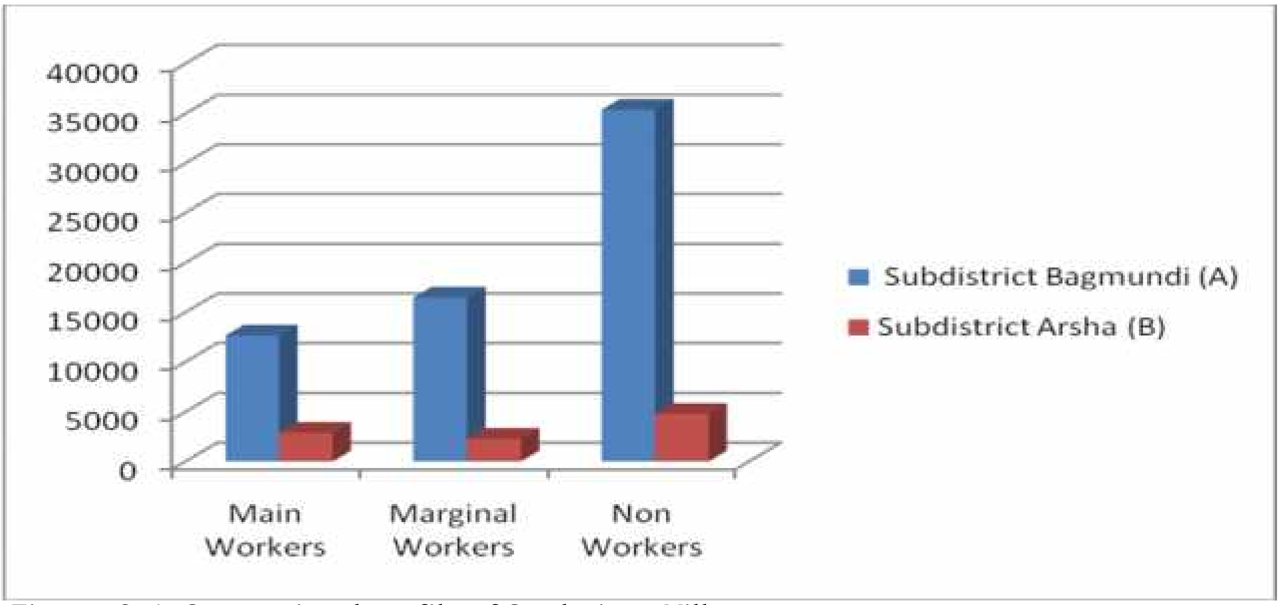


Figure -2.4: Occupational profile of Study Area Villages

CHAPTER-3
SOCIAL IMPACT ASSESSMENT

3.1 INTRODUCTION

Based on the project details and the baseline environmental status, potential impacts as a result of the construction and operation of the proposed Turga Pumped Storage Project on Social Aspects have been covered in the present Chapter.

A project of the magnitude similar to that of TurgaProject is likely to entail both positive as well as negative impacts on the socio-economic fabric of the area. During construction and operation phases, a lot of allied activities will mushroom in the project area. The construction phase would require a large labour force. It is felt that a considerable number of the labour force would come from other parts of the country. Economic opportunities would increase both directly as well as indirectly. Infrastructure facilities are likely to increase. The present chapter covers the impacts on socio-economic environment.

The impacts have been categorized as below:

- Impacts during project construction phase
- Impacts during project operation phase

3.2 LAND REQUIREMENT

The total land required for the project is 292.0 ha. The details are given in Table-3.1.

Table-3.1: Land requirement for proposed project

S. No.	Component	Area (ha)
1.	Upper Reservoir submergence at FRL	87.10
2.	Lower Reservoir submergence at FRL	49.00
3.	Dam site and other structure	13.90
4.	Quarry Site	32.00
5.	Construction facility	15.00
6.	Clay core Area	20.00
7.	Roads	10.00
8.	Stockpile area for construction material, etc.	30.00
9.	Other miscellaneous requirement	35.00
	Total	**292.00**

As per the present status, about 234 ha of land is Forest land and the remaining (58 ha) is non-forest government land and/or Private Land. Out of 58 ha of non-forest government land and/or Private Land, 34 ha of land will be transferred from I&W Directorate, Government of West Bengal to Turga Pumped Storage Project. The remaining 24 ha of land shall be arranged temporarily on leased basis.

3.3 IMPACTS DURING CONSTRUCTION PHASE

The construction phase will last for about 5to 6 years. The peak labour force800 and technical staff required is estimated at about 200. The total number of persons inhabiting the area including the service population will be about 4000. 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 migrate to the project area or near major construction sites, in search of jobs. It has been estimated that about 4000 persons will inhabit the area during construction phase, which is likely to last for a period of about 5 to 6 years.

The benefits however, are always not a certainty and depend on several factors. Often, they are directly related to the way construction phase is handled by the project authorities and their sensitivity to various socio-economic problems that could develop during this phase. The project will open a large number of jobs to the local population. Job opportunities will drastically improve in this area.

The availability of infrastructure is generally a problem during the initial construction phase. However, the construction workers can be subsidized for certain facilities like health, education, etc. The adequacy of water supply, sewage treatment, housing, etc. should therefore, be ensured before and adequate measures would be taken at the very start of the project.

3.3.1 Provide local services like water supply, education, healthcare, community forests etc.

The commissioning of the project will increase gross money flow in the project area. This will lead to significant impacts in the project area. The area will have increased demands for services, such as sewerage system, communication, transportation, medical and educational facilities, etc. It is presumed that all these developments would result in generation of additional employment. Thus, with the increased income levels, there will be an improvement in the local service facilities.

3.3.2 Employment opportunities

The construction phase will last for about 5 to 6 years. The peak labour force and technical staff required is estimated at about 1,000. The total number of persons inhabiting the area including the service population will be about 4,000. 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 in the vicinity of the project area. This would lead to demand for almost all types of goods and services. The locals would avail these opportunities arising from the project and increase their income levels.

The construction of the project will provide an impetus to the industrialization and urbanization in the area. Many of the 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.

3.3.3 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 and the socio-economic status of the area will also be improved.

3.3.4 Subsidiary industrial opportunities

The project construction will improve the subsidiary industrial opportunities on account of commissioning of workshops, small vehicle and equipment repair shops etc. The locals will avails these opportunities arising from the project.

3.3.5 Governmental service enhancement opportunities

Besides upgrading local services like education, drinking water, health, communication, etc. other governmental services like security, bank, finance etc will improve in the area. Government will provide different services to the project, which will also help the locals. Due to increased economic activities and work force to the project area, government as well as private banks will be established. Besides bank saving and cooperative institutions will also develop at local level for saving the earnings.

3.3.6 Land acquisition and population displacement/involuntary resettlement

The important adverse impact during construction phase will be that, pertaining to land acquisition. About 292 ha of land isproposed to be acquired for the proposed Turga Pumped Storage Project. The details are given in Table-3.1. No family will be losing homestead. Some minimum private land is to be acquired on temporary basis and no permanent acquisition of private land is envisaged. Thus, issues related to Resettlement and Rehabilitation are not envisaged in the proposed Project.

Usually government or forest lands act as community property resources (for gathering firewood, fodder, fruits, etc.) for the local residents. Acquisition of forest or government lands would increase pressure on remaining forest and government lands.

3.3.7 Impacts on social services like: 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 of the order of about 1,000 persons, is expected to immigrate into the project area. It is felt that most of the labour force would come from other parts of the country. However, some of the locals would also be employed to work in the project. The labour force would stay near to the project construction sites.

The project will also lead to certain negative impacts. The most important negative impact would be during construction phase. 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.

3.3.8 Impacts on Public health

Increase in water spread area

The construction of reservoirs would convert riverine ecosystem into a lacustrine ecosystem. The vectors of various diseases may breed in shallow parts of the impounded water. The magnitude of breeding sites for mosquitoes and other vectors in the impounded water is in direct proportion to the length of the shoreline. The increase in submergence area would lead to increase in incidence of vector-borne disease on account of proliferation of mosquitoes. As Turga PSP is a pumped storage project, so that water mass in both the reservoirs will fluctuate daily, and chances of breeding of vectors/mosquitoes in a fluctuating water body are much lesser than the stagnant water condition. However, project area could face increased incidence of malaria as a result of various factors like aggregation of labour, formation of stagnant pools near labour camps, colonies, etc.Labour camps could be vulnerable to increased incidence of water-borne diseases, if adequate measures are not undertaken.

Aggregation of labour

About 1000 labourers and technical staff will congregate in the project area during peak construction phase. The total increase in population is expected to be of the order of 4000.

Most of the labour would come from various parts of the country. The labourer would live in colonies/camps provided by the Contractor. Proper sanitary facilities are generally provided. Hence, a proper surveillance and immunization schedule needs to be developed for the labour population migrating into the project area, to assess whether they are carriers of communicable diseases. If found positive, suitable measures need to be undertaken.

Excavations

The excavation of earth from borrow pits etc. is one of the major factor for the increase in prevalence of malaria. After excavation of construction material, the depressions are generally left without treatment where water gets collected. These pools of water, then serves as breeding grounds for mosquitoes.

The flight of mosquito is generally limited up to 1 to 2 km from the breeding sites. Since, no residential areas are located within 1 km from the reservoir, periphery, increased incidences of malaria are not anticipated. However, labour camps, etc. could be vulnerable to increased incidence of malaria, if proper control measures are not undertaken.

Inadequate facilities in labour camps

Improperly planned labour camps generally tend to become slums, with inadequate facilities for potable water supply and sewage treatment and disposal. This could lead to outbreak of epidemics of water-borne diseases. Adequate measures for supply of potable water and sewage treatment have been recommended as a part of Environmental Management Plan outlined in volume-II of this Report.

3.3.9Influence on law and order

Construction period of Turga Pumped Storage Project (major work) will be 63 months. The peak labour and technical staff requirement is estimated to be around 1000, majority of whichwould belong to different socio-cultural background will temporarily migrate to the project area. They will interact and interrelate with the project management and with the local community which is a multi-ethnic, multi-cultural and multi-religious society. Furthermore, cash flow in the area may attract the workers towards gambling, alcohol consumption, stealing, and other such social evils. In such a situation, general breakdown of law and crime may occur. Some of the workers may take advantage of this situation.

Therefore, social disruptive behaviors are likely to increase in the project area during the construction period. Adequate measures need to be implemented to mitigate the impacts on this account.

3.3.10Influence on occupational health, community health, and accidental risks

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 construction area in search of jobs.

It is normally experienced that untreated sewage would find its way into natural drainage system, and is likely to get collected as pools of sewage or it out-falls into the nearest water body along natural drainage pattern. Thus, it is important to provide appropriate sewage treatment facilities at the labour camp and at the construction site prior to disposal on land or in water body.

The garbage comprising of waste materials, e.g. packaging, polythene or plastic materials are likely to be generated during project construction and operation phase at the project site. The same needs to be properly collected and disposed at designated sites.

The main activities during construction, will be drilling, blasting, sorting and haulage of the muck may cause accidents and injuries. The most common injuries that might occur are due to falls from scaffoldings or other structures, injuries due to falling objects such as rocks or other construction equipment, traffic accidents,etc. Working in small underground area with poor light and ventilation could further pose threat to workers health. The construction of dam and other structures involves concrete mixing, concrete pouring, reinforcement banding/installing, steel ribs fabrication, welding, etc. Labour and technical staff working with concrete may be exposed to fine silicate particles that might cause lung diseases. The victims will most probably be construction worker although injuries to local people are also possible.

3.3.11Impact on gender and child discrimination risks

The project shall ensure equal access to participation and decision making ofwomen in mainstreaming a gender perspective in the development process. Project shall provide equal access to women for employment, equal remuneration, occupational health and safety, social security, etc.

During construction phase, large number of local as well as outsiders will be engaged directly and indirectly in project. If both parents will be employed in project they cannot give their time to children, as a result children get affected. Although, the project will have the provision of not employing children less than 18 years of age, poverty may force the parents to engage their children in some form of work like in tea stalls, collection of sand, aggregates etc. Since there would be extra earnings, children will be attracted to help their parents in working with the project rather than going to school for education. This will definitely affect the educational pattern of the project area. At the same time, different project activities such as drilling, blasting and other construction activities pose safety concerns to the locals especially the children. It will be made mandatory for the contractor not to employ child labour in project construction activities.

3.3.13 Impacts due to occupational health and safety

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-3.2.

Table-3.2: 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

3.4. IMPACTS DURING OPERATION PHASE

3.4.1 Improved access to social services (education, health, market etc)

Once the construction of the project starts, significant and visible impacts will be felt in the project area. It can be assumed that economic activities will boom in settlements close to the project facility sites. During construction phase, education centers, health post, market,etc will be improved. After construction phase, there will be withdrawal of economic activities which flourished during construction phase since most of the construction related workforce will leave the project area. However, it is likely that some economic activities will continue or be further promoted these areas, which will be a positive impact.

3.4.2 Rural electrification opportunities

The proposed project would lead to increased availability of power, which can be used for rural electrification. This would be implemented as per the norms and policies of Government of the central and state governments. The improved availability of power will improve the quality of life along with associated health benefits.

3.4.3 Local employment opportunities

The operation of the project will provide an impetus to the industrialization and urbanization in the area. Many of the 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 operation phase.

3.4.4 Subsidiary industrial opportunities

The project will generate 1825GWh of energy. This will be a big input in the National / State level power planning. With the availability of regular electric supply, possibility for the establishment of local and national level industries is always high. This will be a significant positive impact.

3.4.5 Governmental service enhancement opportunities

After completion of construction phase, there will be upgradation of local services like education, drinking water, health post and other social governmental services like security, bank, finance etc will increase at and around the project sites. Government will provide different services to the project, which will automatically help locals. During operation phase, some existing governmental service will continue for long time whereas some services will end by the end of the construction phase. Some government services like revenue office will get an opportunity to collect revenue.

3.4.6 Improvement of Growth centers/strip development

During construction phase there will increase in market centers focusing to the project workers. During this time, there will be strip settlement and market centers along the site of the existing road and nearby the camping areas. After construction phase, there will be reduction in construction workers so there will some change in settlement. However, most of the people will sustain during operation phase, but with less economic flow.

3.4.7 Local participation in the project activities

After the construction work is over, project will require some permanent posts for the smooth operation and regular maintenance of project components. Locals will be recruited for administrative and technical works according to their qualification and skills. These will give permanent employment source to some of the locals.

3.4.8 Noise generated due to powerhouse operation

Power House being underground, no major impacts are anticipated on ambient noise level due to operation of the project.

CHAPTER-4

LOCAL AREA DEVELOPMENT PLAN

4.1 INTRODUCTION

The present chapter outlines the Local Area Development Plan (LADP) for TurgaPumped Storage Project. The objective of the plan is to empower study area villages. LADP is being framed to extend benefits to not only the residents of the affected villages, but also to residents of the villages adjoining to project area which are also within the study area villages.

The following aspects have been covered under the Local Area Development Plan:

- Educational Facilities
- Health Care and Medical Facilities
- Infrastructure Development
- Economic Development
- Social and Cultural Development

A budget of 0.5% of the project cost has been earmarked for implementation of Local Area Development Plan (LADP).

4.2 LOCAL AREA DEVELOPMENT PLAN

4.2.1 UPGRADATION OF EDUCATIONAL FACILITIES

It is proposed to upgrade the primary schools in 25 villages in the periphery of the affected villages. The following activities are proposed under LADP activities:

- Up-gradation of school fixtures, equipment
- Improvement of drinking water facilities
- School bus service

It is suggested to Up-gradation of school fixtures, equipment, etc., and to improve drinking water facilities in one primary school in 35 study area villages. A lump-sum amount of Rs. 12.4 lakh per school is being made for this purpose. The details are given in Table-4.1. Since 35 primary schools are to be upgraded, an amount of Rs. 434 lakh needs to be earmarked for this purpose. In addition, an amount of Rs.120.0lakh has been earmarked for purchase of 6 school vans/mini-buses. Thus, total lump-sum amount of Rs. 554.0lakh has been earmarked for this purpose.

Table-4.1:Break up of cost required for up-gradation of existing primary schools

S. No.	Particular	Amount earmarked /school (Rs. lakh)	Amount earmarked for 35 schools (Rs. lakh)
1	Furniture & fixtures and equipment	3.0	105.0
2	Improvement of drinking water facilities	2.0	70.0
3.	Construction of toilets in schools	5.0	175.0
4.	Improvement of school library/kitchen for mid-day meals	2.4	84.0
	Sub-Total (A)	**12.4**	**434.0**

S. No.	Particular	Amount earmarked /school (Rs. lakh)	Amount earmarked for 35 schools (Rs. lakh)
1	Purchase of school vans/mini-buses x 6Nos.	20.0	120.0
	Sub-Total (B)		**120.0**
	Total (A + B)		**554.0**

4.2.2 SCHOLARSHIPS FOR STUDENTS

It is suggested to provide scholarships for local students. On the one hand school going students who are presently studying between Class–I to Class-XII, scholarships are suggested for an amount of Rs. 10,000 per year for a period of 12 years may be extended as scholarship to about 100 students in the Study Area Villages.

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. 15,000 per year for meeting their fee and study material requirement along with Rs. 5,000 per year for meeting their hostel expenses for a period of 4 years is being made for meritorious students for higher studies. About 50 students are proposed to be covered under this scheme.

A total amount of Rs. 160.00 lakh may be earmarked for providing scholarships, details of which are given in Table – 4.2.

Table-4.2: Details of scholarships

S.No.	Activities	Amount (Rs. lakh)
1	Scholarship for School going students (100 students x 10000 per year for 12 years)	120.0
2	Scholarship for meritorious students–College/ higher education a) Fees/course material (@ Rs.15,000/year x 50 students x 4 years) b) Hostel expenses (@ Rs. 5,000/years x 50 students x 4 years)	 30.0 10.0
	Total	**160.0**

4.3 IMPROVEMENT OF PUBLIC HEALTH FACILITIES

It is proposed up-grade 2 existing Primary Health Sub-Centers as part of the LADP of the area. Up-gradation of this health care facility would involve renovation of existing structure/ construction of new wing, if required. Provision of new and/or latest gadgets and instruments, such as furniture, beds, laboratory equipment/instruments, computers wherever possible, installation of new floorings and ceilings, up-gradation/ construction of new of lavatories, electrification and adequate and proper lighting in rooms, facilities for cold storage of essential medicines, provision of drinking water facilities, etc. An amount of Rs.

44lakh (Rs. 22 lakh per PHSC x 2 PHSCs) has been earmarked for up-gradation of the existing PHSCs. The details are given in Table-4.3.

In addition, it is suggested to purchase 5 vans fitted with life saving equipment and stocked with medicines, which will function as a mobile clinics. It is further suggested to attach these mobile clinics to the 2 PHSCs from where these mobile units will operate.An amount of Rs. 150 lakh hasbeen earmarked for this purpose.

A total amount of Rs. 194.0 lakh is being earmarked for extending health facilities under LADP. The details are given in Table-4.3.

Table-4.3:Budget for up-gradation of PHSCs

S.No.	Item	Amount earmarked per PHSC(Rs. lakh)	Amount earmarked for 2 PHSCs (Rs.lakh)
1	Furniture, Beds, lighting, facilities for cold storage, drinking water, etc.	6.0	12.0
2	Up-gradation of Pathological laboratory	8.0	16.0
3	Up-gradation of operation theater (labor room)	8.0	16.0
	Sub-Total (A)	**22.0**	**44.0**
4	Purchase of 5 mobile clinic vans	30.0	150.0
	Sub-Total (B)	**30.0**	**150.0**
	Total (A+B)		**194.0**

4.4COMMUNITY TOILETS

It is proposed to construct the 10 community toilets in 30 villages.5 toilets each for males and females shall be constructed in each village. An amount of Rs.1200lakh has been earmarked for purpose.The details of the budget for construction of 10 community toilets in each village is given in Table-4.4.

Table-4.4: Budget for construction of community toilet

S.No.	Item	Amount earmarked per village(Rs. lakh)	Amount earmarked for 30 villages (Rs.lakh)
1.	Civil Works(Seat,Tap,Walls,Roofetc)	20.00	600.0
2.	Plumbing	4.50	135.0
3.	Tubewell	3.00	90.0
4.	Electrification	2.00	60.0
5.	Sewer Connection	2.50	75.0
6.	Bio-Digesters	8.0	240.0
	Total	**40.00**	**1200.0**

4.5 ADDITIONAL INFRASTRUCTURAL FACILITIES SOUGHT FOR DURING PUBLIC HEARING

During Public Hearing local people demanded few new infrastructure facilities. The Project Proponent assured to provide the following facilities required by them:

- Potable Water Supply (Digging new Wells) in three villages as decided by district administration
- Digging new ponds in three villages as decided by district administration
- Development of Play Ground in three villages as decided by district administration
- Development & Renovation of Two Temples (Ram Mandir and Vaishno Devi Mandir)

The Budget allocated for the above mentioned works are given in Table-4.5 below:

Table-4.5: Budget Allocation for Additional Infrastructural Facilities Sought for During Public Hearing

Description		Budget (Rs. In Lakhs)
Potable Water facility – Digging of new wells	Total 3 nos: as decided by district administration in consultation with local people	5.00
Digging New Pond	Total 3 nos: as decided by district administration in consultation with local people	36.00
Development of Play Ground	Total 3 nos: as decided by district administration in consultation with local people	30.00
Development and Renovation of Temples	2 nos. (as indicated in the Proceedings of Public Hearing)	25.00
Total		**96.00**

4.6 BUDGET FOR LADP

An amount of Rs. 2204.0 lakh is being made for implementation of the LADP Activities. The details are shown in Table-4.6.

Table-4.6:Budget for implementation of Local Area Development Plan

S. No.	Items	Budget (Rs. Lakh)
1	Construction/Up-gradation schools in Study Area (refer Table-4.1)	554.0
2	Scholarships to students in the Study Area (refer Table–4.2)	160.0
3	Improvement of Public Health Facility (refer Table-4.3)	194.0
4	Construction of Community Toilets(refer Table-4.4)	1200.0
5	Additional Infrastructural Facilities Sought for During Public Hearing(refer Table-4.5)	96.0
	Total	**2204.0**

CHAPTER-5

PLAN FOR PROTECTION OF CULTURAL IDENTITY

5.1 INTRODUCTION

The congregation of large labour population during construction phase is expected to lead to significant impacts on the local population. It is proposed to implement measures so as to minimize social conflicts on account of interaction of the locals with the immigrating population. The key objectives are to:

- Ensure only essential interaction with the local population outside the project area, so that there shall be no impact due to migration of different culture and people in social and cultural life of the local population.
- Requisite interaction with locals will be managed with care and sensitivity through local personnel, in consultation with village Panchayat.

5.2SUGGESTED MEASURES

- No exploitation of natural resources in and around the project area by the labourers / staff of WBSEDCL as well as of contractors will be allowed by the project authority.
- Necessary measures shall be initiated to curb any form of extraction of resources from the village outside the project area by the labourers / staff of WBSEDCL as well as of contractors.
- Project area shall be fully and effectively demarcated and fenced.
- Necessary arrangements to ensure that only necessary intervention take place with the locals will be made.
- Project will not allow any visitor to visit / interact with the locals outside the project area so that curious intrusions are avoided.

5.3REGULATION OF TRAFFIC ON ROAD

The following measures are suggested:

- Traffic on road will be regulated strictly by limiting the traffic to the project works and to ensure that no intervention take place with the locals.
- Vehicles on road will be allowed to move under notified speed limit to avert possible road accidents.

- Traffic on road will be strictly monitored to ensure that there is no interaction between the locals and the labourers/ staff of WBSEDCL as well as contractors. Check gates at different locations shall be installed.

5.4INSTITUTIONAL ARRANGEMENTS

The following measures shall be implemented

- Project authority shall be responsible for the implementation of the aforesaid policy. It shall lay down detailed tasks for each unit of the project in connection with the interaction with the locals.
- Project authority assisted by local administration having knowledge and experience in local community affairs will enforce and monitor implementation of the policy.
- Essential interaction with the locals will take place with the consultation of local administration, panchayat leaders and prominent citizens etc.
- Periodic review of this policy will be done so that the policy is dynamic and takes into account changing needs and circumstances.

5.5ACTION PLAN

Following measures will be implemented to check and preserve the cultural identity of the local population:

- Project area shall be fenced to prevent unauthorized trespassing.
- Limited number of opening / check post shall be installed to guard the unauthorized entry/exist from the project area.
- All workers / officers shall be provided with the identity card.
- No worker shall be allowed to leave the project without any specific and genuine reason and permission.
- Specific passes shall be issued to the worker leaving the project area.
- Strict action shall be taken against the worker/officials not adhering the norms and regulations.
- A committee with participation of local leaders/prominent persons shall be constituted to deal with the problems arising due to any illegal activities by the workers.

5.6 SURVEILLANCE MEASURES

During construction phase, it is proposed to construct 3 (three) check posts to prevent unnecessary inter-mingling of labour population with the locals. Each check post will have two guards and will report directly to a supervisor. The staff manning these check posts have adequate communication equipments. Adequate infrastructure including check-posts, watch towers, accommodation, etc. shall be provided.

An amount of Rs. 98.12 lakh has been earmarked for this purpose. The details are given as below:

a) **Salary**	
• Guards (6 nos.) @ Rs.8000 per month	Rs. 576,000
• One Supervisor @ Rs.20,000 per month	Rs. 240,000
• Total cost for one year	Rs. 816,000
Cost for 63 months (Assuming 10% increase per year)	**Rs. 53.12 lakh**
b) Communication equipment	Rs. 15 lakh
c) Infrastructure	Rs. 15 lakh
d) Purchase of Vehicles	Rs. 15 lakh
Total Cost	**Rs.98.12 lakh**

CHAPTER-6

COST ESTIMATES

6.1 COST FOR IMPLEMENTING MANAGEMENT PLAN FOR SOCIAL ASPECTS

The total amount to be spent for implementation of Management Plan for Social Aspects is Rs. 2302.12lakh. The details are given in Table-6.1.

Table-6.1: Cost for Implementing Social Management Plan

S. No.	Item	Cost (Rs.lakh)
1.	Local Area Development Plan (Refer Table-4.6)	2204.00
2.	Plan to maintain cultural identity (Refer Section 5.6)	98.12
	Total	**2302.12**

वाप्कोस लिमिटेड
WAPCOS LIMITED
(भारत सरकार का उपक्रम)
जल संसाधन, नदी विकास व गंगा संरक्षण मंत्रालय
(A Government of India Undertaking)
Ministry of Water Resources, River Development & Ganga Rejuvenation

Date: 27.11.2015

UNDERTAKING

As per MoEF Office Memorandum no. J-11013/41/2006/-IA-III, dated 5th October, 2011, M/s. WAPCOS Limited, Gurgaon, Haryana herewith declares ownership of the contents (information and data) of the EIA Study for Turga Pumped Storage Project, West Bengal.

Aman Sharma
27/11/15

(Authorised Signatory)

डॉ. अमन शर्मा/ Dr. Aman Sharma
वरि. महा प्रबंधक (गंगा संरक्षण एवं पर्यारण)
Sr. General Manager (Ganga Rejuvenation & Envt.)
वाप्कोस लिमिटेड / WAPCOS LIMITED
(भारत सरकार का उपक्रम/A Govt. of India Undertaking)
76–सी, सैक्टर –18, गुड़गाँव –122015 (हरि०)
76 - C, Sector - 18, Gurgaon -122015 (Hr.)

Accreditation Certificate of the EIA consultant as per the office memorandum issues by MOEF, GOI

National Accreditation Board
for Education and Training

NABET

NABET/EIA/RA068/085

Oct 09, 2015

Chairman cum Managing Director
WAPCOS Limited (A Government of India Undertaking)
Plot-76-C, Sector-18, Gurgaon – 122015, Haryana
(Kind Attention: **Mr. R.K. Gupta**)

Dear Sir,

Sub: Re-Accreditation

This has reference to your application to QCI-NABET for re-accreditation (RA) as EIA Consultant Organization and the assessment carried for same in your organization from Apr. 07-09, 2015.

We are pleased to inform you that based on the document and office assessments during RA, the Accreditation Committee has approved renewal of accreditation given to your organization for a period of three years from **Apr. 09, 2015 to Apr. 08, 2018** subject to coverage of balance Functional areas and specific response to NCs/Obs./Alerts issued, if applicable (Refer Annexure III) with the following details:

1. Annexure I - Scope of accreditation
2. Annexure II - List of experts with approved sectors/ functional areas
3. Annexure III - Non-Conformances/ Observations/ Alerts (NCs/ Obs./ Alerts)
4. Annexure IV - Observations on Quality Management System (QMS)
5. Annexure V - Terms and conditions of accreditation
6. Annexure VI - Result of assessment
7. Annexure VII - Guidelines for addressing Major Non-Conformances/ Observations/ Alerts
8. Annexure VIII - Format to be followed for mentioning the names of the experts involved in EIA reports prepared by **WAPCOS Limited.**

Result of RA including Non-Conformances/ Observations/ Alerts (NCs/ Obs./ Alerts) applicable to your organization as per RA are also posted on QCI website vide minutes of the Accreditation Committee meetings dated June 10, 2015. You are requested to take necessary actions to close the NCs/ Obs. as per guidelines and timeframe mentioned in Annexure VII of this letter. You are also advised to review eligibility of organization as per Version 3 of the Scheme (posted on NABET website) which has become effective from Sep 1, 2015 and meet its requirements by Dec. 31, 2015 positively.

You are required to make all payments to NABET as applicable, within one month from the date of invoice sent to you. Continuation of this accreditation of your organization is subject to the clearance of all dues by your organization, satisfactory compliance to Annexure III and V.

With best regards,

Yours sincerely,

(Abhay Sharma)
Assistant Director

Institution of Engineers Building, 2nd Floor, Bahadur Shah Zafar Marg, New Delhi - 110 002, India
Tel. : +91-11-2337 9321, 2337 8057 Fax : +91-11-2337 8678 e-mail : nabet@qcin.org Website : www.qcin.org

Scope of Accreditation

Annexure I

NAME OF THE CONSULTANT ORGANIZATION: WAPCOS Limited (A Government of India Undertaking)
Plot-76-C, Sector-18, Gurgaon – 122015, Haryana

Sl. No.	Sector number		Name of Sector	Category A/B
	As per MoEF Notification	As per NABET Scheme		
1.	1 (a) (i)	1	Mining of Minerals- Open cast only	A
2.	1 (c)	3	River Valley, Hydel, Drainage and Irrigation projects	A
3.	1 (d)	4	Thermal Power Plants	A
4.	7 (e)	33	Ports, harbours, jetties, marine terminals, break waters and dredging	A
5.	8 (a)	38	Building and large construction projects including shopping malls, multiplexes, commercial complexes, housing estates, hospitals, institutions	B
Total = 05 Sectors *Individual EIA Coordinators approved for different sectors are mentioned in Annexure II*				

The ACO has overall obtained more than 60 % marks and therefore qualifies for Cat. A.

(Abhay Sharma)
Assistant Director

Accreditation Certificate of the laboratory

NABL

National Accreditation Board for Testing and Calibration Laboratories

(An Autonomous Body under Department of Science & Technology, Govt. of India)

CERTIFICATE OF ACCREDITATION

SPECTRO ANALYTICAL LABS LTD.

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

E-41, Okhla Industrial Area, Phase-II, New Delhi

in the discipline of

CHEMICAL TESTING

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Certificate Number T-0249

Issue Date 03/02/2015

Valid Until 02/02/2017

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the additional requirements of NABL.

Signed for and on behalf of NABL

N. Venkateswaran Program Manager	Anil Relia Director	Prof. Ashutosh Sharma Chairman

Accreditation Certificate of the laboratory

NABL

National Accreditation Board for Testing and Calibration Laboratories

Department of Science & Technology, India

CERTIFICATE OF ACCREDITATION

SPECTRO ANALYTICAL LABS LTD.

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

E-41, Okhla Industrial Area, Phase-II, New Delhi

in the discipline of

BIOLOGICAL TESTING

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Certificate Number T-1073

Issue Date 02/03/2014

Valid Until 01/03/2016

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the additional requirements of NABL.

Signed for and on behalf of NABL

Prachi		
Prachi Kukreti	Anil Relia	Dr T. Ramasami
Convenor	Director	Chairman

West Bengal State Electricity Distribution Company limited
(A West Bengal Government Enterprise)
Vidyut Bhavan (5th Floor), Block-DJ , Sector-II, Salt Lake ,Kolkata
West Bengal – 700091 (India)
Tel: 033-23345821/23197628
Fax.: 033-23345855
(April -2016)

WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED

(A Government of West Bengal Enterprise)

VOLUME- III: EMP REPORT

TURGA PUMPED STORAGE PROJECT

(Previously known as Purulia Pumped Storage Extension Project on Turga Nala)

(4 X 250 MW)

APRIL 2016

CONTENTS

CHAPTER-7 PLAN FOR SOLID WASTE MANAGEMENT PLAN & SANITATION FACILITIES IN LABOUR CAMPS

CHAPTER-8 PUBLIC HEALTH DELIVERY SYSTEM

CHAPTER-9 MUCK DISPOSAL PLAN

CHAPTER-10 RESTORATION, STABILIZATION AND LANDSCAPING OF QUARRY SITES

CHAPTER-11 LANDSCAPING AND RESTORATION OF CONSTRUCTION AREAS

CHAPTER-12 ENVIRONMENTAL MANAGEMENT IN ROAD CONSTRUCTION

CHAPTER-13 ENERGY CONSERVATION MEASURES

CHAPTER-14 FIRE PROTECTION IN LABOUR CAMP AND STAFF COLONIES

CHAPTER-15 DISASTER MANAGEMENT PLAN

CHAPTER-16 ENVIRONMENTAL MONITORING PROGRAMME

CHAPTER-17 COST ESTIMATES

CHAPTER-18 DISCLOSURE OF CONSULTANTS INVOLVED IN CEIA STUDY

LIST OF FIGURES

CHAPTER-1

INTRODUCTION

1.1 INTRODUCTION

The Turga Pumped Storage Project on Turganala is located in Purulia district of West Bengal. This is one of the four Pumped Storage Schemes initially identified by erstwhile WBSEB (now known as WBSEDCL). The Turga Pumped Storage Scheme envisages utilization of the waters of the river Turga in Ayodhya hills for peak power generation on a Pumped storage type development. The coordinates of Upper Dam site are 23^{o}12’47”N and 86^{o}04’20”E. Likewise, coordinates of the lower Dam site are 23^{o}11’49’’N and 86^{o}04’13”E. The project site is approachable by a jeepable road taking off from Balarampur – Baghmundi state highway. The nearest rail head is located at Barabhum and nearest airport is located at Ranchi. The project location map is enclosed as Figure-1.1.

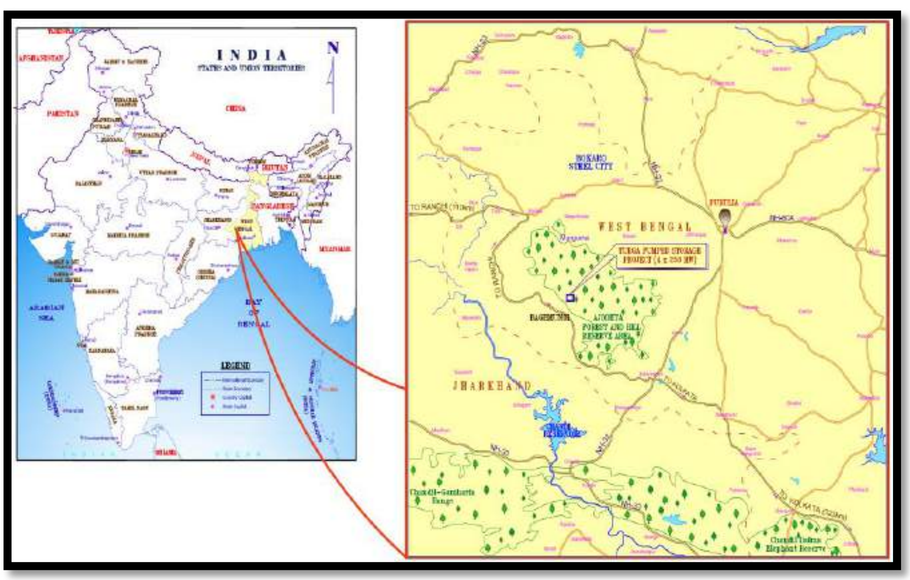


Figure-1.1 Project Location Map

1.2 PROJECT PROFILE

The Turga Pumped Storage Project envisages utilization of hydro potentiality of Ajodhya Plateau, an extension of Chhota Nagpur Plateau. The project envisages the construction of Upper Dam (C.A. 8.29 Sq. Km) across TurgaNala, a tributary of Subarnarekha river and a water conductor system with an underground Power House on the downstream of Upper Dam and a Lower Dam having intermediate catchment of 4.37 sq. km (total C.A. 12.66 sq. km).

The Project is a Close Loop type Pumped Storage Scheme. It comprises two reservoirs at two different levels (the difference of water levels of the reservoirs will represent the effective "head" of the Project) and water conductor system will connect the two reservoir through an underground power house. During peak hours power will be generated by depleting the water reserve of the upper reservoir which will pass through the waterway and the generator and turbines installed at the power house and will be stored in the Lower Reservoir. During off peak hours the excess power from thermal stations will be fed back to pump the water from Lower Reservoir to Upper reservoir through power house where generators and turbines will then act as motors and pumps respectively. The same cycle of operation will be repeated during peak and lean period.

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

1.3 SALIENT FEATURES

The salient features of Turga Pumped Storage Project are given in Table-1.1.

Table-1.1: Salient Features of Turga Pumped Storage Scheme

1. LOCATION	
Country **State** **District**	India West Bengal Purulia
River	TurgaNala a tributary of Subarnarekha River
Dam Axis (Upper)	Left Bank Latitude $23^0$12' 47.2" & Longitude 86^0 04' 19.9" E 405064.831 , N 2567415.095(UTM) Right Bank Latitude $23^0$12' 46.2" & Longitude 86^0 03'54.16" E 404332.556 , N 2567391.165(UTM)
Dam Axis (Lower)	Left Bank Latitude $23^0$11' 48.8'' & Longitude 86^0 04' 12.5" E 404843.406 , N 2565619.006(UTM) Right Bank Latitude $23^0$11' 50.7'' & Longitude 86^0 03' 41.9" E 403973.742 , N 2565682.666(UTM)
Access to the Project	
	i) Kolkata to Chandil along 380km

Road	NH 33 via Jamshedpur ii) Chandil to Balrampur along NH 32 — 30km iii) Balrampur to Patherdhi along State-Highway — 30km iv) Patherdhi to Project Site (Upper dam) — 10km **Total 450 km**
Airport	Ranchi
Railhead (with unloading facilities)	Barabhum Railway Station (30km from project site) on the Howrah Purulia Broad Gauge Line of South **Eastern railway** 335km from Howrah via Adra 320 km from Howrah via Tatanagar
Port	Haldia, Kolkata
2. PROJECT	
Type	Pumped Storage Project (Closed Loop Type)
Power	1000MW
Installed Capacity	4 X 250 MW
Peak Operating duration	5 hours daily
3. HYDROLOGY	
Catchment Area	
Upper Dam	8.29 km^2
Lower Dam	12.66 km^2
Average Annual Rainfall in Basin	1334 mm
Average annual Run-off	
Upper Reservoir	4.51 Mm^3
Lower Reservoir	6.88 Mm^3
75% Dependable Run-off	
Upper Reservoir	3.68 Mm^3
Lower Reservoir	5.63 Mm^3
90% Dependable Run-off	
Upper Reservoir	2.93 Mm^3
Lower Reservoir	4.47 Mm^3
Maximum Design Flood (PMF)	
Upper Reservoir	280 m^3/s
Lower Reservoir	428 m^3/s
Annual Average Sediment Load	1045m^3 /Km^2/yr
4.0 CIVIL STRUCTURE	
4.1 UPPER RESERVOIR	
FRL	464.00 m
MDDL	441.40 m (With irrigation Storage depleted) 444.40 m(For Pumped storage Generation)
Pondage at FRL	21.6 Mm^3
Pondage at MDDL(at 441.40m)	5.9 Mm^3

Pondage at MDDL(at 444.44m)	7.4 Mm^3
Live Pondage	14.2 Mm^3
4.2 LOWER RESERVOIR	
FRL	316.5 m
MDDL	280.4 m
Pondage at FRL	18 Mm^3
Pondage at MDDL	3.8 Mm^3
Live Pondage	14.2 Mm^3
4.3 UPPER DAM	
Type	Rock fill with **Central impervious core**
Top of Dam	EL 467.5 m
Accepted Foundation Elevation	EL 404 m
Length of Dam at top	732 m
Max. Height of Dam	63.5m
Top width of dam	10.00 m
4.4 SPILLWAY ARRANGEMENT	
Type	Over Flow Ogee Type on Left Bank(Concrete)
Crest Elevation	EL 464.0m at FRL
MWL	EL 466m
Design Flood	280 m^3 /s
No. of Bays	4 Bays , 13m wide each
No. of Piers	3 Piers, 2 m wide each
Waterway	58 m
4.5 DIVERSION CUM BOTTOM OUTLET ARRANGEMENTS	
Type	Tunnel on left bank
Diversion Flood	109 m^3/s
Length & Diameter	691m , 4m (Concrete Lined)
Invert Level of DT at Inlet	EL 410.0m
Invert Level of DT at Outlet	EL 408.0m
Bottom Outlet	
Length & Diameter	Same as Diversion Tunnel will act as Bottom Outlet
Invert of Bottom Outlet at Inlet	EL 423.5m
Invert of Bottom Outlet at Outlet	EL 408.0m
Deletion Time	27 hrs(Approx.)
4. 6 MAIN LOWER DAM	
Type	Concrete Gravity
Top of Dam	EL 320m
Foundation Elevation	EL 256 m
Length of Dam at top	872 m

Max. Height of Dam	64 m
No. of OF blocks	4 nos, 18m wide each
No. NoF Blocks	40 nos, 20m wide each
Top width of dam	10.00 m
4.7 LOWER SADDLE DAM	
Type	Rock fill with central impervious core
Top of Dam	EL 320.0 m
Foundation Elevation	EL 270 m
Length of Dam at top	595 m
Max. Height of Dam	50.0 m (from Bed level)
Top width of dam	10.00 m
4.8 SPILLWAY ARRANGEMENT	
Type	Over Flow Ogee Type
Crest Elevation	EL 316.5 m at FRL
MWL	EL 318.53m
Design Flood	428 m3 /s
No. of Bays	5 Bays , 15m wide each
No. of Piers	4 Piers, 3 m wide each
Total Waterway	87 m
4.9 DEPLETION SLUICE	
Location	In Block No. 38
Size	1.5m(W) X 2.0(H)
Crest Elevation	EL 270m
Gate Chamber	7.7m(L)X 6m(W)X 5m(H)
Depletion Time	97 hrs.
4.10 DIVERSION ARRANGEMENT	
Coffer Dam with overflow spillway	Rockfill with earthen Core
Bed Level	EL265m
FRL/MWL	EL280m/283.5m
Diversion Flood	167 m^3/s
Height of Coffer Dam	20m
Spillway Crest	EL 280m
Spillway crest Length	35m
4.11 Power Intake	
Type H x W x No. x Line	Horizontal Type with anti-vortex lubbers 12.0m x 13.0m x 3 nos x 2 lines
4.12 Headrace Tunnel (Intake Tunnel)	
D x L x line	D 9.0 m x L 618.11 m x 2 lines
4.13 Penstock (Steel Lining)	

D x L x line After Bifurcation	D 9.0 m x L 224.37m x 2 lines D 6.4 m- D 4.4 m x L 73.73 m x 4 lines
4.14 Tailrace Tunnel	
Tailrace Tunnel No1 Tailrace Tunnel No2	D 7.0 m x L 126.90 m x 1 line D 7.0 m x L 114.40 m x 1 line D 10.0 m x L 419.14 m x 1 line D 7.0 m x L 102.90 m x 1 line D 7.0 m x L 89.40 m x 1 line D 10.0 m x L 402.77 m x 1 line
4.15 Tailrace Outlet	
Type H x W x No. x Line	Horizontal Type with anti-vortex lubbers 12.0m x 13.0m x 3 nos x 2 lines
4.16 Powerhouse	
-Type -Four Fixed Speed Pump/Turbine units -One Variable Speed Pump/Turbine unit + Three Fixed Speed Pump/Turbine units	Type; Underground Bullet shape L 160.00m x B 25.00 m x H 53.00 m L 160.00 x B 25.00 m x H 55.00 m
4.17 Transformer Room	Type;
Type L x B x H	Underground Bullet shape L 139.17 m x B 16.00m x H 16.00m
4.18 Switch Yard	
Type W x B	Type; Open air Type W 165 m x B 50 m at EL 340 .00 m
5.0 Hydro-mechanical Equipment	
5.1 Intake Equipment	
Intake Trashrack Intake Maintenance Gate Intake Gate	3 sets x 2 lines, W 13.0m x H 12.0m Vertical lift fixed wheel type steel gate 2 sets W 7.0m x H 9.0m Vertical lift fixed wheel type steel gate2 sets W 7.0m x H 9.0m
5.2 Steel Penstock	
- Type of penstock - Type, number of bifurcation - Inside diameter Before bifurcation After bifurcation - Total length	Embedded type welded steel penstock Internal reinforced type bifurcation 2sets 9.0 m (main pipe) 6.4~4.4 m (branch pipe) 975.7 m/lane (824.2 m : main pipe) (75.7 m/75.7 m: branch pipe to unit No.1(3), No.2(4))
5.3 Steel Liner of Tailrace	

Tunnel	
- Number of lane - Type of steel liner - Type, number of junction - Inside diameter Before junction After junction - Total length	4 lanes Embedded type welded steel liner Internal reinforced type junction 2 sets 7.0 m (brunch pipe) 10.0 m (main pipe) 213.8 m (No.1), 164.4 m (No.2)
5.4 Draft Equipment	
- Quantity - Type of gate - Clear span - Clear height	4 sets High pressure slide type steel gate (Bonneted gate) with transition pipe 5.60 m 5.60 m
5.5 Tailrace Equipment	
Tailrace Trashrack Tailrace Gate	3 sets x 2 lines, W 13.0m x H 12.0m Vertical lift slide type steel gate 2 sets W 8.00 m x H 10.00 m
5.6 Bottom Outlet Equipment of Lower Dam	
Bulkhead Gate Auxiliary Gate Main Gate	Slide Type Steel Gate (Stoplog) 1 set W2.49m x H3.34m High Pressure Slide Type Steel Gate 1 set W 1.50m x H 2.00m High Pressure Slide Type Steel Gate 1 set W 1.50m x H 2.00m
5.7 Bottom Outlet Equipment of Upper Dam	
Trashrack Stoplog Auxiliary Gate Main Gate	Vertical Fixed Type Steel Trashrack 1 set W 4.0 m x H 4.0 m Slide Type Steel Gate 1 set W 4.0 m x H 4.0 m High Pressure Slide Type Steel Gate 1 set W 1.45m x H 1.80m Jet Flow Gate 1 set W 1.80m x H 1.80m
6.0 Electromechanical Equipment	
6.1 Pump Turbine	
Type	Francis type, vertical shaft reversible pump-turbine
Number of unit	Four (4) units
Effective head at normal static head	146.4 m

Maximum Turbine Output at normal effective head	255,500kW , 280,600kW (10% Overload)
Maximum Pump Input	285,000 kW
Maximum Turbine Discharge	197.0 m^3/s
Maximum Pump Discharge	196.7 m^3/s
Revolving Speed	187.5 rpm
6.2 Generator-Motor	
Type	Three (3) phase, alternating current synchronous, generator-motor, vertical shaft, rotating field, enclosed housing, rim-duct air-cooled and semi-umbrella type
Number of unit	Four (4) units
Rated Capacity	Generator; 306MVA Motor (output); 255 MW
Power Factor	Generator; 0.90 (lagging) Motor; 0.95 (leading)
Rated Voltage	18.0kV
Rated Current	2,574A
Rated Frequency	50 Hz
Rated Revolving Speed	187.5 rpm
Over Load Capacity	110 % rated capacity
6.3 Main Power Transformer	
Type	Indoor, oil-immersed, 3 single phase transformers with on-load tap changer (OLTC) for pumping operation
Number of unit	4 units
Rated Capacity	330 MVA
Rated Voltage	Primary; 18 kV Secondary; 400 kV adjustable range of the secondary voltage: -5% to +10%(3kV/tap)
Connection	Primary: Delta Secondary: Wye
Neutral Grounding System for Secondary Winding	Solidly Grounded
Basic Impulse Insulation Level (BIL)	Primary: 95 kV Secondary: 1,425 kV Neutral Secondary: 38 kV r.m.s(power frequency)
6.4 Generator-Motor Circuit Breaker	
Type	Indoor, Metal-enclose, SF6 gas blast and single pressure type
Number of Unit	Four (4) units
Rated Voltage	24 kV
Rated Normal Current	11,000 A
Rated Short Circuit Breaking	80 kA

Current	
6.5 Gas Insulated Switchgear	
6.5.1 Circuit Breaker	
Type	400 kV Gas Insulated Switchgear (GIS)
Number of Feeder	Nine (9) feeders including two (2) feeders for future expansion of transmission lines
Rated Voltage	420 kV
Rated Normal Current	2,000 A
Rated Short Time (2 sec) withstand Current	50 kA
Rated Lighting Impulse withstand Voltage	1,425 kV
6.5.2 Rating Disconnecting Switch	
Rated Voltage	420 kV
Rated Normal Current	2,000 A
Rated Frequency	50 Hz
Rated Short Time (2 sec) withstand Current	50kA
Rated peak withstand Current	100 kA
Rated Lighting Impulse withstand Voltage	1,425 kV
6.5.3 Current Transformer	
Rated Primary Current	2,000A
Rated Secondary Current	1 A
Rated Frequency	50Hz
Rated Lighting Impulse withstand Voltage	1,425 kV
6.5.4 Rating Voltage Transformer	
Rated Primary Voltage	400 kV/√3
Rated Secondary Voltage	110 V/√3
Rated Frequency	50 Hz
Rated Lighting Impulse withstand Voltage	1425 kV
6.6 Diesel Engine Generator	
Number of Unit	Two (2) units
Rated Capacity	1,000 kVA
6.7 EOT Crane	
Type	Indoor, Low speed type Electric Overhead Traveling Crane
Number of Unit	Two (2) units
Rated Capacity	250 ton (Main hoist), 50 ton and 10 ton

and /or Private Land, 34 ha of land will be transferred from I& W Directorate, Government of West Bengal to Turga Pumped Storage Project. Remaining 24 ha of land to be arranged temporarily on leased basis.Appropriate compensation measures as per ownership status has been suggested as a part of the Environmental Management Plan.

1.5 OUTLINE OF THE REPORT

The document for the Comprehensive EIA study for the proposed Turga Pumped Storage Project has been presented in four volumes. The details are given as below:

- Volume-I presents the Environmental Impact Assessment (EIA) Study
- Volume-II covers the Social Impact Assessment (SIA) Study
- Volume-III outlines the Environmental Management Plan (EMP) Report
- Volume-IV outlines the Public Hearing Proceedings Report

The present document (Volume-III) outlines the findings of the Environmental Management Plan for the proposed Turga Pumped Storage project.

Chapter-1 gives an overview of the Turga Pumped Storage Project.

Chapter-2: outlines the Catchment Area Treatment Plan for the Turga Pumped Storage project. A combination of engineering and biological measures have been suggested as a part of Catchment Area Treatment Plan.

Chapter-3: outlines the Biodiversity Conservation and Management plan.

Chapter-4: presents the plan tominimize the impacts on fish population due to the proposed Turga Pumped Storage Project.

Chapter-5: presents the Greenbelt Development Plan.

Chapter-6 :outlines the measures proposed to control water, air and noise pollution during construction phase.

Chapter-7: presents a plan for disposal of solid waste disposal generated from labour camps and colonies during construction phase, and the water supply and sanitation facilities proposed to be developed in labour colonies.

Chapter-8: covers Public Health Delivery system which shall be developed by to cater for the need of labour population migrating in the project area during construction phase.

Chapter-9: delineates measures for disposal of muck generated during construction of various project appurtenances.

Chapter-10:outlines the plan for Restoration, Stabilization and Landscaping of Quarry Sites.

Chapter-11: outlines measures suggested for landscaping and restoration and of construction areas.

Chapter-12: suggests measures for Environmental Management during road construction.

Chapter-13: outlines the energy conservation measures to be implemented during project construction as well as operation phases.

Chapter-14: Thechapter outlines the Fire Protection Plan.

Chapter-15: delineates the Disaster Management Plan.

Chapter-16: covers the Environmental Monitoring Programmefor implementation during project construction and operation phases.

Chapter-17: outlines the cost required for implementation of various measures outlined as a part of Environmental Management Plan and Environmental Monitoring Programme.

Chapter-18: gives the disclosure of Consultants.

CHAPTER-2

CATCHMENT AREA TREATMENT PLAN

2.1 INTRODUCTION

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 8.29 km^2 and 12.66 km^2

respectively. The sub-watersheds in the catchment area considered for the present study are given in **Figure-2.1**

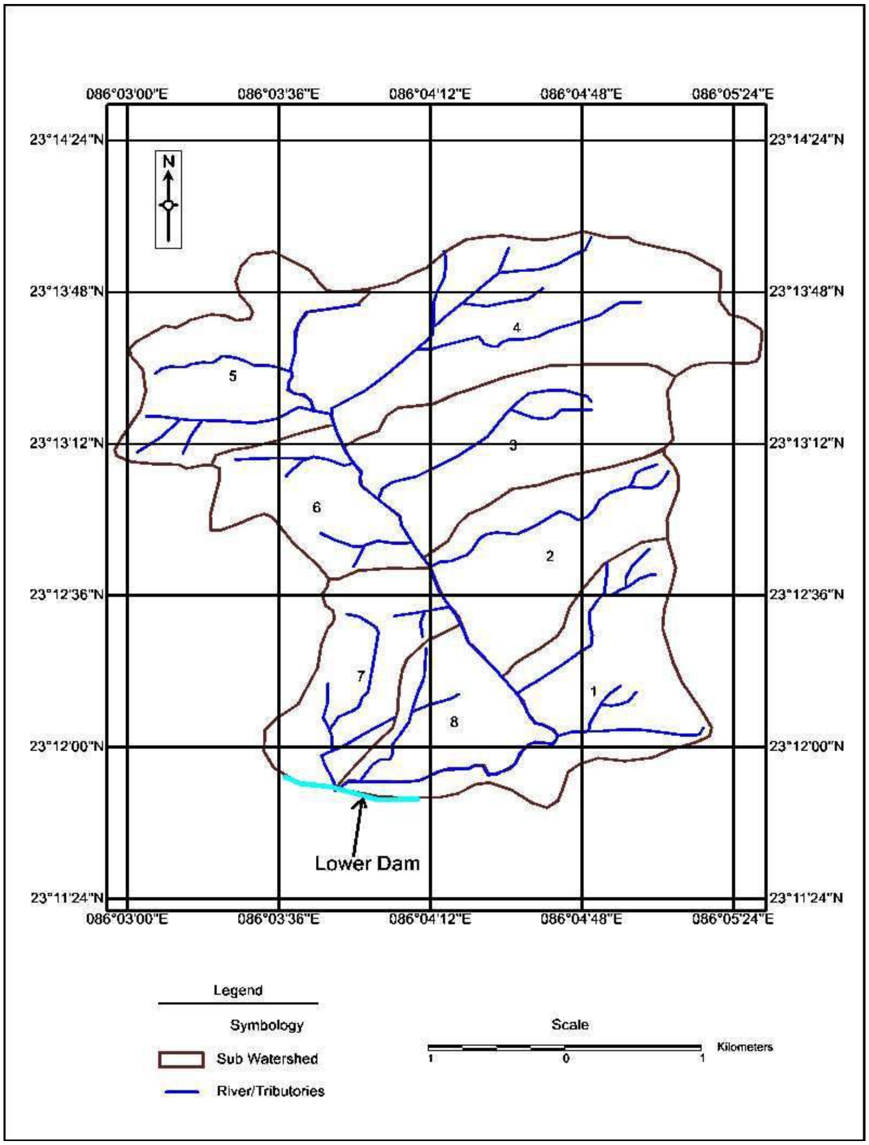


Figure-2.1: Sub-watersheds for catchment area for Turga HEP

The catchment area treatment involves

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

In the present study **`Silt Yield Index' (SYI)**, method has been used. In this method, the terrain is subdivided into various watersheds and the erodibility is determined on relative basis. SYI provides a comparative erodibility criteria of catchment (low, moderate, high, etc.) and do not provide the absolute silt yield. SYI method is widely used mainly because of the fact that it is easy to use and has lesser data requirement. Moreover, it can be applied to larger areas like sub-watersheds, etc.

2.2 APPROACH FOR THE STUDY

A detailed database on natural resources, terrain conditions, soil type of the catchment area, socio-economic status, etc. is a pre-requisite to prepare treatment plan keeping in view the concept of sustainable development. Various thematic maps have been used in preparation of the CAT plan. 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:

2.2.1 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.

2.2.2 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, one Resources at-LISS III (path 106, row 056 dated 26.04.2013) 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 **Figure-2.2** The land use pattern of the catchment area is summarized in **Table- 2.1.**

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).

Table -2.1: Land use classification for free draining catchment at diversion site

Land use/Land cover	Area (ha)	Area (%)
River/ Water body	6	0.47
Vegetation	830	65.56
Agricultural Land	80	6.32
Barren Land/Rocky outcrops	162	12.80
Scrub	176	13.90
Settlements	12	0.95
Total	**1266**	**100.00**

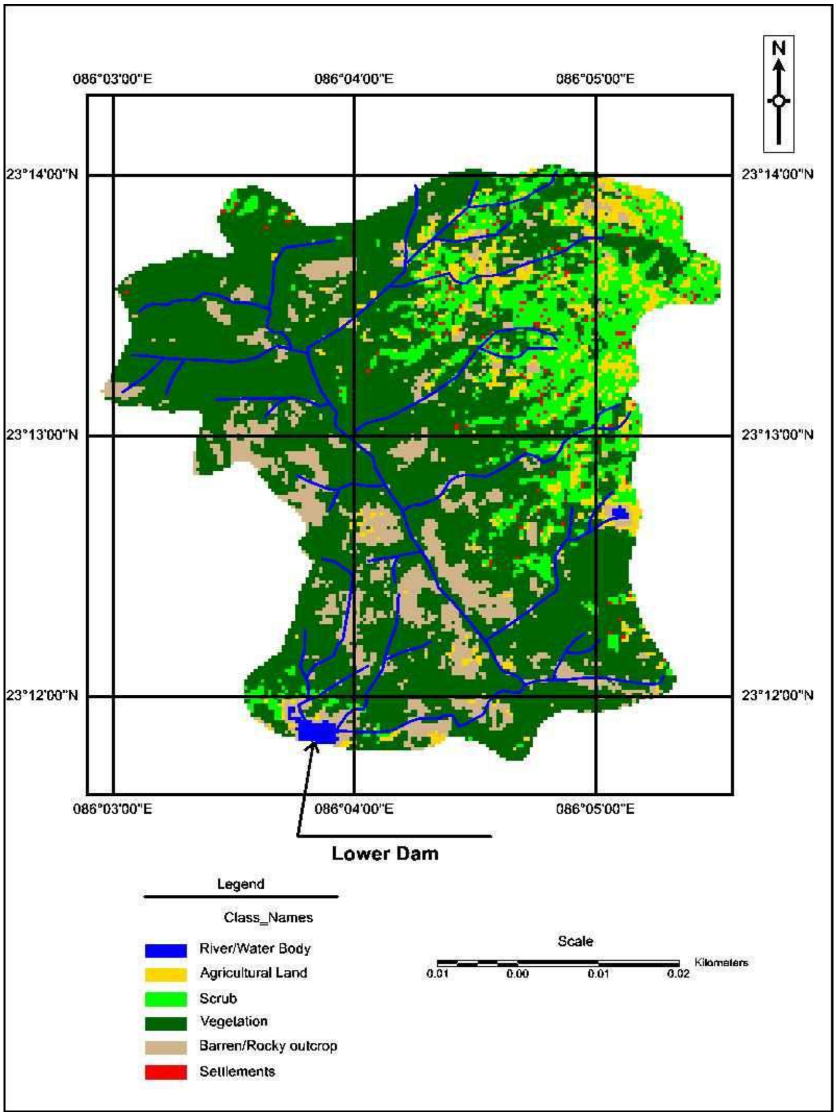


Figure-2:2 Classified imagery of catchment area for Turga HEP

A Digital Terrain Model (DTM) of the area was then prepared, which was used to derive a slope map. The slope was divided in classes of slope percentages. The slope map is enclosed as **Figure-2.3.** The Area under different slope categories are given in **Table-2.2**

Table 2.2: Area under various slope categories

Slope categories (%)	Area (ha)	Area (%)
0-10	807	63.73
10-20	392	30.96
20-30	56	4.46
30-40	11	0.85
>40	-	-
Total	**1266**	**100.0**

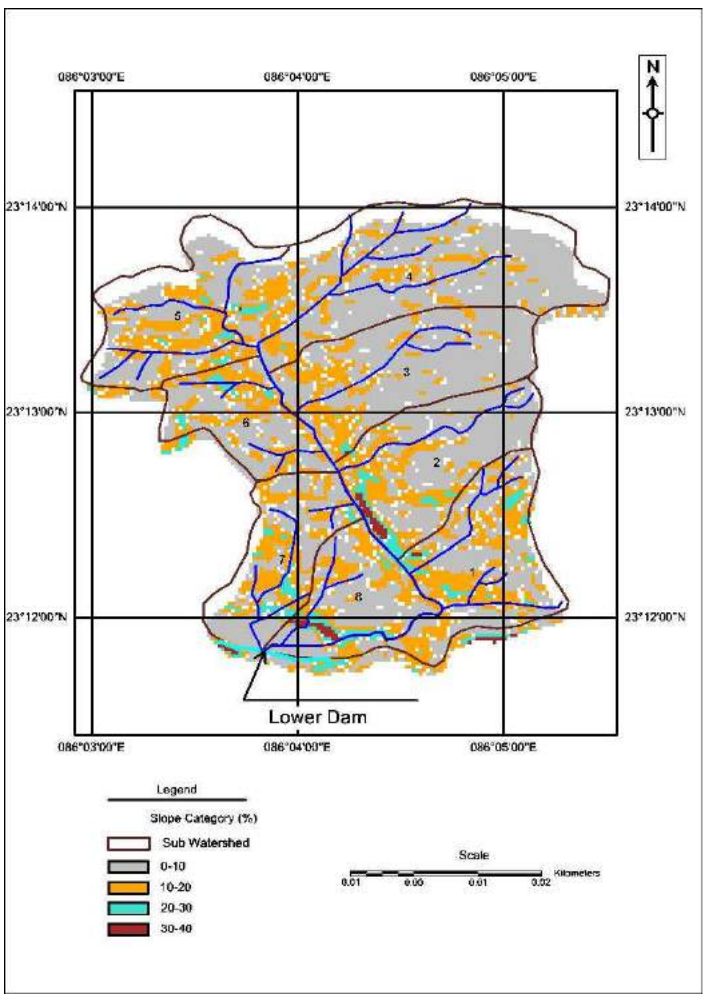


Figure-2.3: Slope Map of catchment area for Turga HEP

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)

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.

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:

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 ith unit (EIMU)
Wi	=	Weightage value of ith 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 2.3.**

Table 2.3: Criteria for erosion intensity rate

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.

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

e. Infrastructure Development

- Holistic Support to Staff
- Operational Support to Staff
- Maintenance of Departmental Buildings and inspection paths

2.5 CATCHMENT AREA TREATMENT (CAT) PLAN

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 as per a SYI index is given in **Table-2.4.** The details are shown in **Figure-2.4**. The area under different erosion categories is given in **Table-2.5.** The CAT plan has been suggested for Sub-watersheds with high erosion category.

Table-2.4: Erosion intensity categorization as per SYI classification

Watershed number	Area (ha)	SYI value	Category
W1	172	1210	High
W2	155	1220	High
W3	185	1142	Medium
W4	301	1136	Medium
W5	146	1156	Medium
W6	97	1208	High
W7	118	1148	Medium
W8	92	1214	High
Total	**1266**		

Table-2.5:Area under different erosion categories

Category	Area (ha)	Area (%)
Low	-	-
Medium	750	59.24
High	516	40.76
Total	**1266**	**100.00**

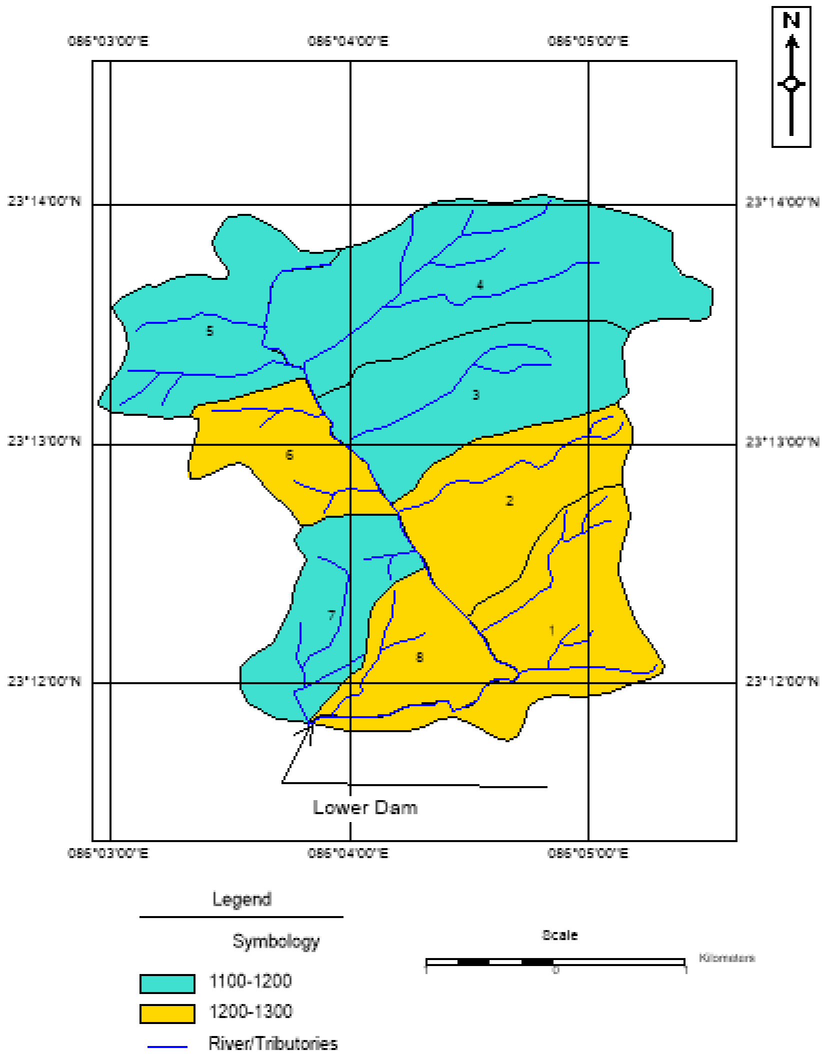


Figure-2.4: Prioritisation of Sub Watersheds for catchment area for Turga HEP

The area under high erosion category has to be treated by the project proponents, which accounts for about 42% of the total free draining catchment area. Sub-watershed wise proposed treatment measures are depicted in **Figure 2.5.** It is proposed that treatment measures shall be implemented by the Forest Department, State Government of West Bengal. CAT plan will be implemented within two years.

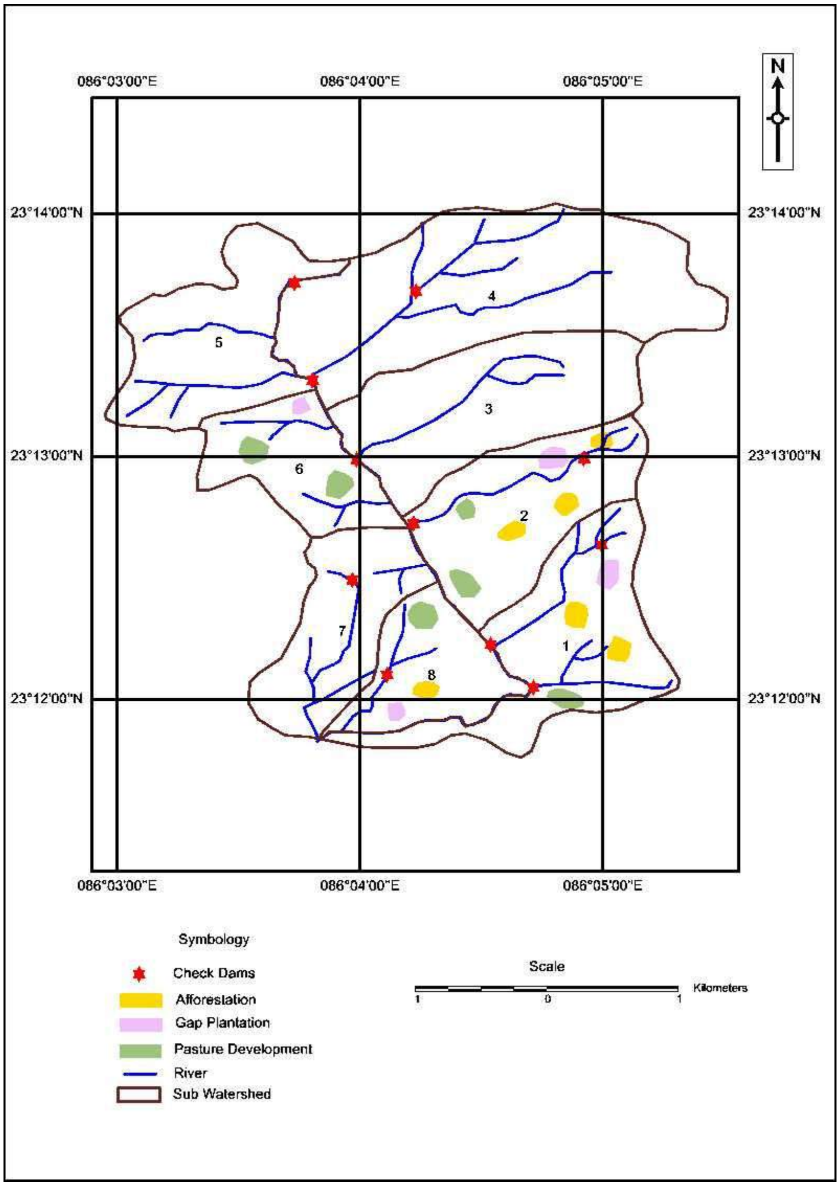


Figure-2.5: CAT Measures for catchment area of Turga HEP

2.6 CATCHMENT AREA TREATMENT MEASURES

2.6.1 Afforestation

An amount of Rs. 170.85 lakh has been earmarked for various afforestation measures. The details are given in Table-2.6.

Table-2.6: Cost Estimate for implementation of Afforestation measures as a part of CAT Plan

S. No.	Item	Unit Rate (Rs.)	Unit	Target	
				Physical	Financial (Rs. lakh)
1.	Afforestation	1,80,000/ha	ha	15	27.0
2.	Maintenance of afforestation area	12,000/ha	ha	15	1.8
3.	Enrichment Plantation	60,000/ha	ha	40	24.0
4.	Pasture development	30,000/ha	ha	20	6.0
5.	Nursery development	10,00,000/ no.	no.	2	20.0
6.	Vegetative fencing	65,000/km	km	5	3.25
7.	Watch and ward for 2 years average 10 persons per month	12,000/man-month	Man-months	240	28.8
8.	Rim Plantation	Lumpsum			50.0
9.	Social Forestry	Lumpsum			10.0
	Total				**170.85**

2.6.2 Soil & Water Conservation Works

An amount of Rs. 58.5 lakh has been earmarked for various Soil & Water Conservation measures. The details are given in Table-2.7.

Table-2.7: 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)
1.	Check Dams	3,50,000	Nos.	11	38.5
2.	Drainage line treatment				20.0
	Total				**58.5**

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 various treatments 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. 115.3 lakh has been earmarked for this purpose. The details are given in **Table-2.8.**

Table-2.8: Cost earmarked for establishing Silt Observation points

S. No.	Parameter	Cost (Rs. lakh)
1	Cost of one laboratory – Rs 5,00,000/- for silt analysis per laboratory	5.0
2	One observation hut (@ Rs 5.0 lakh/site)	5.0
3	Cost for hiring services of one person (Average salary- Rs 10,000/- for 10 years) considering 10% escalation per year	19.1
4	Cost for hiring services of supervisor one person (Average salary Rs. 20,000/- for 10 years) considering 10% escalation per year	38.2
5	Consumables for the measurement Rs. 3.0 lacs per year for next 10 years, considering 10% escalation per year	48.0
	Total	**115.3**

2.6.4 Research Training and Capacity Building

An amount of Rs. 50 lakh has been earmarked for Training & Capacity building of forest staff as well as local community through State Forest Training Institutes and reputed organizations.

2.6.5 Infrastructure Development

The total budget kept for infrastructure development for Forest Department during the implementation of CAT Plan is Rs. 65.0 lakh. The details are given in Table-2.9.

Table-2.9: 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	2 No.	10.0	20.0
2	GPS equipment	3 No.	3.0	9.0
3.	Maintenance of Departmental buildings			16.0
6.	Maintenance of Forest roads/inspection paths			20.0
	Total			**65.0**

2.7 COST ESTIMATES

The cost required for implementation of various measures is Rs. 409.65 lakh. The details are given in Table 2.10.

Table-2.10: Cost earmarked for implementation of CAT plan

S.No.	Activity	Amount (Rs. lakh)
1	Afforestation	170.85
2	Soil & Water Conservation Works	58.5
3	Silt Observation Points	115.3
4	Infrastructure Development	65.0
	Total	**409.65**

2.8 SCHEDULE FOR IMPLEMENTATION OF CAT PLAN

It is proposed to implement the CAT Plan in 2 years. The year wise implementation of physical and financial targets is given in Table-2.11.

Table-2.11: Year-wise implementation schedule for CAT Plan

S. No.	Activity	Year I		Year II		Total	
		Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)
A.	**Biological Treatment Measures**						
i)	Afforestation	7 ha	12.6	8 ha	14.4	15 ha	27.00
ii)	Maintenance of afforestation area	-	-	-	1.8	-	1.8
iii)	Enrichment Plantation	20 ha	12.0	20 ha	12.0	40 ha	24.0
iv)	Pasture Development	10 ha	3.0	10 ha	3.0	20 ha	6.0
v)	Nursery Development	2 No.	20.0	-	-	2 No.	20.00
vi)	Vegetative Fencing	3 km	1.95	2 km	1.30	5 km	3.25
vii)	Watch and ward	80 man-months	9.64	160 man-months	19.2	240 man-months	28.84
viii)	Rim Plantation	-	25.00	-	25.00	-	50.00
ix)	Social Forestry	-	5.0	-	5.0	-	10.00
	Sub-Total (A)		**89.19**		**81.7**		**170.85**
B.	**Soil & Water Conservation Works**						
i)	Check Dams	6	21.0	5	17.5	11.0	38.50
ii)	Drainage line treatment		10.0		10.0	-	20.00
	Sub-Total (B)		**31.0**		**27.5**		**58.5**
C.	**Silt Observation Points**						
i)	Setting of one laboratory	1 No.	5.0	-	-	1 No.	5.00
ii)	One observation hut	1 No.	5.0	-	-	1 No.	5.00

S. No.	Activity	Year I		Year II		Total	
		Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)
	at each site						
iii)	*Cost of hiring one person (Average Salary Rs. 10,000/- for 10 years) considering 10% escalation per year	-	1.20	-	1.32	-	2.52*
iv)	*Cost of hiring one supervisor (Average Salary Rs. 20,000/- for 10 years) considering 10% escalation per year	-	2.40	-	2.64	-	5.04*
v)	*Consumables (Rs. 3.0 lac per year for next 10 years and considering 10% escalation per year)	-	3.0	-	3.3	-	6.3*
	Sub-Total (C)		**16.6**	**-**	**7.26**	**-**	**23.86***
D.	**Infrastructure Development**						
i)	Vehicle including O&M	2 No.	20.0	-	-	2 No.	20.00
iv)	GPS	3 No.	9.0	-	-	3 No.	9.00
v)	Maintenance of Departmental Buildings	-	8.0	-	8.0	-	16.00
vi)	Maintenance of Forest Roads/Inspection Pattern	-	10.0	-	10.0	-	20.00
	Sub-Total (E)		**47.0**	**-**	**18.0**	**-**	**65.0**
	Grand Total	**-**	**259.79**	**-**	**196.46**	**-**	**318.21**

Note: Cost of CAT Plan in Table-2.10 is 409.65 lakh and cost in Table-2.11 is 318.21 lakh. The difference is due to the fact that salary of manpower which has been taken for 10 years in Table-2.10, and in Table-2.11 salary for manpower has been taken for 2 years only.

CHAPTER-3

BIODIVERSITY CONSERVATION AND MANAGEMENT PLAN

3.1 INTRODUCTION

The proposed Turga Pumped Storage Project will not lead to acquisition of National Park, Sanctuary, Biosphere Reserve, or any other protected area. A detailed floral and faunal survey was carried out in the project area to assess the presence of various floral and faunal species. The rare and endangered species likely to be affected by the project were also assessed.

Conservation is the sustainable use of natural resources, so that it is preserved for future generation as well. Natural conservation involves proper management of natural wealth, places that sustain these resources besides the human pressure that affect the resources. The present chapter outlines the Bio-diversity Conservation Plan including plan for conservation of rare and endangered species as well.

The Forest Department of West Bengal is responsible for conservation and Management of forests in the state. The objective of the compensatory afforestation is to make up for the loss of forest land proposed to be diverted for construction of the proposed Turga Pumped Storage Project. The other objectives are to combat soil erosion, afforestation and last but not least to maintain and improve the ecological and environmental balance.

3.2 AFFORESTATION

The Indian Forest Conservation Act (1980) stipulates:

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

The total land required for the project is 292 ha, of which 234 ha forest land. About 234 ha of Non-forest land would be acquired for compensatory afforestation purpose. The unit cost of afforestation on forest land is Rs. 96,200/ha. The cost for afforestation of 234 ha is Rs. 225.12 lakh. In addition to above the project proponent will pay for the NPV, which shall be estimated by the Forest Department. The indigenous species shall be used for afforestation, which shall be selected in consultation with the Forest Department. The species recommended for greenbelt are given in Table-3.1.

3.3 BIODIVERSITY CONSERVATION

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

- Conservation of Avi-fauna
- Wildlife protection measures
- Training & Publicity Programmes

3.3.1 Conservation of Avi-fauna

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

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

Features of a Nest Box:

The characteristic features of nest box are listed below and is depicted in Figure-3.1.

- 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. The nest boxes shall be located in vicinity to reservoir and other water bodies in the study Area.

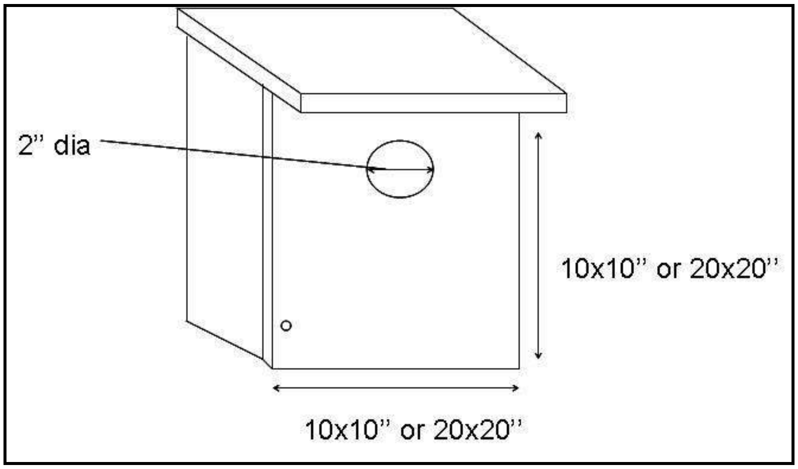


Figure-3.1: Nest Box

It is proposed that one qualified person be hired for a period of five years.

Other Measures

With the change in nature of landscape, its aquatic and terrestrial vegetation will change the habits of the aquatic birds. The aquatic culture i.e. both floral and faunal environments will change to the large extent e.g. in the initial years of the reservoir water storage. The other measures recommended for improvement of habitats are:

- Fodder and wild fruit plantation for wild animals and for roosting, breeding and hiding cover for migratory birds etc.
- Annual bird count of migratory birds by involving locals and bird experts.
- Removal of weeds and rehabilitation with local fruit bearing species in gaps.
- Anti-grazing drive in draw down area to protect the bird breeding areas in proximity to reservoir during breeding season.
- Construction of watch towers

An amount of Rs. 62.76 lakh shall be earmarked for habitat improvement of avi-fauna in the study area. The details are given in Table-3.1.

Table-3.1: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. 2000 per wooden box) and installation in the area along the green belt (200 Nos)	4.0

S. No.	Particulars	Amount (Rs. lakh)
2	Repair and maintenance of the nests	0.8
3.	Fodder and wild fruit plantation for wild animals and for roosting, breeding and hiding cover for migratory birds etc.	10.0
4.	Annual bird count of migratory birds by involving locals and bird experts.	8.0
5.	Removal of weeds and rehabilitation with local fruit bearing species in gaps.	8.0
6.	Anti-grazing drive in draw down area to protect the bird breeding areas in breeding season	5.00
	Sub-Total (A)	**35.8**
B	**Recurring Cost (for 5 years)**	
1	Salary for one qualified person @ Rs. 30,000 per month for implementation and data collection including 10% escalation	21.96
2	Contingencies (including avifaunal biodiversity awareness programme for the local inhabitants)	5.0
	Sub-Total (B)	**26.96**
	Total (A+B)	**62.76**

3.3.2 Wildlife Protection Measures

Anti-poaching Measures

There are no ecologically sensitive areas around the project sites. However, forests at the site and in the study area serve as a habitat for wildlife. Due to construction activities and increased human interferences, as a result of immigration of large labour population and their family members, some adverse impacts may take place on wildlife during construction phase; the increased human interferences can have adverse impact on wildlife in and around the project area.

It is recommended that check posts are installed along the following sites to prevent anti-poaching activities. In view of this it is recommended that 4 check posts be developed. The location of these check posts could be:

- Near Upper dam site
- Near Lower dam site
- Near Labour camp-1
- Near Labour camp-2

Each check posts will have 3 guards to ensure that poaching does not take place in the area. One range officers will supervise the guards of various check posts. The check post shall have appropriate transportation and communication facilities. Other infrastructure, like areas and communities, etc. too shall be provided.

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. 20 lakh has been earmarked. The anti-poaching kits will include equipments for self defense of the staff as well.

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. 30 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., spotoscope, binoculars, video as well as digital still cameras are essential. Purchase of field vehicle will help in increased vigilance. For better communication and purchase of survey equipment an amount of Rs. 20 lakh has been earmarked.

Construction of Check posts: To improve vigilance for anti-poaching, better protection, enforcement for control grazing practices, control-grazing-cum-anti poaching check posts shall be constructed. An amount of Rs.25 lakh has been earmarked for this purpose.

Wildlife Protection Force

A team of forest personnel and guards shall be deployed for works under forest & wildlife protection plan and an amount of Rs. 90.62 lakh has been earmarked for this purpose. The details are given as below:

Salary

▪ Guards (12 nos.) @ Rs.8000 per month	Rs. 11,52,000
▪ One range officer @ Rs.20000 per month	Rs. 2,40,000
▪ Total cost for one year	Rs. 13,92,000
Cost for 63 months (Assuming 10% increase per year)	Rs. 90.62 Lakhs

An amount of Rs. 185.62 lakh has been earmarked for implementation of various measures as a part of Wildlife Protection Plan. The details are given in Table-3.2.

Table-3.2: Measures for implementation of Wildlife Protection Plan

S. No.	Particulars	Amount (Rs. lakh)
	Non-recurring	
1	Anti Poaching Kits	20.00
2	Infrastructure	30.00
3	Survey equipment & vehicle	20.00
4	Check posts	25.00
	Sub-Total (A)	**95.00**
	Recurring	
5	**Salary for wildlife protection force**	**90.62**
	Sub-Total (B)	**90.62**
	Total (A+B)	**185.62**

3.3.3 Training & Publicity Programmes

Under this programme, 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 of knowledge on environment and ecology in village schools.
- Publishing of research documents, pamphlets, brochures, hoardings
- 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. 10 lakh has been earmarked for this purpose.

3.4 BUDGET

A total provision of Rs. 483.50 lakh has been earmarked for biodiversity conservation. The details are given in Table-3.3.

Table-3.3: Estimated cost of Biodiversity Conservation and Management Plan implementation

S.No.	Particulars	Cost (Rs. lakh)
(A)	Compensatory Afforestation Plan	225.12
	Sub-total (A)	**225.12**
(B)	**Biodiversity Conservation & Management Plan**	
1	Habitat improvement for avi-fauna	62.76
2	Wildlife protection	185.62
3	Training and Publicity Programmes	10.00
	Sub-total (B)	**258.38**
	Total (A+B)	**483.50**

CHAPTER-4

FISHERIES MANAGEMENT PLAN

4.1 FISHERIES STATUS

Turga is a small river with shallow bottom, therefore, hardly harbours small species like *Barilius bendelisis*, *Chela cachius*, *Puntius* spp. and *Nemacheilus* spp. Some of the species like *Labeo rohita*, *L. calbasu*, *Catla catla*, *Cirrhinus mrigala*, *Anabas testudineus*, *Badis badis*, etc have been introduced in the existing reservoir of I&W Dte. Govt. of West Bengal. The list of fish species observed in the Study Area is given in Table-4.1.

Table-4.1: Fish species composition in Study Area

S. No.	Scientific Name	Vernacular Name	Distribution	IUCN Status
	Cyprinidae			
1	*Labeo rohita*	Rohu	Irrigation Dam Reservoir	LC
2	*Labeo calbasu*	Rohu	Irrigation Dam Reservoir	LC
3	*Cirrhinus mrigala*	Mrigal	Irrigation Dam Reservoir	LC
4	*Gibelion catla*	Catla	Irrigation Dam Reservoir	LC
5	*Puntius sophor*	Puthi	Irrigation Dam Reservoir/ Turga River	LC
6	*Puntius chola*	Puthi	Irrigation Dam Reservoir/ Turga River	LC
7	*Puntius ticto*	Puthi	Irrigation Dam Reservoir/ Turga River	LC
8	*Garra spp.*	Garra fish	Irrigation Dam Reservoir	LC
9	*Barilius bendelisis*	Korong	Study Area	LC
10	*Chela cachius*	-	Study Area	LC
	Ambassidae			
11	*Chanda / Parambassis ranga*	Glassy fish	Irrigation Dam Reservoir	LC
	Balitoridae			
12	*Nemacheilus sp.*	-	Study Area	-
13	*Nemacheilus montanus*	-	Study Area	-
	Cobitidae			
14	*Lepidocephalus guntea*	-	Study Area	LC
	Cichlidae			
15	*Oreochromis mossambicus*	Cichlids	Irrigation Dam Reservoir	LC
	Channidae			
16	*Channa punctatus* (Bloch,1793)	Snake head	Irrigation Dam Reservoir	LC
	Gobiidae			
17	*Glossogobius giuris*	-	Irrigation Dam Reservoir	
	Anabantidae			
18	*Anabas testudineus*	Koi	Irrigation Dam Reservoir	DD
	Notopteridae			
19	*Notopterus notopterus*	Pupda	Irrigation Dam Reservoir	LC
	Nandidae			
20	*Badis badis*	Dum	Irrigation Dam Reservoir	LC

S. No.	Scientific Name	Vernacular Name	Distribution	IUCN Status
	Mastacembelidae			
21	*Macrognathus aral*	Bam	Irrigation Dam Reservoir	

LC = least concerned, DD = data deficient

During post monsoon season, a total of 6 species were observed from different sites. *Puntius* sophore, *Puntius ticto* and *Macrognathus aral* or bam eel were landed from the downstream of the reservoir with the help of local fishermen. *Chela cachius* and *Barilius bendelisis* were found to inhabit Turga nalla.

In summer season, maximum number of catch belonged to *Oreochromus mosambicus*, followed by Puntius sp –small barbs and other trash fishes like Indian Glassy fish.

In monsoon season a total of 5 species were observed from the downstream of reservoir, Turga nalla and reservoir. Fish fauna of middle stretch comprised of *Garra* species, *Macrognathus aral* and *Puntius* sophore. Turga nallah harboured *Nemacheilus montanus* and *Puntius* sp. Other species listed in Table-4.1 were reported to inhabit reservoir and other wetland of Baghmundi division.

During field investigation, local fishermen using different gears were found to land fish from the outlet of Irrigation Dam Reservoir of lower dam during post-monsoon, summer and monsoon seasons. The catch size ranges from 0.4 to 1.2 kg for two hours fishing. Fishermen used cast net to land fish.

As per the Fisheries Department atleast two societies known as Baghmundi Thana FCS Ltd exist in the Baghmundi division. Under these societies, many fishermen are registered. In addition, Paddy fishery in the Baghmundi area was also observed during the field studies.

4.2 SUSTENANCE OF RIVERINE FISHERIES

Release of Minimum Flow

The dry segment of river between barrage/dam site and tail race at certain places may have shallow water 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, considered to maintain a minimum flow to ensure survival and propagation of invertebrates and fish.

For Turga Pumped Storage Project, the Environmental Flows for Upper and Lower Reservoir are given in Tables-4.2 and 4.3 respectively.

Table-4.2: Recommended Environmental Flows for Upper Reservoir

Month/Season	Flow in 90% DY (MCM)	Percentage of inflow as Environmental Flow	Environmental Release (MCM)
June	0.11	30%	0.03
July	0.38	30%	0.11
August	0.02	30%	0.006
September	1.55	30%	0.47
October	0.56	30%	0.17
Monsoon (Total)- **(A)**	2.63	30%	0.786
Non-Monsoon (Total)- **(B)**	0.29	25%	0.0725
Annual (A+B)	**2.92 MCM**		**0.8585, say 0.86 MCM**

Table-4.3: Recommended Environmental Flows for Lower Reservoir

Month/Season	Flow in 90% DY (MCM)	Percentage of inflow as Environmental Flow	Environmental Release (MCM)
June	0.17	30%	0.05
July	0.58	30%	0.17
August	0.04	30%	0.01
September	2.37	30%	0.71
October	0.86	30%	0.26
Monsoon (Total)- **(A)**	4.01	30%	1.20
Non-Monsoon (Total)- **(B)**	0.44	25%	0.11
Annual (A+B)	**4.45 MCM**		**1.31 MCM**

It is considered to release the environmental flow from very beginning of the construction of both the Dams, so that environmental and ecological aspects can be maintained properly in that area. The existing irrigation and drinking water requirements during filling period of reservoirs shall be met by diverting water from other sources e.g., Bamni nala.

4.3 MANAGEMENT OF HABITAT

The management of reservoirs is based on the stocking–cum capture fishery technique. The formation of fish population in reservoir is basically from the parental population of the inundated river and watershed areas. It is usually characterised by strengthening of lacustrine species and decline in riverine species as a result of change from riverine to lacustrine condition which do not favour them. The management techniques involve :

- Introduction of selected varieties of carps from extraneous sources, so as to develop a carp dominated fishery through self-propagation as well as regular stocking.
- A rational system of exploitation based on the concept of fishing effort and population dynamics of the fish stock.

- Conservation measures e.g. regulation of mesh size, imposition of size limits, observance of closed season, ban on destructive methods of fishing etc.
- Preservation, transport and marketing of fresh fish.

The initial trophic burst stage is the most critical stage of management. The reservoir is amenable for stock manipulation or correction during these initial crucial years by selective stocking with greater emphasis on fishes of short food chain (phytophagus) and close to primary producers like Indian major carps viz, Catla, Rohu and Mrigal.

The Indian major carps are stocked as they find the environment suitable for growth and production, and their compatibility and non-cannibalistic trait, high fecundity and breeding success, etc. For better utilization of the unutilized fraction of food (phytoplankton, zooplankton, benthos, periphyton, detritus, etc.) stocking of *L. calbasu, L. fimbriatus, L. bata*.

4.3.1 Impacts of Stocking

Stocking in the medium and large reservoirs could be considered as successful only when the stocked fish are recaptured. Indian experience of stocking medium and large reservoirs suggests that by and large, the stocking becomes effective only when the stocked fishes propagate themselves. Moreover, this breeding population can be built-up only if the stocking is resorted to during the early phase of the reservoir formation.

4.3.2 Stocking Density

Decision regarding number of fingerlings to be stocked in any impoundment are vital and depends upon the potential of the biotope. A number of methods are in vogue for calculating the stocking rate. Huet (1960) provided a general stocking formula, which can be applied universally irrespective of the size of the reservoir. The fish yield can be estimated from the primary productivity studies or trophodynamic models. While estimating the percentage loss, chances of survival of the stocked fish in the light of predator pressure, escapement through the outlets and over fishing are to be taken into consideration:

$$\text{Stocking rate (No./ha.)} = \frac{\text{Total yield (in kg./ha.)}}{\text{Individual growth rate of fish in kg.}} + \text{loss (\%)}$$

A desired balance between the stocking rate, population density and growth is to be maintained with enough flexibility so as to swing it to suit the changes in the environmental factors.

4.3.3 Fish Seed Requirement

Based upon experience gained in the past, a stocking rate of 300 fingerlings per ha. (above 100 mm.) for reservoir has been proposed in the initial years of development. The total requirement of advanced fingerlings will thus be 0.44 lakh (100 mm.).

The submergence area of the Upper and Lower Reservoir is 146.05 ha. In order to attain this target, the requirement of fish seed of different sizes have been worked out as under:

(i) Requirement of advanced fingerlings:

Stocking @ 300 advanced fingerlings / ha. (100 mm.)

146.05 ha x 300 = 0.44 lakh

(ii) Requirement of standard fingerlings:s (50 mm.) at 80% survival

$$\frac{0.44 \times 100}{80} = 0.55 \text{ lakh}$$

(iii) Requirement of fry (25 mm.) at 60% survival

$$\frac{0.55 \times 100}{60} = 0.92 \text{ lakh}$$

(iv) Requirement of spawn = 0.92*100/40 = 2.291 lac, say 2.3 lakh

REQUIREMENT OF REARING SPACE

(i) Nursery area : 0.5 ha.
(ii) Rearing area for fry to standard fingerlings (50 mm.) @ of 3.00 lakhs / ha. Thus requirement for 2.3 lakh fingerlings x shall be about 1 ha.
(iii) Advanced fingerlings ponds @ 8 lakh / ha.= 0.3 ha.

If for S.No. (i) and (ii) two crops are taken the rearing area will be further reduced as under :

N.P. = 0.5

R.P. = 0.25

Total : 0.75 ha.

Brood Stock Ponds: Adequate provision for maintenance of brood stock should also be made, preferably in close vicinity of the hatchery. In addition to the above rearing space, for raising advanced fingerlings, 0.3 ha of advance fingerling ponds would be needed. These grow out ponds should be managed and operated as far as possible with peoples participation for which necessary technical expertise will be provided by State Fisheries Department. Some of the village ponds situated along the periphery of the reservoir could also be used for raising advanced fingerlings. This will generate additional income to the locals.

The Schematic Diagram for Proposed Hatchery is enclosed as Figure-4.1.

4.3.4 Organisation of Fishermen and Training

Fishermen in India, belong to the lower socio economic segment of the population, are mostly illiterate and chronically indebted to the middlemen. Hence, socio-economic reforms for 'welfare of Fishermen' is an essential aspect for the all round development of fisheries in India. The primary societies are basically producer societies engaged in fishing activities. The apex body will provide credit and supplies to the primaries and market their catch. They will also arrange for the infrastructures needed for storage, transportation of fish, welfare of the fishermen etc. and distribute bonus / dividend to the primaries in addition to payment of catching charges of fish. It is proposed to bring about 50 fishermen in the cooperative sector.

These fishermen will be imparted training in fishing techniques and operation of boats, handling, storage and transport of fish etc. They will also be provided with productive assets to pursue their vocation.

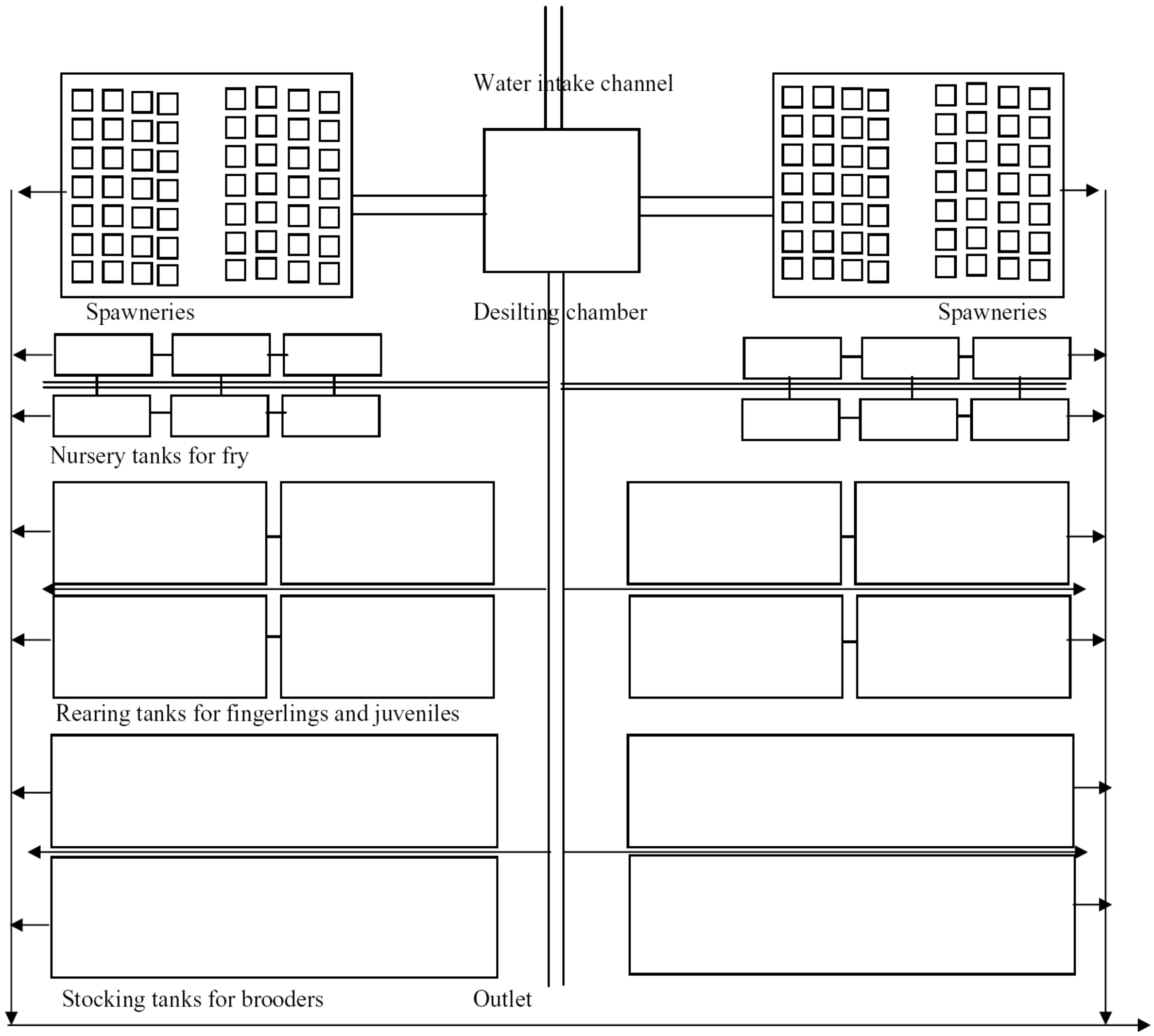


Figure-4.1: Schematic Diagram for Proposed Hatchery

4.3.5 Fish Production Potential

If the optimum rate of stocking is maintained from the very beginning, commercial fishing could be taken up 3 years after initiation of the stocking programme. During this period, the endemic fish population shall be available for partial exploitation. On full development, a fish yield of 50 kg. per ha. is envisaged with an annual production of about 7.0 metric tonne.

4.3.6 Infrastructure Facilities

Fishing Nets

Under the project each fisherman will be provided with 20 kg. of finished nylon nets with floats etc. The nets could be supplied in 2 years @ 10 kg/yr. Boat seines/drag nets could be operated in selected large shallow areas from where trees, stumps, etc. have been removed flush to the ground.

Fishing Boats

For the proposed project, it is proposed to provide one fishing boat for every 2 fishermen.

Transport Vehicles

Mini Truck

One mini truck of 1 Ton capacity is proposed for transportation of fish from the landing centres/packing centres to local marketing points. It will also be used for transportation of ice and packing materials, and transportation of iced fish to railway station. It will be also used for hatchery needs and transportation of fish seed to stocking sites.

Jeep with Trolley

One jeep with trolley is proposed for inspections, supervision, transportation, patrolling purposes, etc.

Post-Harvest Facilities

The post harvest facilities will consist of two fish handling sheds, one Ice Plant –cum cold storage of 1 ton capacity, one Ice crushing machines and 100 stockable crates.

4.3.7 Conservation and Management Fisheries Rules

It is proposed to formulate reservoir fishing rules, which would include regulation of mesh size, restrictions on catching of major carps below certain size and weight, observance of closed season etc.

Closed Season

Under the existing rules fishing is restricted from 16 June to 15 August each year which is the breeding season of major carps and also certain cat fishes.

Regulation of Mesh Size

Regulation of mesh size will be enforced to protect destruction of spawners and juveniles particularly during closed season. Restrictions on minimum size of important fishes like Catla, Rohu, etc. will also be imposed.

Motivation and Awareness

During the last decade or so, it has been observed that the conservation rules for Natural Resource Management (NRM) could be enforced properly with peoples' participation and emphasis is laid on community conserved Bio-diverse Areas. For this, apart from Motivation and Awareness creation involvement of fishing community in the fishery development process is essential.

4.4 COST ESTIMATES

The total cost estimates of the project works out to Rs. 88.7 lakh. The details are given in Table-4.4.

Table-4.4: Cost estimate for implementation of fisheries management plan

S. No.	Items	Cost (Rs. Lakh)
1	**Assistance to fishermen**	
A	Fishing nets, floats etc. @ Rs. 10000/- per fisherman for 50 fishermen.	5.0
B	Boats: @ one boat for 2 fishermen, total 25 boats @ Rs. 20,000/- each.	5.0
C	Training expenses @ Rs. 2000/- per fisherman for 50 fishermen.	1.0
	Sub Total (1)	**11.0**
2	**Survey and identification of fishermen and organisation of societies.**	2. 0
	Sub Total (2)	**2.0**
3	**Stocking of fingerlings :**	
	Construction of hatchery (composite fish farm) including farm equipments, approach/ internal roads etc.	30.0
	Sub Total (3)	**30.0**
4	**Fish transport and marketing :**	
A	Mini Truck - 1 No.	5.0
B	Jeeps with trolly – 1 No.	7.5
	Sub Total (4)	**12.5**
5	**Post Harvest facilities :**	
A	Fish handling sheds – 2 Nos.	15.0
B	Ice Plant (1 Ton) with Cold storage - 1 No	15.0
C	Ice-crushing machine (Elec.- cum - diesel) -1 Nos.	2.0
D	Stockable crates - 100 Nos.	1.20
	Sub Total (5)	**33.20**
	Total	**Rs.88.70 lakh**

CHAPTER 5

GREENBELT DEVELOPMENT PLAN

5.1 INTRODUCTION

The forest loss due to the reservoir submergence and construction of other project appurtenances shall 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

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.

5.2 PLANTATION

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 recommended for greenbelt development are given in **Table 5.1**.

Table 5.1: Species recommended for greenbelt development for Turga PSP

Scientific Name	Local Name
Trees	
Aegle marmelos	Bael
Albizia procera	Safed Siris
Albizzia lebbek	Kala siris
Altsonia scholaris	Saptparni
Artocarpus lacucha	Dahua
Cassia fistula	Amaltas
Ficus bengalensis	Bargad
Holoptelea integrifolia	Kanju

Scientific Name	**Local Name**
Mallotus philippinensis	Kamla
Syzygium cumini	Jamun
Terminalia arjuna	Arjun
Terminalia bellirica	Bahera
Terminalia chebula	Haritaki
Shrubs	
Abutilon indicum	Jhampi
Annona squamosa	Seethaphal
Calotropis gigantean	Akand
Carissa spinarum	Auka Kuli
Zizyphus mauritiana	Ber

5.3 COST ESTIMATE FOR GREEN BELT DEVELOPMENT

The cost of plantation per hectare is estimated at Rs. 84,000 per ha which includes sapling cost, nursery cost, labour cost, cost of manure, weeding etc. It is proposed to afforest about 20 ha of land as a part of Greenbelt development. The total cost works out to be Rs. 16.8 lakh.

CHAPTER -6

CONTROL OF WATER, AIR AND NOISE POLLUTION

6.1 WATER POLLUTION CONTROL

6.1.1 Control of Water Pollution during Construction Phase

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

The construction activities would require a crusher to crush large lumps of rocks to the requisite size for coarse as well as fine aggregates. The effluent generated from these crushers will have high-suspended solids. The effluent needs to be treated before disposal. Settling tanks of appropriate size for treatment of effluent from various crushers should be provided.

During tunneling work ground water flows into the tunnel along with construction water, which is used for various works like drilling, shortcreting, etc. The effluent thus generated in the tunnel contains high suspended solids. Normally, water is collected in the side drains and drained off into the nearest water body without treatment. It is recommended to construct a settling tank of adequate size to settle the suspended impurities. The sludge from the various settling tanks can be collected once in 15 days and disposed at the site designed for disposal of municipal solid wastes from the labour camps. The sludge after drying could also be used as cover material at landfill disposal site. An amount of Rs. 20.0 lakh has been earmarked for construction of various settling tanks.

6.1.2 Control of Water Pollution during Operation Phase

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 the well-designed colony of existing PPSP Project Colony with all the infrastructural facilities, water pollution due to disposal of sewage is not anticipated.

6.2 AIR POLLUTION CONTROL

6.2.1 Control of Emissions

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

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

6.2.2 Control of Air Pollution 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 6.1**, and are recommended to be followed.

Table 6.1: Emission limits for DG sets prescribed by CPCB

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

* Light absorption coefficient at full load (m^{-1})

The above standards need to be followed by the contractor operating the DG sets.

The other measures are recommended as below:

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

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

  H = Total height of stack in metre

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

  KVA = Total generator capacity of the set in KVA

6.2.3 Dust Control

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

- Identification of construction limits (minimal area required for construction activities).
- When practical, excavated spoils will be removed as the contractor proceeds along the length of the activity.
- When necessary, stockpiling of excavated material will be covered or staged offsite location with muck being delivered as needed during the course of construction.
- Excessive soil on paved areas will be sprayed (wet) and/or swept and unpaved areas will be sprayed and/or mulched. The use of petroleum products or similar products for such activities will be strictly prohibited.
- Contractors will be required to cover stockpiled soils and trucks hauling soil, sand, and other loose materials (or require trucks to maintain at least two feet of freeboard).
- Contractor shall ensure that there is effective traffic management at site. The number of trucks/vehicles to move at various construction sites to be fixed.
- 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.

6.3 NOISE CONTROL MEASURES

6.3.1 Control of noise from construction equipment

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

- vehicles to be equipped with mufflers recommended by the vehicle manufacturer.
- staging of construction equipment and unnecessary idling of equipment within noise sensitive areas to be avoided whenever possible.
- notification will be given to residents within 100 m of major noise generating activities. The notification will describe the noise abatement measures that will be implemented.

- monitoring of noise levels will be conducted during the construction phase of the project. In case of exceeding of pre-determined acceptable noise levels by the machinery will require the contractor(s) to stop work and remedy the situation prior to continuing construction.

6.3.2 Control Noise from 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 up to 1000 KVA shall be 75 dB(A) at 1 m from the enclosure surface.
- Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
- The Acoustic Enclosure should be made of CRCA sheets of appropriate thickness and structural/ sheet metal base. The walls of the enclosure should be insulated with fire retardant foam so as to comply with the 75 dBA at 1m sound levels specified by CPCB, Ministry of Environment & Forests.
- The acoustic enclosure/acoustic treatment of the room should be designed for minimum 25 dB (A) Insertion Loss or for meeting the ambient noise standards, whichever is on the higher side.
- The DG set should also be provided with proper exhaust muffler.
- Proper efforts to be made to bring down the noise levels due to the DG set, outside its premises, within the ambient noise requirements by proper siting and control measures.
- A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

6.3.3 Control Noise from crushers

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

It is known that continuous exposure to noise levels above 90 dB(A) affects the hearing of the workers/operators and hence has to be avoided. Other physiological and psychological effects have also been reported in literature, but the effect on hearing acuity has been specially stressed. To prevent these effects, it has been recommended by international specialist organizations that the exposure period of affected persons be limited as specified in **Table 6.2**.

Table-6.2: Maximum Exposure Periods specified by Occupational Safety and Health Administration (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

6.4 IMPLEMENTING AGENCY

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

CHAPTER-7

PLAN FOR SOLID WASTE MANAGEMENT PLAN & SANITATION FACILITIES IN LABOUR CAMPS

7.1 INTRODUCTION

The labour camp for and residential complex for technical staff involved in construction phase will be located in the vicinity of construction sites. The total increase in labour population during construction phase shall be about 4,000. In addition to this, during construction stage it is expected that about 100-200 people from nearby villages will visit project site every day for commercial purposes and constitute the regular floating population. This floating population may also generate solid waste.

7.2 SANITATION FACILITIES IN LABOUR CAMPS

7.2.1 Increase in Labour Population

The project construction is likely to last for a period of 63 months. About 200 technical staff and 800 labour population shall be involved in construction phase. The total increase in population shall be about 4,000. The aggregation of large number of workers in the project area during the construction phase is likely to put considerable stress on the prevailing biotic and abiotic environment of the area. The stress could be on account of increased water demand, sewage and solid waste generation, fuel requirements etc. The aim of this EMP is to minimize these stresses.

7.2.2 Facilities in Labour Camps

a) Housing

It shall be made mandatory for the contractor involved in the construction activities to provide adequate facilities for water supply and sanitation. It is recommended that the contractor provides living units to each of the labour family involved in the construction activities. The units should have proper ventilation.

b) Water supply

As mentioned earlier, about 4000 workers and technical staff (including family) are likely to congregate during project construction phase. The domestic water requirement of the labour/employee population is expected to be of the order of 0.28 mld @ 70 lpcd. Appropriate water supply sources need to be identified. Proper infrastructure for storage and if required treatment e.g. disinfection or other units, shall also be provided.

c) Sewage treatment

The domestic water requirement shall be of the order of 0.28 mld. It is assumed that about 80% of the water supplied will be generated as sewage. Thus, the total quantum of sewage generated is expected to be of the order of 0.23 mld. The BOD load contributed by domestic sources will be about 180kg/day. The sewage generated from labour camps shall be treated prior to disposal.

The labour population is proposed to be situated in existing colonies. One community toilet shall be provided for 20 persons. The sewage from the community toilets can be treated in a Sewage Treatment Plant (STP) comprising of aerated lagoon and secondary settling tank. The treated sewage can be used for meeting irrigation requirements of areas being afforested under greenbelt development. The total cost required for implementation of sanitation facilities in labour camps shall be Rs. 90.0 lakh. The details are given in Table 7.1.

Table 7.1: Cost estimate for sanitation facilities in labour camps

Item	Unit	Number	Total cost (Rs. lakh)
Community toilet	Rs. 30,000/community toilet	200	60.0
Aerated lagoon & Secondary settling tank	Lump sum		30.0
Total			**90.0**

The dimensions of the various units of sewage treatment plant are given as below:

Aerated lagoon

- Length : 30 m
- Width : 15 m
- Depth : 3 m

Secondary Settling tank

- Diameter : 3.5 m
- Depth : 2.5 m

7.3 SOLID WASTE MANAGEMENT

7.3.1 Quantity of Solid Waste Generation

The quantity of waste generated in Indian cities reported to be in the range of 0.2-0.6 kg/capita /day as per the "Manual on Solid Waste Management" prepared by Central Public Health & Environment Engineering Organisation (CPHEEO), Ministry of Urban Development, Govt. of India. The Waste Generation pattern is very much dependant on the living style of the population. As the major share of the population is labour force will stay in the project area, the solid waste generation factor of 210 g/capita/day has been taken into consideration.

Solid waste generation will be the leading problem among the negative impacts assuming that huge quantity of municipal waste that would be generated from residential colony, labour camps and office buildings when the project is constructed. Huge amount of sewage will also be generated from the similar sources during the construction and operation phase of the proposed project.

The major generation sources for sewage and municipal wastes would be as follows:

- Municipal waste from residential colony, labour camps, office buildings
- Sewage from residential colony, labour camps, office buildings
- Hazardous wastes (i.e. Bio-Medical wastes) from primary health centre and hospitals

It is also expected that if proper management measures for solid waste are not adopted, it will degrade the nearby environment, create hazards for labour and staff that would be posted in the project area during construction/ operation period of the project. Therefore, all the problems due to origination of solid waste require proper management facilities. The types of wastes, its composition and major generation sources during the construction/ operation of proposed Project are indicated in Table-7.2.

Table-7.2: Expected typical composition of waste in proposed project

Waste Type	Composition of waste	Sources of waste generation
Municipal waste	Food wastes, plastics, paper, sewage, glass, vegetables waste.	From residential and labour camp areas
Construction waste	Empty cement begs, dust, debris, demolition and construction wastes, scrap, dust and ashes etc.	From construction site and crusher etc.
Bio-medical waste	Syringes, cotton, bandages, glass tubes, etc.	From primary health centers

7.3.2 Composition of Municipal Solid Wastes

The composition of garbage in India indicates lower organic matter and high ash or dust contents. It has been estimated that recyclable content in solid waste varies from 13 to 20% and compostable materials is about 80-85%. A typical composition of municipal solid waste is given below in Table-7.3.

Table-7.3: Typical composition of municipal solid wastes expected in the proposed project

Description	Percentage by weight
Vegetable, leaves	40.15
Grass	3.80
Paper	0.81
Plastic	0.62
Glass/ceramics	0.44

Description	Percentage by weight
Metal	0.64
Stones/ashes	41.81
Miscellaneous	11.73

Source: Central Pollution Control Board

Chemical composition of solid waste is another important aspect for evaluating alternative processing and energy recovery point of view. The details of typical chemical composition of municipal wastes in India are given in Table 7.4.

Table 7.4: Chemical components of municipal solid wastes expected in the proposed project

Component	C (%)	H (%)	O (%)	N (%)	S (%)	Ash (%)
Food wastes	48	6.4	37.6	2.6	0.4	5
Paper	43.5	8	44	0.3	0.2	6
Card board	44	5.9	44.6	0.3	0.2	5
Plastic	60	7.2	22.8	-	-	10
Textiles	55	6.6	31.2	4.6	0.15	2.5
Rubber	78	10	-	2	-	10
Leather	60	8.0	11.6	10	0.4	10
Garden trimming	47.8	6	38	3.4	0.3	4.5
Wood	49.5	6	42.7	0.2	0.1	1.5
Dirt, ashes, brick etc	26.3	3	2	0.5	0.2	68

Source: Central Pollution Control Board

7.3.3 Administrative Set Up

Administratively, a Solid Waste Management Committee (SWMC) comprising of the project representatives will look after the management of solid waste. The SWMC may comprise of the following:

- In-charge of civil works, at least of the rank of Divisional Engineer / Assistant Engineer (1 No.)
- Supervisors/SAE (2 Nos.)

The SWMC will be supported by sanitary workers, sweepers etc., the number of which may be decided by the SWMC after assessing the work requirement.

7.3.4 Solid Waste Management Plan

A solid waste management system works on four basic principles viz. segregation & primary storage at the source, collection, transportation, treatment and disposal.

a) Segregation at source

- Segregation of waste is one of the critical activities in the Solid Waste Management as it saves undue efforts on transportation and disposal of recyclable or inert wastes. The segregation of such wastes, before they are transported to the processing/ disposal site, should be carried out.

- Waste segregation cannot be introduced without public awareness and should be implemented in a phased manner. In order to achieve this, the following strategy may be adopted for promoting public awareness:
  i. The residents shall be educated about appropriate use of biodegradable waste like kitchen & garden wastes.
  ii. Extensive awareness campaigns have to be organized by SWMC for educating the public on the aspects related to impacts of solid waste on environment and health, ill effects of littering and burning of wastes, segregation of municipal solid wastes, proper primary storage within their house premises, etc. The awareness can be spread through posters, distribution of pamphlets etc.
  iii. Residents may be advised to develop the habit of segregating the biodegradable waste material like kitchen and garden waste and store in a separate bag or a bin installed at their respective houses.
  - The SWMC would educate its sanitary workers about the revenue earning potential of recyclable waste and various options to earn revenue. The sanitary workers should be advised to collect such waste separately. To encourage collection of recyclables, SWMC may think of devising a plan which can provide some revenue opportunities for the sanitary workers. Market potential with respect to the forward linkages for effective disposal of recyclable waste is to be identified and exploited by the SWMC for the purpose.
  - Collection and segregation of hazardous wastes from the workshops viz. used batteries, transformer oil, used oil, metal scraps etc. and selling them to CPCB registered vendors having Environmentally Sound Management (ESM) system.
  - The operator of waste processing/disposal facility should be advised to carry out inspection of waste received to further segregate recyclables and sell them to recyclers. If it is not feasible to segregate recyclables on their own, the processing/disposal facility operator may allow registered scavengers to enter the premises of the compost plant and pick recyclable waste. This would ensure reduction in rejects, reducing burden on processing plant as well as landfill.
  - SWMC may register the names of recyclers for the recyclables such as plastics, newspapers, glass, metals etc. from residential and commercial sources and the

names of registered recyclers should be published or made known to the public residing in the project / labour colonies / labour sheds.

- SWMC may associate and involve local residents, in increasing awareness among the people to segregate recyclable material at source and hand it over to a designated waste collector identified by SWMC.

b) Primary Storage of Wastes

It is recommended to segregate waste into two categories & store the segregated wastes in two different containers:

- ❑ One container **(Green Coloured)** for the **"Biodegradable Waste"** or the **"Wet Waste"**
- ❑ Other container **(Blue Coloured)** for the **"Non-biodegradable Wastes"** or the "**Dry Waste".**

Wet waste (Biodegradable) includes the following:

- Kitchen waste including food waste of all kinds, cooked and uncooked, including eggshells and bones
- Flower and fruit waste including juice peels and house-plant waste
- Garden sweeping or yard waste consisting of green/dry leaves
- Sanitary wastes
- Green waste from vegetable & fruit vendors/shops
- Waste from food & tea stalls/shops etc.

Dry waste (Non-biodegradable) includes the following:

- Paper and plastic, all kinds
- Cardboard and cartons
- Containers of all kinds excluding those containing hazardous material
- Packaging of all kinds
- Glass of all kinds
- Metals of all kinds
- Rags, rubber
- House sweeping (dust etc.)
- Ashes
- Foils, wrappings, pouches, sachets and tetra packs (rinsed)
- Discarded electronic items from offices, colonies viz. cassettes, computer diskettes, printer cartridges and electronic parts.

- Discarded clothing, furniture and equipment

- The wet and dry wastes are to be stored in two different containers as mentioned above. As the biodegradable waste degrades and generates liquid, it is advisable to use non-corrosive container with lid for the storage of bio-degradable/wet waste.
- A **Green** coloured container of 10 liters capacity for a family of about 5-6 members would generally be sufficient for wet waste. However, it is advisable that a household should keep larger container or standby container to store the additional wastes produced in 24 hours. The household may have a spare capacity of 100% to meet unforeseen delay in clearance or unforeseen extra loads.
- Dry waste can be stored in another **Blue** coloured container of 10-12 litre capacity or plastic bag/Jute Bag/plastic/polymer containers.
- The containers are to be procured by SWMC and provided to individual households in the project colonies & labour colonies/camps. Some containers of bigger capacity (0.5 m^3) will also be kept at public places, as community bins, like offices, workshops, shops, community centre, school, canteens/ mess, guest houses etc. The places where community bins have to be placed away from drinking water sources and preferably on elevated areas where water stagnation is not there during rainy days.
- In addition to the above wastes, another type of waste called **"Domestic Hazardous Waste"** may also be generated at household level. These include used aerosol cans, batteries, household kitchen and drain cleaning agents, car batteries and car care products, cosmetic items, chemical-based insecticides/rodenticides, light bulbs, tube-lights and compact fluorescent lamps (CFL), paint, oil, lubricant and their empty containers. These wastes are to be stored separately, whenever generated and sold for recycling or handed over to the sanitary workers who come for house-to-house collection.
- To enforce successful implementation, necessary rules/by-laws should be framed by SWMC to make segregation and storage at source compulsory and also to avoid littering and burning of wastes at the project sites.

c) Collection of Solid Wastes

- It is recommended to have a mechanism for door to door collection of waste from the staff/ labour colonies and labour sheds. The sanitary workers / sweepers) will have tricycle with containers or containerized handcarts having ringing bell and will go for waste collection from individual house at a fixed time every day. The sanitary workers would ring the bells at the time of reaching the particular area/locality, giving a signal for waste collection to the residents.

- In labour colonies also, the door-to-door collection of waste would be carried out. The containerized rickshaws or handcarts would be employed for collection of wastes. The labourers should be strictly advised to store the wastes in available plastic containers of suitable size. The waste bins including community bins are to be cleaned daily by the sanitary workers at an informed timing.
- During collection of wastes from the bins, care shall be taken to avoid waste spillage and it shall be the responsibility of the sanitary workers to clean & maintain hygienic conditions at the places where community bins are kept.

d) Waste Handling

- As per Municipal Solid Waste (Solid Waste Management & Handling) Rules, 2000; the manual handling of waste has to be avoided. As per the recommended system, the waste from their source of generation is either collected by sanitary workers during door-to-door collection from the colonies or from community bins.
- The sanitary workers, after primary collection, will transport the waste to the storage depots from where it will be lifted by dumper placers and transported to the processing & disposal sites.
- The community bins of size 0.5 m^3 are to be lifted manually and unloaded into the containers kept in the transportation vehicles.
- The sanitary workers involved in manual lifting are to be provided with gloves and masks and shall be instructed to use them compulsorily while handling waste. It will be the responsibility of the sanitary supervisors to monitor the proper use of personnel protective equipment by the workers.

e) Transportation of Solid Wastes

- It is recommended to use tricycles/push carts/containerized handcarts, for primary collection of waste from the individual households, offices and other public places, as described above, up to the waste storage depots. The sufficient number of tri-cycles / push carts/containerized handcarts shall be arranged for effective door-to-door collection system.
- The wastes collected from the street sweeping and drain cleaning is to be shifted to the waste storage depots using tricycles/handcarts.
- The transportation of waste from the waste storage depots to the processing and disposal sites will be done in the covered trucks/dumpers etc. so that the waste is

not exposed to the human population and there is no spillage of waste on the roads during transportation.

- To take care of certain unavoidable circumstances, if it is required to lift waste from some open place, front-end loaders and tractor trolleys may be used. However, the waste in tractor trolley has to be covered with LDPE sheet during its transport.

7.3.5 Disposal of Solid Waste (Non-degradable Portion)

As per the requirements of the Municipal Solid Waste (Solid Waste Management & Handling) Rules 2000, land filling would be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Land filling shall be done following proper norms and landfill sites shall meet the specifications as given in these rules. The quantum of solid waste to be disposed for landfill is given in **Table-7.5**.

Table-7.5: Estimation of Quantity of waste to be disposed to landfill

S. No.	Description	Data
1.	Per capita MSW generation at present	0.21 kg per capita per day
2.	Population during construction stage of the project	4000
3.	Total Solid Waste (SW) generation at the rate of 0.21 kg/capita/day	840 kg/day
4.	Considering the fraction of bio-degradable waste as 45 % of total SW generated, total quantity of bio-degradable waste to be generated (for vermi-composting)	378 kg/day
5.	Inorganic waste for disposal (48% of total waste) to landfill (considering that recyclable waste in form of paper, glass, metals, plastic etc. constitute 7 % of total waste)	403.2 kg/day
6.	Quantity of rejects generated from the compost plant to be disposed to landfill, assuming the rejects as 30% of waste going to compost plant	114 kg/day
7.	Hence total waste to be disposed in landfill at present	517.2 kg/day
8.	Waste to be disposed to landfill	16.0 tons/month
9.	Waste to be disposed to landfill in 63 months	1010 tonnes

The details of landfill site are given as below:

- Length 20 m
- Width 16 m
- Depth of fill 5 m

A provision of 15% of the total area, for accommodating infrastructure facilities has also been 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)
- 0.2m thick protective layer of sandy silt
- 1.50mm 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).

7.3.6 Treatment of Solid Waste (Degradable Portion)

Considering the fraction of bio-degradable waste as 45 % of total SW generated, total quantity of bio-degradable waste to be generated (for vermi-composting), which amounts to about 0.6 m^3/day. The vermi-composting the process takes around 60 days to mature. Thus the total capacity of pits required would be (60 X 0.6) 36 cu m.

A pit of 2 m x 1.5 m x 1.3 m deep (0.3m freeboard) size can take 3.0 cu m of compostable waste. Thus the no. of pits required shall be 12. 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 110 m^2. The pits will be covered with GI sheets. Additional 60 sq m would 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 the 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 45 to 60 days where after the composted waste from the pit is taken out and after drying it is screened with screens having 2 mm diameter holes. The screened compost would be filled in plastic bags and used as good manure especially for cultivation of vegetables and flowers.

7.4 GENERAL SANITARY MEASURES

Sweeping of Streets, Public Spaces & Drain Cleaning

In the project colonies, office complexes etc. sweeping should be carried out by the sanitary workers daily. Sweeping should be carried out between 6 to 8 am in the morning and between 2 to 4 pm in the afternoon. The Sanitary workers will be allotted some specified area and after sweeping they would collect the waste in the form of heaps on the street side. These heaps would be loaded into handcarts and these handcarts will be emptied at waste collection points. For proper solid waste Solid Waste Management, suitable tools, equipment & vehicles in sufficient numbers are necessary for handling, lifting and transportation of waste. The equipment required for Solid Waste Management are mentioned under cost estimation table.

The sanitary workers involved in drain cleaning may be given tools like seamless handcarts and shovels. It is also recommended to maintain separate roster for cleaning of drains.

Burning of waste causes hazardous/toxic gaseous pollutants and must be avoided. The SWMC will discourage burning of waste along the roadside and/or on public places.

7.5 COST ESTIMATE FOR SOLID WASTE MANAGEMENT PLAN

The total cost required for solid waste management is Rs. 204.75 lakh. The details are given in Table-7.6.

Table-7.6: Cost Estimate for Solid Waste Management and Sanitation Facilities in Labour Camps

S. No.	Item	Cost (Rs. lakh)
1.	Waste bins & Community Bins	1.5
2.	Waste Storage Depots	2.0
3.	Vehicles	7.0
4.	Cost of land for land filled vermin-composting sites	6.0
5.	Reclamation and stabilization cost of landfill and vermin-composting sites	5.0
6.	One covered truck for conveyance of solid waste to landfill and vermin-composting site	20.0
7.	Manpower cost for 4 persons @ Rs. 10,000/ month for 63 months including 10% escalation/year	31.25
8.	02 tractors with trolleys @ Rs. 500,000/ per tractor with trolley	10.0
9.	Awareness programme	2.0
10.	Water facility & Toilet facilities at landfill and vermin-composting site	23.0
11.	Tools & Implements	3.0
12.	Yard lighting maintenance store room lighting, Monitoring station @5000/ fixture x 40'	1.0
13.	Periodical Training & Medical Checkup	3.0
14.	Sanitation Facilities in Labour Camps	90.0
	Total	**204.75**

CHAPTER-8

PUBLIC HEALTH DELIVERY SYSTEM

8.1 INTRODUCTION

The construction of dam may involve many diversified activities and require a large number of labourers. The change in population density through immigrants/influx may cause new health problems in this region. People may carry different types of contagious diseases if any and spread in locality. Influx of human work force may also bring stress on available drinking water sources and sanitary facilities. The additional sewage generated may contaminate drinking water sources resulting in spread of various communicable diseases, if proper precautionary measures are not taken. As a part of Environmental Management Plan, a detailed plan for development of public health and medical facilities has been prepared.

8.2 PUBLIC HEALTH DELIVERY SYSTEM

8.2.1 Control of malaria

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

The suggested measures are given in following paragraphs:

- Site selected for habitation of workers should not be in the path of natural drainage.
- Adequate drainage system to dispose storm water drainage from the labour colonies should be provided.
- Adequate vaccination and immunization facilities should be provided for workers at the construction site.

8.2.2 Development of medical facilities

A population of about 4000 is likely to congregate during the construction phase. The labour population will be concentrated at two or three sites. It is proposed that during construction stage, that existing medical facilities of the block hospital at Bagmundi and existing medical facilities at Purulia Pumped Storage Project (PPSP) will be improved and upgraded to take care of the health care system of Turga Pumped Storage Project workforce. Apart from the above, a dispensary will be developed, during project construction phase, so that it can serve the labour population migrating in the area as well as the local population.

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

Manpower

Doctor : 1
Qualification : M.D.

1 doctor can be employed in the dispensary and will reside in the PPSP Township. The para-medical staff required for assistance to the doctor is given in Table-8.1.

Table-8.1: Details of Para-medical staff for dispensary

Para medical staff	Number
Auxiliary Nurse	1
Male Multipurpose Health worker	1
Attendants	2
Drivers	2
Total	**6**

Residential accommodation will be provided for the para-medical staff.

Proposed Health Facilities at Construction sites and labour camp

It is possible that during the construction work, the technical staffs operating different equipment are not only exposed to the physical strain of work but also to the physical effects of the environment in which they are working. The workers and other technical staff may come up with common manifestations such as insect bites, fever, diarrhea, work exhaustion and other diseases. In addition they may invariably come up with injuries caused by accidents at work site. Under all circumstances, workers need immediate medical care.

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

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

Health Extension Activities

The health extension activities will have to be carried out in the villages situated in the nearby areas. It is important to inculcate hygienic habits of environmental sanitation specially with respect to water pollution by domestic wastes. There would be possibility of the transmission of communicable diseases due to migration of labour population from other areas at the construction site. The doctors from the dispensary shall make regular visits to nearby villages and organize health promotional activities with the active participation of the local village Panchayat, 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.

8.3 COST ESTIMATES

The cost required for implementation of various public health measures shall be Rs. 282.23 Lakhs. The details are given in the following paragraphs:

A. Expenditure on salaries

Dispensary

Post	**Number**	**Monthly Emoluments (Rs.)**	**Annual Expenditure (Rs.)**
Doctor	1	100,000	12,00,000
Nurse	1	30,000	360,000
Male Multi-purpose Health Workers	1	30,000	360,000
Attendants	2	15,000	360,000
Drivers	2	10,000	240,000
Total			**25,20,000**
First Aid Posts			
Health Assistants	2	20,000	4,80,000
Total			**4,80,000**

Total Expenditure = Rs. 30.0 lakh per year

B. Expenditure on Material and Supplies

Dispensary

Non-recurring

i)	1 Vehicle	Rs. 10,00,000
ii)	Furniture, etc.	Rs. 4,00,000
iii)	Hospital equipment	Rs. 6,00,000
iv)	Ambulance 1 No.	Rs. 8,00,000
Total		**Rs. 28,00,000**

Recurring

i) Drugs and Medicine,	Rs. 20,000/yr
ii) 2 First-Aid Posts at construction sites	Rs. 1,00,000/yr
iii) R & M of Ambulance -2 No.	Rs. 4,00,000/yr
Total	**Rs. 5,20,000/yr**

Infrastructure

One existing quarter of Purulia Pumped Storage Project (PPSP) township will be restored and converted into dispensary, for which an amount of Rs. 20.0 lakh has been earmarked.

<u>2 First-Aid Posts</u>: These are of temporary nature and will be constructed. The cost for construction of two First Aid Posts shall be of the order of Rs.5.0 lakh @Rs. 2.5 lakh/First-aid post.

The total cost for developing the infrastructure will be Rs.25 lakh.

A. Recurring Expenditure

*	Expenditure on salaries	:	Rs. 30,000,000/yr
*	Expenditure on materials & supplies	:	Rs. 5,20,000/yr
	Sub-Total		**Rs. 35,20,000/yr**
Total expenditure for 63 months (A) : (considering 10% escalation per year period)			**Rs. 229.23 lakh**

B. Non-Recurring Expenditure

*	Infrastructure (Construction of Dispensary & 2 First aid posts)	:	Rs. 25 lakhs
*	Expenditure on materials, supplies and equipment	:	Rs. 28 lakhs
	Total (B)		**Rs.53 lakhs**
Total A + B			**Rs. 282.23 lakh**

8.4 DISPOSAL OF BIO-MEDICAL WASTE

Dispensaries use a variety of drugs including antibiotics, cytotoxics, corrosive chemicals etc. a part of which is generated as a solid waste. With greater emphasis on disposables, the quantum of solid waste generated in a hospital is quite high. As per the Bio-Medical Waste (Management and Handling) Rules 1998, the bio-medical waste has been classified into various categories which are outlined in Table-8.2.

Table-8.2: Categories of bio-medical waste as per the Bio-Medical Waste (Management and Handling) Rules 1998

Waste Category No.	Waste category type
Category No. 1	**Human Anatomical Waste** Human tissues, organs, body parts
Category No. 2	**Animal Waste** Animal tissues, organs, body parts, carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals, colleges, discharge from hospitals, animal houses
Category No. 3	**Micro-biology and Biotechnology wastes** Wastes from laboratory cultures, stocks or specimens of micro-organisms, live or attenuated vaccines, human and animal cell culture used in research and infections agents from research and industrial laboratories, wastes from production of biologicals, toxins, dishes and devices used for transfer of cultures
Category No. 4	**Waste sharps** Needles syringes, scalpels, blades, glass, etc. that may cause punctures and cuts, including both used and unused drugs
Category No. 5	**Discarded medicines and cytotoxic drugs** Wastes comprising of outdated, contaminated and discarded medicines
Category No. 6	**Soil Waste** Items contaminated with blood and body fluids including cotton, dressings, soiled plaster casts, lines bleedings other material contaminated with blood.
Category No. 7	**Solid Waste** Wastes generated from disposable items other than the waste sharps, such as tubings, catheters, intravenous sets, etc.
Category No. 8	**Liquid waste** Waste generated from laboratory and washing, cleaning, house keeping and disinfecting activities
Category No. 9	**Incineration Ash** Ash from incineration of any bio-medical waste
Category No. 10	**Chemical Waste** Chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.

Out of the categories listed in Table-8.2, the biomedical waste categories to be generated in the dispensary proposed to be developed as a part of the project are given in Table-8.3.

Table-8.3: Categories of bio-medical waste to be generated in the dispensary proposed to be developed as a part of the project

Waste Category No.	Waste category type
Category No. 1	**Human Anatomical Waste** Human tissues, organs, body parts

Waste Category No.	Waste category type
Category No. 4	**Waste sharps** Needles syringes, scalpels, blades, glass, etc. that may cause punctures and cuts, including both used and unused drugs
Category No. 5	**Discarded medicines and cytotoxic drugs** Wastes comprising of outdated, contaminated and discarded medicines
Category No. 6	**Soil Waste** Items contaminated with blood and body fluids including cotton, dressings, soiled plaster casts, lines bleedings other material contaminated with blood.
Category No. 7	**Solid Waste** Wastes generated from disposable items other than the waste sharps, such as tubings, catheters, intravenous sets, etc.
Category No. 8	**Liquid waste** Waste generated from laboratory and washing, cleaning, house keeping and disinfecting activities
Category No. 9	**Incineration Ash** Ash from incineration of any bio-medical waste
Category No. 10	**Chemical Waste** Chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.

The bio-medical waste must be segregated in accordance to the guidelines laid under Schedule-I of Bio-medical Waste (Management and Handling) rules notified by Ministry of Environment and Forests. The proposed colour coding and container for disposal are given in Table-8.4. The treatment measures recommended for various categories of waste is outlined in Table-8.5.

Table-8.4: Colour coding and type of container for disposal of Bio-medical waste

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

Table-8.5: Recommended treatment measures of various categories of waste

Waste type	Recommended treatment
Category No. 1 – Human Anatomical wastes	Incineration
Category No. 4 – Waste sharps	Secured landfill

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

It is proposed to treat the effluent generated from the dispensary prior to its disposal. An amount of Rs. 26.0 lakh has been earmarked for the above.

8.5 BUDGET FOR PUBLIC HEATH DELIVERY SYSTEM

The total budget earmarked for Public Health delivery system shall be Rs. 308.23 lakh. The details are given in Table-8.6.

Table-8.6: Budget for Public Health Delivery System

S.No.	Item	Cost (Rs. lakh)
1.	Commissioning and operation of public health facilities	282.23
2.	Disposal of bio-medical waste	26.00
	Total	**308.23**

CHAPTER 9

MUCK DISPOSAL PLAN

9.1 GENERAL

The total quantity of muck expected to be generated has been estimated to be of the order of 32 lakh m^3. Considering, 25% swelling factor, the total muck to be handled is 40 lakh m^3. About 5o% material shall be used as construction material Thus, 20 lakh m^3 of muck is planned to be disposed. The component wise detail of muck to be generated and identified zones for accommodating the muck generated is given in Table-9.1.

Table-9.1: Component wise details of muck to be generated

S.No.	Description of Items	Unit	Quantity
A	**DIVERSION CHANNEL(730m long)**		
1	Open Excavation (Soil)	m^3	4200
2	Open Excavation (Rock)	m^3	420
b	**COFFER DAM**		
1	Open Excavation (Soil)	m^3	47530
2	Open Excavation (Rock)	m^3	7130
B-LOWER CONCRETE DAM (872 m long & 64m high)			
1	Open Excavation (Soil)	m^3	309773
2	Open Excavation (Rock)	m^3	132760
C-LOWER SADDLE DAM (595 m long & 50 m high)			
1	Open Excavation (Soil)	m^3	75680
2	Open Excavation (Rock)	m^3	88060
E-UPPER ROCKFILL DAM (732 m long & 63.5 m high)			
1	Open Excavation (Soil)	m^3	93400
2	Open Excavation (Rock)	m^3	304852
F-UPPER DAM SPILLWAY			
1	Open Excavation (Soil)	m^3	1350
2	Open Excavation (Rock)	m^3	5008
G-DIVERSION TUNNEL CUM BOTTOM OUTLET			
1	Open Excavation (Soil)	m^3	500
2	Open Excavation (Rock)	m^3	1000
INTAKE			
Inlet Structure			
1	Open Excavation (Soil)	m^3	365580
2	Open Excavation (Rock)	m^3	243720
head race &Penstock including Intake Gate Shaft			
Head race &Penstock			
1	Inclined Shaft Excavation	m^3	32,560
2	Tunnel Excavation (including Upper Penstock)	m^3	140,320
Intake Gate Shaft			
1	Open Excavation (Soil)	m^3	1070
2	Open Excavation (Rock)	m^3	710

S.No.	Description of Items	Unit	Quantity
INTAKE GATE SHAFT (Underground)			
1	Excavation	m^3	12560
WORK ADIT to HRT			
1	Open Excavation (Soil)	m^3	1150
2	Open Excavation (Rock)	m^3	4590
	Tunnel Excavation	m^3	49070
Work Adit to Lower Penstock			
1	Underground Excavation	m^3	27160
Tail Race			
Tail race Tunnel			
1	Tunnel Excavation	m^3	112870
Tailrace gate shaft (Tunnel)			
1	Gate Shaft Excavation	m^3	9610
Work Adit toTRT			
1	Tunnel Excavation	m^3	28380
TailRace Outlet			
outlet Structure			
1	Open Excavation (Soil)	m^3	408640
2	Open Excavation (Rock)	m^3	272430
POWER HOUSE			
1	Cavern Excavation	m^3	171010
2	Busbar Excavation	m^3	3580
DRAFT TUNNEL			
1	Tunnel Excavation	m^3	3160
Transformer Cavern			
1	Cavern Excavation	m^3	38180
2	Draft Gate shaft Excavation	m^3	3480
MAT			
1	Open Excavation (Soil)	m^3	6410
2	Open Excavation (Rock)	m^3	25640
3	Tunnel Excavation (UG)	m^3	46460
Top Heading Tunnel to Powerhouse			
1	Tunnel Excavation	m^3	2380
Cable Tunnel & Ventilation Tunnel			
1	Inclined Shaft Excavation	m^3	5720
2	Tunnel Excavation	m^3	1770
Switchyard			
1	Common Excavation	m^3	42540
2	Rock Excavation	m^3	63460
3	Excavation for Foundation	m^3	7370
TOTAL MUCK GENERATED			**3203243**
SWELL Factor @ 25%			4004054
Quantity to be used as Construction material @ 50%			2002027
Quantity to be disposed off			**2002027, say 20 lakh cum**

The total volume to be disposed is 20 lakh m^3. The muck will be disposed in 3 muck disposal sites, as outlined in Table-9.2. The area of muck disposal sites is 11.04 ha. The capacity of of muck disposal sites 11.04 lakh m^3. The remaining muck (8.96 lakh m^3) will be disposed in Kudna and Dulgubera Quarry areas, which have a total capacity of 9.7 lakh m^3.

Table-9.2: Muck Disposal Area and Capacities

Zone No.	Area (ha)
USP-1	2.20
USP-2	4.32
LSP-2	4.52
Kudna Quarry Area	9.80
Dulgubera Quarry Area	3.25
Total	**24.09**

9.2 IMPACTS DUE TO MUCK DISPOSAL

Muck, if not securely transported and dumped at pre-designated sites, can have serious environmental impacts, such as:

- 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.

9.3 RESTORATION OF MUCK DISPOSAL SITES

The unused muck (20 lakh m^3) would be piled at an angle of repose at the proposed dumping sites. For the stabilization of dumped materials various engineering and phyto-remedial measures are being proposed in the management plan.

Phyto-remediation of Muck Disposal Areas

The work plan formulated for re-vegetation of the muck disposal areas through “Integrated Biological and Biotechnological Approach” is based on following parameters:

1. Depending upon the quality of muck material formulation of appropriate blends of organic waste and soil to enhance the nutrient status of rhizosphere.
2. Isolation and screening of specialized strains of rnycorrhizal fungi, rhizobium, azotobacter and phosphate solubilizers (bio-fertilizers inoculum) suitable for the dumped material.
3. Mass culture of plant specific bio fertilizer and mycorrhizal fungi to be procured from different institutions/organizations which are engaged in the phyto-remediation activity of degraded areas.
4. Plantation of dumping sites/areas using identified blend and bio fertilizer inoculum.

The afforestation with suitable plant species of high ecological and economic value, which can adapt to local habitat, will be undertaken.

Proper dumping shall be done over the designated dumping sites. The waste material dumped at spoil tips would comprise mainly of loose rock fragments that would be mechanically compacted and properly levelled with suitable safe slopes and retaining walls/crate walls shall be constructed so that in no case the dumped material is washed away into the river. Construction material like stones, sand, etc. required for the construction of road should be obtained mostly from the excavated material to minimize the environmental damage. The efforts shall be made to utilize maximum dumped material for the project activities and backfilling. In the streams, box culverts will be provided to prevent the erosion of stream bed.

Re-vegetation of Spoil Tips

After proper dumping of the muck all three dumping sites shall be rejuvenated using bio-technological approach. The area shall be restored through plantation and turfing on the slope.

Soil Working and Plantation Techniques

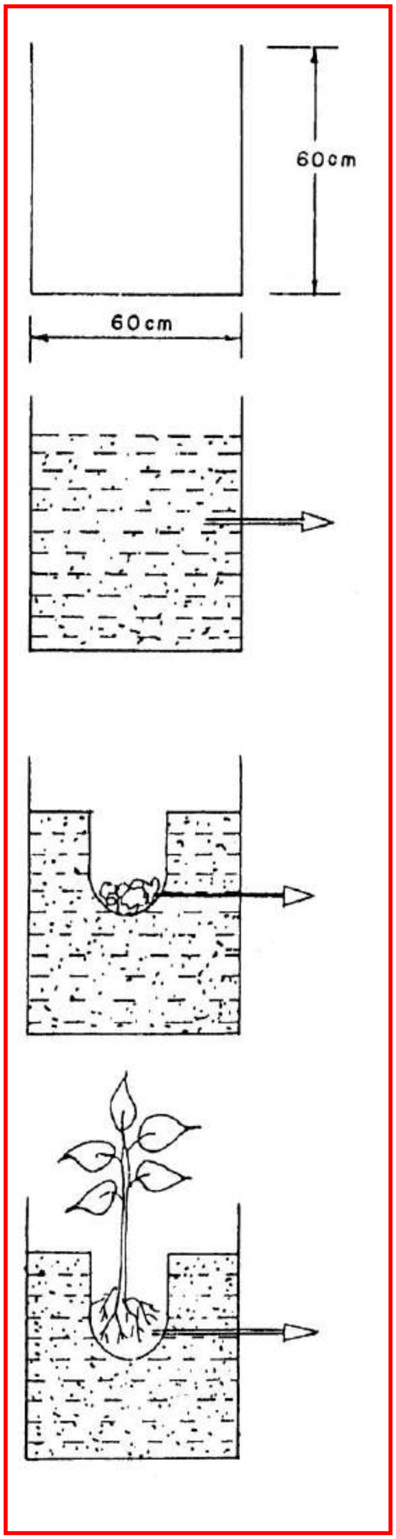
Isolation and screening of specialised strains of mycorrhizal fungi, rhizobia, azotobacters and phosphate solubilizers (biofertilizer inoculum) in accordance with the suitability for the spoil tips will be done at site, based on following:

- Inoculation of plants with specific biofertilizers and mycorrhizal strains.
- Periodical evaluation of rhizosphere development for physical, chemical and microbiological parameters.
- Monitoring of growth response in different plant species periodically and identification of corrective measures, if necessary. Mass culture of plant specific biofertilizers and mycorrhizal fungi.

The pitting details are as follows:

- Total No. of pits : 1800 per hectare
- Size of each pit : 0.6 m x 0.6m
- Spacing between pits : 2.5m x 2.0m

The excavated material from the pits will be mixed with 43.2 litre of external soil, 10 kg of apple peel and 5 kg of farmyard manure, and 2 kg of vermi-compost. The pit will be refilled with the mixture, 10-15 gm of mycorrhizal inoculum near the root system is to be added. After this, plant saplings already inoculated with biofertilizers (Rhizobium and Azotobacter bacteria) would be planted and refilling will be done to cover the entire plant root system. The schematic technique of plantation is shown in Figure-9.1 Turfing (sodding) and suitable shrubs will be grown at slopes. About 5 cm of thick layer external soil will be spread on the slope area. Sod patches (40 cm x 20 cm) will be grown per square meter. Before sowing, the area will be properly amended with the manure @ of 2 kg/m^2.



1. Excavate in spoil dump pit of size 60 cm x 60 cm x 60 cm

2. Mix 43.2 litres of soil, 10 kg of apple peel compost, 5 kg of farm yard manure and 2 kg of vermi-compost with excavated spoil (Soil : Spoil = 1:4)

3. Refill the pit with Mixture

4. 10 –15 g of Mycorrhizae inoculum near the root system

5. Plantation of sapling inoculated with biofertilizers (*Rhizobium* + *Azotobactor*) and refilling

Figure-9.1: Schematic representation of plantation using VAM technique

Irrigation Facility

Generally, afforestation programme in the vicinity is not supplemented with any irrigation modalities and depends on rains. However, in order to ascertain quick greenery and growth in the spoil tip areas, irrigation, especially during the drought period is to be provided. For this, water-harvesting tanks will be constructed to supplement the drip irrigation facility in the downstream for the horticultural crops. Research trenches will also act as water harvesting structures to facilitate irrigation for the cash crops.

Fencing

All the sites will be properly fenced to protect the area from human and animal interference. About 4400 m of fence would be required at all the sites.

9.4 COST ESTIMATE FOR MUCK DISPOSAL PLAN

An amount of Rs. 120.0 lakh has been earmarked for stabilization of muck disposal sites. The details are given in Table-9.3.

Table-9.3: Summary of cost required for muck disposal

S. No.	Cost	Amount (Rs. lakh)
1.	Plantation on spoil tips (plain area) including bio-fertilizer cost	15.0
2.	Turfing on slopes	15.0
3.	Fencing cost	15.0
4.	Retaining Wall	75.0
	Total Cost	**120.0**

CHAPTER-10

RESTORATION, STABILIZATION AND LANDSCAPING OF QUARRY SITES

10.1 INTRODUCTION

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

10.2 QUARRYING OPERATIONS

The estimated requirements of construction material for the project are listed in Table-10.1. The quantum of construction material available in various quarries is given in Table-10.2.

Table-10.1: Quantities of Construction Material Required

S. No.	Structure	Core Material (Lac m^3)	Filter Material (Lac m^3)	Rockfill Material (Lac m^3)	Fine Aggregate (Lac m^3)	Coarse Aggregate (Lac m^3)
1	Upper Dam	5.50	2.23	28.80	0.21	0.42
2	Lower Dam	-	-	-	3.78	7.55
3	Lower Saddle Dam	2.90	1.40	14.97	-	-
4	Power House and T.H.	-	-	-	0.25	0.50
5	Waterway	-	-	-	0.36	0.72
	Total	**8.4**	**3.63**	**43.77**	**4.60**	**9.19**

Table-10.2: Quantities of Construction Material Available

S. No.	Description	Name of Quarry	Quantity (lakh m^3)
1	Clay	• Jilingtadh • Hathinada • Purana tarpania	1.37 5.85 2.27
		• Kudna • Turga Lower Reservoir • Gosaidih • Drift Area and Bagmundi	1.49 0.18 0.73 1.03
2	Rockfill & Filter	• Kudna • Dulgubera	220 10
3	Coarse Aggregate & Fine Aggregate	• Turga • Dulgubera • Malti • Kudna • Hadhadi nala	22 10 50 220 75

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

River Bed Material for Aggregates

The extraction of construction material can affect the water quality of Hadhadi nala due to increase in the turbidity levels. This is mainly because the dredged material gets released during one or all the operations mentioned below:

- Excavation of material from the river bed.
- Loss of material during transport to the surface.
- Overflow from the dredger while loading
- Loss of material from the dredger during transportation.

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

$$\gamma H/C < 5.5$$

where,

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

10.3 RESTORATION PLAN FOR QUARRY SITE AND BORROW AREA

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

i) Measures to be adopted before quarrying

The top soil, wherever, available in the quarry will be removed before starting the quarrying activity or any other surface disturbance. This top soil will be kept separate and stock piled so that it can be reused after quarrying is over for rehabilitation of sites.

ii) Measures to be adopted after quarrying

Diversion of run off

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

Filling of depressions

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

Construction of retaining walls

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

Rocks for landscaping

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

Laying of the top soil

The depressions/craters filled up with rock aggregates will be covered with top soil. Fungal spores naturally present in top soil will aid plant growth and natural plant succession. The top soil will be further enriched by organic manure and Vesicular-arbuscular mycorrhizal (VAM) fungi. This will help in the process of soil reclamation and the early establishment of juvenile seedlings.

Re-vegetation

The work plan formulated for re-vegetation of the dumping sites through 'Integrated Biological and Bio-technological Approach' would be based upon the following parameters:

i) Evaluation of rock material for their physical and chemical properties to assess the nutrient status to support vegetation.

ii) Formulation of appropriate blends of organic waste and soil to enhance the nutrient status of rhizosphere.

iii) Isolation and screening of specialized strains of mycorrhizal fungi, rhizobium, azotobacter and phosphate solubilizers (bio-fertilizers inoculums) suitable for the mined out sites.

iv) Mass culture of plant specific biofertilizer and mycorrhizal fungi to be procured from different institutions/organisations which are engaged in the phyto-remediation activity of degraded areas.

v) Plantation at quarry sites/areas using identified blend and biofertilizer inoculum.

10.4 BUDGET

A provision of Rs. 60.0 lakh has been earmarked for quarry slope stabilization. The details are given in **Table-10.1.**

Table-10.1: Cost estimate for restoration of quarry site and borrow area

S. No.	Activities/purpose	Cost (Rs. lakh)
1.	Filling up the land with soil	5.0
2.	Cost of green manure	5.0
3.	Cost of saplings	7.0
4.	Cost of fertilizers and pesticides	5.0
5.	Fencing with RCC pillars and barbed wire	20.0
6.	Maintenance activities including cleaning of weeds @ Rs.1.2 lakh for 5 years	6.0
7.	Digging of pits	2.0
8.	Construction of garland drains	10.0
	Total	**60.0**

CHAPTER-11

LANDSCAPING AND RESTORATION OF CONSTRUCTION AREAS

11.1 RESTORATION OF CONSTRUCTION SITES

Due to various construction activities, natural environment of the project area will be affected. Engineering and biological measures are suggested for the stabilization and beautification of the disturbed area. Following measures should be adopted for the restoration and landscaping of the construction sites.

- During the construction phase, proper roads and lanes would be provided in the working area. Open area in working area would be planted with various plant species. Ornamental plants and avenue plantation should be done along the roads and lanes and in open places in the dam area.
- Patch plantation may be done at all vacant sites in and around, adits, working areas etc. with plantation in 2-3 or even more rows wherever possible.
- Parks and play grounds with all play implements will be developed in the colony areas during the construction phase and at vacant spaces after completion of the work.
- Green areas would be developed in front of offices, hospital, officers club, field hostels, guest houses etc. during the construction phase.

11.2 POST PROJECT CONSTRUCTION LANDSCAPING

After the completion of all the construction activity, the construction sites and other temporary settlements would be removed and area would be covered with the top soil to support the growth of plant species. These plant species which grow first are considered ecological pioneers and would initiate the process of succession and colonization. Areas close to colony and suitable areas will be landscaped to develop children parks, gardens, etc. The maintenance of the area will be done by the project in O&M stage for the life of the project. Rest of the area will be vegetated and restored.

11.3 COST ESTIMATE FOR RESTORATION OF COSNTRUCTION AREAS

An amount of Rs. 20.0 lakh has been earmarked for landscaping and restoration of construction sites. The details are given in **Table-11.1**.

Table-11.1: Cost Estimate for Restoration of Construction Areas and Landscaping

S. No.	Item of Work	Amount (Rs. lakh)
1	Planting of trees and shrubs	10.0
2	Planting of flowering plants and other herbs	5.00
3	Development of parks	5.00
	Total	**20.0**

CHAPTER-12

ENVIRONMENTAL MANAGEMENT IN ROAD COSNTRUCTION

12.1 INTRODUCTION

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

12.2 ENVIRONMENTAL MANAGEMENT IN ROAD COSNTRUCTION

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

12.2.1 Design

- Where the road is in cutting, half cut and half fill type selection which involves least disturbance to the natural ground should be adopted subject to considerations of economy and road stability being satisfied.
- The cut slopes should be made stable for the type of strata in the initial construction stage itself by adoption of appropriate slopes with benches, etc. including the use of stabilizing structures like breast walls, pitching, etc.

12.2.2 Construction

- Area for clearing and grubbing should be kept to the minimum subject to the technical requirements of the road. The clearing area should be properly demarcated to save trees and shrubs and to keep tree cutting to the minimum.
- Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control of features can follow immediately thereafter, if the project conditions permit; otherwise temporary erosion control measures shall be provided between successive construction stages. Under no circumstances, however, should very large surface area of erodible earth material be exposed at any one time by clearing and grubbing.
- The method of balanced cut and fill formation should be adopted to avoid large difference in cut and fill quantities.
- The cut slopes should be suitably protected by breast walls, provision of flat stable slopes, construction of catch water and intercepting drains, treatment of slopes and unstable areas above and underneath the road, etc.

- Where rock blasting is involved, controlled blasting techniques should 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 turfed or provided with some vegetative cover.

12.2.3 Drainage

- Drainage of the water from hill slopes and road surface is very important. All artificial drain must be linked with the existing natural drainage system for which separate detailed engineering survey may be carried out and planning done.
- The surface drains should have gentle slopes. Where falls in levels are to be negotiated, check dams with silting basins should 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

12.2.4 Grassing and Planting

- Deforestation and road construction should be bare minimum and strict control must be exercised in consultation with the forest department. Equivalent amount of new trees must 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.

12.2.5 Control of Landslides along the Roads

Steeply sloping banks are liable to landslides, which can be controlled by drainage. The basic principle is to intercept and divert as much water as possible, before it arrives at a point, where it becomes a nuisance. The erosion hazard that of surface erosion of the bank is best controlled by vegetation, but the difficulty lies in growing vegetation on steeply sloping banks. Engineering solutions such as surface drainage, sub-surface drainage, toe protection and rock bolting can be used. Landslides can be stabilized by several methods – engineering or bio-technical measures alone or a combination of these.

12.3 COST ESTIMATES

An amount of Rs. 40.0 lakh has been earmarked for implementation of measures to mitigate adverse impacts due to construction of roads. The details are given in **Table- 12.1.**

Table-12.1: Details of expenditure for implementation of measures for management of Impacts due to construction of roads

S. No.	Item	Cost (Rs. lakh)
1.	Construction of retaining walls	10.0
2.	Stream bank stabilization	10.0
3.	Provision of drainage system along roads	5.0
4	Carpeting the slopes with coir, jute or local fibres	5.0
5	Mulching	5.0
6.	Roadside plantation, Jute matting etc.	5.0
	Total	**40.0**

CHAPTER13

ENERGY CONSERVATION MEASURES

13.1 INTRODUCTION

It is estimated that during the construction of the project, which would last for about 63 months, around 4000 labourers (including their family members) 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.

For meeting 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. Further, community kitchen facilities would also be provided to the labourers by the contractors. In addition to above, efforts would be made towards energy conservation by installing non-conventional energy sources as discussed in the subsequent paragraphs.

13.2 ENERGY CONSERVATION DURING CONSTRUCTION PHASE

13.2.1Provision of Free Fuel

As a part of EMP, following measures are proposed:

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

The project proponents in association with the state government should make necessary arrangements for distribution of kerosene oil and LPG.

The total cost required for provisions of fuel has been estimated as Rs. 312.37 lakh. The details are given in Tables 13.1.

Table-13.1: Cost estimate for LPG distribution

Year	No. of Employees	Annual requirement @1cylinder per 10 persons/ per month (No. of cylinders)	Total Cost @Rs. 1,000/cylinder (Rs. lakh) including 10% escalation every year
I	1000	4800	48.0
II	1000	4800	52.8
III	1000	4800	58.08
IV	1000	4800	63.89

Year	No. of Employees	Annual requirement @1cylinder per 10 persons/ per month (No. of cylinders)	Total Cost @Rs. 1,000/cylinder (Rs. lakh) including 10% escalation every year
V	1000	4800	70.28
VI 3 months	1000	1200	19.32
	Total		**312.37**

13.2.2 Other Energy Conservation measures 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
- Designing roads on site to reduce transportation distances.
- Regular maintenance of equipment to ensure optimum operations and fuel efficiency
- The specification of energy efficient construction equipment.

13.3 ENERGY CONSERVATION DURING OPERATION PHASE

The following energy conservation measures would be implemented during operation phase:

- Use of CFL lights up to maximum possible extent.
- Awareness about the use of CFL lights by locals.
- Employing renewable energy sources such as day lighting and passive solar heating.

CHAPTER –14

FIRE PROTECTION IN LABOUR CAMP AND STAFF COLONIES

14.1 INTRODUCTION

It has been envisaged that the fire protection planning in labour camps and staff colonies shall be taken up. The details are given in following sections of this chapter.

14.2 CONSTRUCTION OF CAMPS ETC. AND PLACEMENT OF FIRE PROTECTION EQUIPMENT

It has been planned that all facilities to be constructed shall be fully equipped with the fire protection equipments as per IS standards. The analysis of fire hazard in the construction of these camps, colonies and other facilities is given in Table-14.1.

Table-14.1: Analysis of fire hazard in the construction of camps, colonies and other facilities

S. No	Stage	Potential hazard	Remedial Measures
1.	Construction of labourcamps and staff colonies	• Fire prevention and firefighting not considered in design • Inadequate fire protection measures during construction phase	**BY PROJECT PROPONENT** • While construction of Field hostels, Guest House/office and other facilities owned by 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 fightingequipments 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. • Fire fightingequipments will be placed at all common places (within 15 meters of work place)

14.3 IMPLEMENTATION OF FIRE PROTECTION SYSTEM

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 byproject proponent or any of its Contractors. The analysis of responsibility for this EHS team in respect of Fire protection system is given in Table-14.2

Table-14.2: Responsibility for this EHS team in respect of Fire protection system

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 fire fighting arrangements • Lack of knowledge • Lack communication • Lack of Knowledge on fighting fire and handling fire equipment • Inadequate emergency response	• 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 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 labourcamp. • 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 effective communication. • Ensure proper access is

S.No.	Stage	Potential hazard	Remedial Measures
			maintained around and to the residential blocks • Identification of emergency Muster points at safe distance

14.4 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 non compliance to site management.

14.5 TRAINING AND AWARENESS

Training of employees on fire prevention and fire fighting is important to prevent occurrence of fire incident in project area. All employees will be given brief overview of fire prevention, fire fighting 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.

14.6 BUDGET

Implementation of this plan will be mandatory for all contractors. Requirements of this plan will be part of contract agreement. The tentative cost of the fire protection in labour camps and staff colonies is estimated about Rs. 40.0lakh. The details are given in Table-14.3.

Table-14.3: Details of cost for fire protection in labour camps and staff colonies

S. No.	Provision	Estimated cost (Rs. lakhs)
1	Provision of fire extinguishers in labour camps and staff colony	
a)	Fire extinguisher DCP 5 kg/ 10 kg/ 30 kg	10.0
b)	Fire Extinguisher CO_2 10 kg	5.0
c)	Fire extinguisher Foam Type 30 kg	5.0
2	Refilling and maintenance	10.0
3	Inspection Charges	5.0
4	Training, Campaign and poster installation	5.0
	Total	**40.0**

The firefighting system in the project area will be suitably built in the contract document which would be executed by specialized vendors. Hence, the same has not been included in the project cost.

CHAPTER-15

DISASTER MANAGEMENT PLAN

15.1 INTRODUCTION

Any Dam project if not designed on the sound principles of design after detail investigations in respect of hydrology, geology, seismicity etc., could spell a large scale calamity. Thus these are inherent risk to the project like improper investigation, planning, designing and construction which ultimately lead to human catastrophy. Though through detailed field investigations it has been ensured that the dam is founded on firm foundation, designed for suitable seismic design parameters, yet in view of that uncertain element of "Force Mejure" the eventuality of a disaster cannot be ignored but a rescue plan has to be devised for confronting such an exigency without being caught in the vast realm of unpreparedness.

A disaster is an unwarranted, untoward and emergent situation that culminates into heavy toll of life and property and is a calamity sometimes caused by "force mejure" and also by human error. The identification of all types of disaster in any proposed project scenario involves the critical review of the project vis-à-vis the study of historical past incidents/disasters in the similar situations. The evolution of disaster management plan dwells on various aspects such as provision of evacuation paths, setting up of alarms and warning systems, establishing communicating system besides delineating an Emergency Response Organization with an Effective Response System. Keeping in view the grievous affects a disaster can cause on human or animal population, loss of property and environment in and around the areas of impact. Therefore it is essential to assess the possibility of such failures in context to the present project and formulate a contingent plan.

15.2 DAM BREAK INUNDATION ANALYSIS

The outflow flood hydrograph from a dam failure is dependent upon many factors such as physical characteristics of the dam, volume of reservoir and the mode of failure. The parameters which control the magnitude of the peak discharge and the shape of outflow hydrograph include: the breach dimensions, the manner and length of time for the breach to develop, the depth and volume of water stored in the reservoir, and the inflow to the reservoir at the time of failure. The shape and size of the breach and the elapsed time of development of the breach are in turn dependent upon the geometry of the dam, construction materials and the casual agent for failure.

For reasons of simplicity, generally, wide applicability and the uncertainty in the actual mechanism, the **BOSSDAMBRK** model has been used. The model uses failure time interval, terminal size and shape of the breach as the inputs. The possible shapes of the breach that can be accomplished by the model are rectangular, triangular and trapezoidal. The model is capable of adopting either storage routing or dynamic routing methods for routing floods through reservoirs depending on the nature of flood wave movement in reservoirs at the time failure.

The dynamic routing method based on the complete equations of unsteady flow is the appropriate technique to route the flood hydrograph through the downstream valley. The method is derived from the original equations developed by St. Venant. The model uses St. Venant's equations for routing dam break floods in channels.

15.3 METHODOLOGY

The National Weather Service's DAMBRK model developed by Dr. L. Fread has been used in the study. This model simulates the failure of dam, computes the resultant outflow hydrograph and also simulates movement of the dam break flood wave through the downstream river valley. The model is built around three major capabilities, which are reservoir routing, breach simulation and river routing. However, it does no rainfall-runoff analysis and storm inflow hydrographs to the upstream of reservoir must be developed external to the model. A brief description of the capabilities of the model is described in the following paragraphs

15.3.1 Reservoir Routing

The storage routing is based on the law of conservation given as:

$I - Q = dS/dt$ ………………………….. (1)

In which, I is reservoir inflow. Q is the total reservoir outflow which includes the flow spillway, breach, overtopping flow and head independent discharge, and rate of change of reservoir storage volume. Equation (1) can be expressed in finite difference form as :

$(1 + I') \; 2 - (Q + Q')/2 = \Delta S/\Delta t$ -.-----(2)

In which the prime (') superscript denotes the values at the time t - Δt and the notation approximates the differential. The term ΔS may be expressed as:

$\Delta S = (As + A's)\,(h-h')/2$ ………………(3)

In which, As is the reservoir surface area coincidental with the elevation (h) and is a function of h. The discharge Q which is to be evaluated from equation (2) is a function of h and this known h is evaluated using Newton–Raphson iteration technique and thus the estimation of discharge corresponding to h.

15.3.2 Dynamic Routing

The hydrologic storage routing technique, expressed by equation (2) implies that the water surface elevation within the reservoir is horizontal. This assumption is quite adequate for gradually occurring breaches with no substantial reservoir inflow hydrographs. However, when the breach is specified to form almost instantaneously so as to produce a negative wave within the reservoir, and/or the reservoir inflow hydrograph is significant enough to produce a positive wave progressing through the reservoir, a routing option which simulates the negative and /or positive wave occurring within the reservoir may be used in DAMBRK model. Such a technique is referred to as dynamic routing. The routing principle is same as dynamic routing in river reaches and it is performed using St. Venant’s equation. The movement of the dam break flood wave through the downstream river channel is simulated using the complete unsteady flow equations for one dimensional open channel flow, alternatively known as St. Venant’s equations. These equations consist of the continuity equation

$$\frac{\partial Q}{\partial t} + \frac{\partial (A + A0)}{\partial t} = q \text{ ....}(4)$$

and the conservation of momentum equation :

$$\frac{\partial Q}{\partial t} + \frac{\partial (A2/\ + A)}{\partial t} + g\,A\left(\frac{\partial h}{\partial t} + Sf + S\,e\right) + Lc = 0 \text{ ......}(5)$$

where,

A = active cross – sectional flow area

A0 = inactive (off-channel storage) cross – sectional area

X = distance the channel

q = lateral inflow or outflow per unit distance along the channel

g = acceleration due to gravity

Q = discharge

H = water surface elevation

Ss = friction slope

Se = expansion – contraction loss slope

Lc = lateral inflow/outflow momentum effect due to assumed flow path of inflow being perpendicular to the main flow.

The friction slope and expansion – contraction loss slope are evaluated by the following equation

$$S_f = \frac{n^3 Q^2}{2.21 A^2 R^{3/4}} \quad \text{..................................(6)}$$

and,

$$S_e = \frac{K\Delta(Q/A)^2}{2g\,\Delta X} \quad \text{..(7)}$$

where,

n = Manning's roughness coefficient

R = A/B where B is the top width of the active portion of the channel

K = Expansion – contraction coefficient varying from 0.1 to 0.3 for contraction and 0.5 to – 1.0 expansion

$\Delta(Q/A)^2$ = Difference in $(Q/A)^2$ for cross sections at their end of a reach

The non-linear partial differential equations (4) and (5) are represented by a corresponding set of non-linear finite difference algebraic equations and they are solved by the Newton-Raphson method using weighted four point implicit scheme to evaluate Q and h. The initial conditions are given by known steady discharge at the dam, for which steady state non-uniform boundary flow equation are used. The outflow hydrograph from the reservoir is the upstream boundary condition for the channel routing and the model is capable of dealing with fully supercritical flow or fully supercritical flow in the reach or the upstream reach having supercritical flow and downstream reach having subs critical flow. There is a choice of downstream boundary conditions such as internally calculated loop rating curve, user provided single valued rating curve, user provided time dependent water surface elevation, critical depth and dam which ma pass flow via spillways, overtopping and/or breaching.

15.3.3 Statement of the problem

The computation of flood wave resulting from a dam breach basically involves two scenarios which can be considered jointly or separately: (1) the outflow hydrograph from the pond (2) the routing of the flood wave downstream from the breached dam along the river valley and the flood plain. If breach outflow is independent of downstream conditions, or if their effect can be neglected, the reservoir outflow hydrograph is referred to as the free outflow hydrograph. In this case, the computation of the flood characteristics is divided into two distinct phases: (a) the determination of outflow hydrograph with or without the routing of the negative wave the reservoir, and (b) the routing of flood wave downstream from the breached dam. In this study the problem of simulating the failure of “Dam” and computing the free outflow hydrograph from the breached section using storage routing technique’ with the aim of reproducing the maximum water level marks reached during the passage of flood wave is considered. The information regarding inflow hydrograph into the pond due to the storm at the time of failure, the structural and the hydraulic characteristics details of the dam, the time of failure, the channel cross sections details, the maximum water level marks reached in the reservoir at the time of failure and those observed in the downstream reach of the dam to the passage of flood wave etc. are available for the study.

15.3.4 Availability of Data

The input data required for the National Weather Service’s BOSS DAMBRK model can be categorized into two groups. The first data group pertains to the dam and inflow hydrograph into the reservoir and the second group pertains to the routing of the outflow hydrograph through the downstream valley. These are described in the following paragraphs.

- **First Data Group**

  With reference to the data group pertaining to the dam, the information on reservoir elevation-volume relationship, spillway details, elevation of bottom and top of dam, elevation of water surface in the pond at the beginning of analysis and at the time of failure, breach description data are required and available for the study.

- **Second Data Group**

  The second group of data pertaining to the routing of the outflow hydrograph through the downstream valley consists of a description of cross-sections, hydraulic resistance coefficients of the reach, steady state flow in the river at the beginning of the simulation and downstream boundary condition. The cross section is specified by location mileage, and tables of top width and corresponding elevation. In this study, four cross sections details, at km. 0.0, 2.0, 3.5 and 4.2 km downstream of dam, have been used.

15.4 RESULT AND CONCLUSIONS

A rectangular breach at an El 495 masl with side slope 1:0 and breach formation time as 0.5 hr. have been considered in the study for dam break analysis of rock fill Turga upper dam and flow from upper dam will further break lower dam. After the breach, immediately below the dam, the maximum flow will occur immediately after the start of breach. The magnitude of the simulated outflow hydrograph will be 9368 cumec corresponding to maximum stage elevation 491.20 masl at Km. 0.00 is attenuated to 9314 cumecs corresponding to maximum stage elevation of 424.10 masl at km. 2.00. The further break of lower dam will increase the flow to 18642 at a distance of 3.5Km. The maximum flow and time at various distances d/s of the dam is shown in following **Table-15.1**.

Table-15.1: Summary of wave profile in the event of Dam Break

Distance from Dam (km)	Max Elevation, (masl)	Maximum Flow (cumec)	Time to Maximum Stage, hr.
0.000	491.20	9368	0.000
2.000	424.10	9314	0.540
3.500	398.1	18642	0.600
4.200	288.10	18523	0.680

- Failure of rock fill dam like the proposed Turga Pumped Storage Project, which is designed to the present technical standards and built with adequate quality control, is a very remote possibility.
- The monoliths having the least resistance to withstand the unforeseen loading combinations may give way, which in turn provides a relief and prevents failure of other monoliths. Under such as situation, the discharge and the water depth will be much lesser than those determined from the study.

15.5 DISASTER MANAGEMENT PLAN

The emergency planning for dam break scenario is devised on the basis of results of dam break analysis mainly the travel time of flood wave to various locations in the downstream stretch of the river. It is inferred from the analysis that in case of main dam failure the flood peak discharge as it prorogates through valley shall inundate downstream stretch of 2.0 km within 0.54 Hrs and the flood wave peak will reach 4.2 km in 0.68 Hrs, implying that a little reaction time for executing any rescue plan. The plan is, therefore, based on such measures, which are purely preventive in nature.

15.5.1 Dam Safety and Maintenance Manual

Based on standard recommended guidelines for the safety inspection of dams 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 cover on the routine maintenance schedule of all hydro-mechanical and electrical instruments. It should be cover 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.

15.5.2 Emergency Action Plan (EAP)

Dam safety programme as indicated above includes the formation of an Emergency Action Plan for the dam. 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 shall include all potential indicators of likely failure of the dam, since the primary concern is for timely and reliable identification and evaluation of the emergency situation, which may lead to dam failure.

This EAP shall cover presents warning and notification procedures to follow during the monsoon season in case of failure or potential failure of the dam. The objective is to provide timely warning to nearby residents and alert key personnel responsible for taking action in case of emergency.

15.5.3Administration 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 itto the Junior Engineer who will report to the Superintending Engineer/ DivisionalEngineer for their reporting to the Chief Engineer through fastest available fastest communication system. The Engineer-in-Charge will keep the district administration informed regarding the developing situation. 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 dam. The EAP is drawn at a priority for the regular inspection of the dam. For this purpose, providing an adequate and easy access to the dam site is a necessity. The dam, 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 dam crest are observed, the personnel on patrol is required to inform immediately to the Assistant

Engineer (AE)/Sub-Assistant Engineer (SAE)for initiation of the execution of EAP. They are required to inform the Engineer-in-Charge and the local administrative authorities. It is desirable that 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.

15.5.4 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 dam 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 dam, 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 dam 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.

15.5.5 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 and dam-break situation must be made clear to the downstream population.

15.5.6 Evacuations 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 dam. It would normally include an order for evacuation of delineated inundation areas.

15.5.7 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.

15.5.8 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 dam failure, which form part of public awareness for disaster mitigation may also include following:

- Listen to the radio and cable network 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.
- Never wander around a flood area.

15.5.9 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.

15.5.10 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/cell phones may be kept for back up, wherever available. It is also preferred that the entire flood cells, if more than one, are tuned in the same wireless channel. It will ensure communication from the dam site to the control rooms. The communication can be established by messenger service in the absence of such modes of communication.

15.5.11 Management after receding of Flood Water

It is to be accepted that in the event of dam 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 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.

15.6 COST ESTIMATE

The budget for different activities required to be carried out for mitigation and prevention of dam break hazard exclusively from the upper and lower dam is Rs40.0 lakh as per details given in **Table-15.2**.

Table-15.2: Budget earmarked for implementation of Disaster Management Plan

S. No.	Particular	Cost (Rs. lakh)
1.	Installation of alert system and communication between Upper and Lower Dams	20.0
2.	Setting up of communication system between dam and d/s settlements	10.0
3.	Public information system	10.0
	Total	**40.0**

CHAPTER-16

ENVIRONMENTAL MONITORING PROGRAMME

16.1 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.

16.2 AREAS OF CONCERN

Based on the findings of the Environmental Impact Assessment study in various Environmental Management Plan the important parameter viz. Catchments Area Treatment, Biodiversity Conservation & Management, Public Health Delivery System, Fish Management, Restoration of Dumping Sites, Quarry areas, Landscaping and Restoration of Construction Area, Green Belt Development etc. have been proposed.

16.3 WATER QUALITY

Construction Phase

It is proposed to monitor the effluent before and after treatment from oxidation ditch. The frequency of monitoring could be once per month. It is assumed that 2STPs shall be constructed to treat the sewage generated from five labour camps. A total of (2STPs X 12 months X 2 samples, i.e. before and after treatment) 48 samples/year need to be analysed. The parameters to be monitored include pH, Bio-chemical Oxygen Demand, Total Suspended Solids and Total Dissolved Solids. The cost of analysis of one sample is expected to be Rs. 2,000. Thus, total cost for analysis of 48 samples is expected to be Rs. 0.96lakh/year. The analysis work can be done by a laboratory recognized by the State Pollution Control Board.

Operation phase

The surface water quality of river Turga 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 UpperReservoir site.
- Upper Reservoir.
- 1km downstream of the proposed Upper Dam site
- Lower Reservoir
- 1, 3 and 5 km downstream of theproposedLower 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 State Pollution Control Board.

16.4 AIR QUALITY AND METEOROLOGY

Project Construction Phase

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

- Winter
- Summer
- Post-monsoon

The frequency of monitoring could be twice a week for four consecutive weeks at each station for each season. The parameters to be monitored are 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. 4.5 lakh has been earmarked for purchase of meteorological instruments.

16.5 NOISE

Project Construction Phase

Noise emissions from vehicular movement, operation of various construction equipment may be monitored during construction phase at major construction sites. The frequency of monitoring could be once every three months. For monitoring of noise generators an Integrating Sound Level Meter will be required. An amount of Rs. 1.0 lakh has been earmarked for the purpose.

Project Operation Phase

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

16.6 ECOLOGY

Project Construction Phase

A detailed ecological survey covering forestry, fisheries, wildlife 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.18.00 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.18.00 lakh/year can be kept for this purpose. The monitoring can be conducted by a reputed external agency.

16.7 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 constructedfor labour camps
Cost per annum	:	Rs.5.00 lakh

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 per annum : Rs.5.00 lakh

16.8 LANDUSE PATTERN

Project Operation Phase

During project operation phase, it is proposed to monitor land use pattern once every year. An amount of Rs. 5.00 lakh can be earmarked for this purpose.

16.9 SUMMARY OF ENVIRONMENTAL MONITORING PROGRAMME

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

Table 16.1: Summary of Environmental Monitoring Programme during Project Construction Phase

S. No.	Item	Parameters	Frequency	Location
1.	Effluent from STPs	pH, BOD, COD, TSS, TDS	Once every 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 every season	At major construction sites
5.	Meteorological aspects	Wind direction & velocity temperature humidity, rain	Once every season	At one of the ambient air quality sampling sites
6.	Ecology	Status of afforestation programmess of green belt development, Terrestrial Flora and fauna and aquatic ecology	Once every season	
7.	Aquatic ecology	Phytoplanktons, zooplanktons, benthic life, fish composition	Once every season	

Table 16.2: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,	Once every season	• 1 km upstream of submergence site.

S. No.	Items	Parameters	Frequency	Location
		Magnesium, Total Hardness, Chlorides, Sulphates, Nitrates, DO. COD, BOD, Iron, Zinc, Manganese		• Proposed Upper dam Reservoir. • 1km downstream of the ProposedUpper dam site • ProposedLower dam Reservoir • 1, 3 and 5 km downstream of the ProposedLower dam reservoir
2.	Effluent from Sewage Treatment Plant (STP)	pH, BOD, COD, TSS, TDS	Once every week	• Before and after treatment from Sewage Treatment Plant (STP)
3.	Ecology	Status of afforestation programmess of green belt development, Terrestrial Flora and fauna and aquatic ecology	Once every season	-
4.	Water-related diseases	Identification of water-related diseases, sites, adequacy of local vector control measures, etc.	Once every season	• Villages adjacent to project sites
5.	Aquatic ecology	Phytoplanktons, zooplanktons, benthic life, fish composition	Once every season	• 1 km upstream of submergence site. • Proposed Upper dam Reservoir. • 1km downstream of the ProposedUpper dam site • Proposed Lower dam Reservoir • 1, 3 and 5 km downstream of the ProposedLower dam reservoir
6.	Landuse	Landuse pattern using satellite data	Once in a year	Catchment area

16.10 COST ESTIMATE FOR ENVIRONMENTAL MONITORING PROGRAMME

The cost required for implementation of the Environmental Monitoring Programme is of the order of Rs. 187.23lakh. 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 63 months.The details are given in **Table 16.3**.

Table 16.3: Cost for Implementing Environmental Monitoring Programme during construction phase

S. No	Item	Cost (Rs. lakh/year)	Total cost for construction period of 63 months with 10% escalation per year (Rs.in lakh)
1	Water quality	0.96	6.25
2	Ambient Air quality	4.80	31.25
3.	Ecology	18.00	117.18
4.	Incidence of water related diseases	5.00	32.55
	Total	**28.76**	**187.23**

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 16.4**.

Table 16.4: Cost for Implementing Environmental Monitoring Programme duringoperation phase

S. No.	Item	Cost (Rs.in 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**

CHAPTER-17

COST ESTIMATES

17.1 COST FOR IMPLEMENTING ENVIRONMENTAL MANAGEMENT PLAN

The total amount to be spent for implementation of Environmental Management Plan (EMP) is Rs.4618.85 lakh or Rs. 46.19 crore. The details are given in Table-17.1.

Table-17.1: Cost for Implementing Environmental Management Plan

S.No.	Item	Cost (Rs. Lakh)
1.	Catchment Area Treatment	409.65
2.	Compensatory Afforestation, & Bio-diversity Conservation	483.50
3.	Fisheries Management	88.70
4.	Greenbelt development	16.80
5.	Water, Air & Noise pollution control	20.00
6.	Environmental Management in labour camps	204.75
7.	Public health delivery system	308.23
8.	Muck management	120.00
9.	Restoration, Stabilization and Landscaping of Quarry sites	60.00
10.	Restoration and Landscaping of construction sites	20.00
11.	Environmental management in roadconstruction	40.00
12.	Energy Conservation measures	312.37
13.	Disaster Management Plan	40.00
14.	Local Area Development Plan(Refer Table-4.6, Volume-II)	2204.00
15.	Plan to preserve cultural identity of the locals (Refer Section 5.7, Volume-II)	98.12
16.	Environmental Monitoring during construction phase (Refer Table-16.3, Volume-I)	187.23
17.	Purchase of meteorological instruments(Refer Section 16.4, Volume-III)	4.50
18.	Purchase of noise meter(Refer Section 16.5, Volume-III)	1.00
	Total	**4618.85**

CHAPTER-18

DISCLOSURE OF CONSULTANTS INVOLVED IN THE CEIA STUDY

The CEIA study has been conducted by WAPCOS Ltd., a government of India Undertaking under Ministry of Water Resources. The company has a full-fledged Centre for Environment who has conducted the above referred study. The list of the Experts involved in the CEIA study is given in Table-18.1.

Table-18.1: List of Experts involved in the CIEA study

S. No.	Name	Expertise	Signature
1.	Dr. Aman Sharma	EIA Coordinator	
2.	Mr. Shambhu Azad	Hydrologist & Ground Water Expert	
3.	Dr. A. K. Sharma	Ecology and Bio-diversity Expert	
4.	Mr. R.V. Ramana	Noise Expert	
5.	Dr. K.K. Gaur	Social Expert	
6.	Mr. S.M. Dixit	Air Quality Expert	
7.	Mrs. Moumita Mondal Ghosh	Landuse Expert	

वाप्कोस लिमिटेड
WAPCOS LIMITED
(भारत सरकार का उपक्रम)
जल संसाधन, नदी विकास व गंगा संरक्षण मंत्रालय
(A Government of India Undertaking)
Ministry of Water Resources, River Development & Ganga Rejuvenation

Date: 27.11.2015

UNDERTAKING

As per MoEF Office Memorandum no. J-11013/41/2006/-IA-III, dated 5th October, 2011, M/s. WAPCOS Limited, Gurgaon, Haryana herewith declares ownership of the contents (information and data) of the EIA Study for Turga Pumped Storage Project, West Bengal.

Aman Sharma
27/11/15

(Authorised Signatory)

डॉ. अमन शर्मा/ Dr. Aman Sharma
वरि. महा प्रबंधक (गंगा संरक्षण एवं पर्यावरण)
Sr. General Manager (Ganga Rejuvenation & Envt.)
वाप्कोस लिमिटेड / WAPCOS LIMITED
(भारत सरकार का उपक्रम/A Govt. of India Undertaking)
76–सी, सैक्टर –18, गुड़गाँव –122015 (हरि०)
76 - C, Sector - 18, Gurgaon -122015 (Hr.)

Accreditation Certificate of the EIA consultant as per the office memorandum issues by MOEF, GOI

NABET

National Accreditation Board
for Education and Training

NABET/EIA/RA068/085

Oct 09, 2015

Chairman cum Managing Director
WAPCOS Limited (A Government of India Undertaking)
Plot-76-C, Sector-18, Gurgaon – 122015, Haryana
(Kind Attention: **Mr. R.K. Gupta**)

Dear Sir,

Sub: Re-Accreditation

This has reference to your application to QCI-NABET for re-accreditation (RA) as EIA Consultant Organization and the assessment carried for same in your organization from Apr. 07-09, 2015.

We are pleased to inform you that based on the document and office assessments during RA, the Accreditation Committee has approved renewal of accreditation given to your organization for a period of three years from **Apr. 09, 2015 to Apr. 08, 2018** subject to coverage of balance Functional areas and specific response to NCs/Obs./Alerts issued, if applicable (Refer Annexure III) with the following details:

1. Annexure I - Scope of accreditation
2. Annexure II - List of experts with approved sectors/ functional areas
3. Annexure III - Non-Conformances/ Observations/ Alerts (NCs/ Obs./ Alerts)
4. Annexure IV - Observations on Quality Management System (QMS)
5. Annexure V - Terms and conditions of accreditation
6. Annexure VI - Result of assessment
7. Annexure VII - Guidelines for addressing Major Non-Conformances/ Observations/ Alerts
8. Annexure VIII - Format to be followed for mentioning the names of the experts involved in EIA reports prepared by **WAPCOS Limited.**

Result of RA including Non-Conformances/ Observations/ Alerts (NCs/ Obs./ Alerts) applicable to your organization as per RA are also posted on QCI website vide minutes of the Accreditation Committee meetings dated June 10, 2015. You are requested to take necessary actions to close the NCs/ Obs. as per guidelines and timeframe mentioned in Annexure VII of this letter. You are also advised to review eligibility of organization as per Version 3 of the Scheme (posted on NABET website) which has become effective from Sep 1, 2015 and meet its requirements by Dec. 31, 2015 positively.

You are required to make all payments to NABET as applicable, within one month from the date of invoice sent to you. Continuation of this accreditation of your organization is subject to the clearance of all dues by your organization, satisfactory compliance to Annexure III and V.

With best regards,

Yours sincerely,

(Abhay Sharma)
Assistant Director

Scope of Accreditation **Annexure I**

NAME OF THE CONSULTANT ORGANIZATION: WAPCOS Limited (A Government of India Undertaking)
Plot-76-C, Sector-18, Gurgaon – 122015, Haryana

Sl. No.	Sector number		Name of Sector	Category A/B
	As per MoEF Notification	As per NABET Scheme		
1.	1 (a) (i)	1	Mining of Minerals- Open cast only	A
2.	1 (c)	3	River Valley, Hydel, Drainage and Irrigation projects	A
3.	1 (d)	4	Thermal Power Plants	A
4.	7 (e)	33	Ports, harbours, jetties, marine terminals, break waters and dredging	A
5.	8 (a)	38	Building and large construction projects including shopping malls, multiplexes, commercial complexes, housing estates, hospitals, institutions	B
Total = 05 Sectors *Individual EIA Coordinators approved for different sectors are mentioned in Annexure II*				

The ACO has overall obtained more than 60 % marks and therefore qualifies for Cat. A.

(Abhay Sharma)
Assistant Director

Accreditation Certificate of the laboratory

NABL

National Accreditation Board for Testing and Calibration Laboratories

(An Autonomous Body under Department of Science & Technology, Govt. of India)

CERTIFICATE OF ACCREDITATION

SPECTRO ANALYTICAL LABS LTD.

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

E-41, Okhla Industrial Area, Phase-II, New Delhi

in the discipline of

CHEMICAL TESTING

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Certificate Number T-0249

Issue Date 03/02/2015

Valid Until 02/02/2017

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the additional requirements of NABL.

Signed for and on behalf of NABL

N. Venkateswaran	Anil Relia	Prof. Ashutosh Sharma
Program Manager	Director	Chairman

Accreditation Certificate of the laboratory

NABL

National Accreditation Board for Testing and Calibration Laboratories

Department of Science & Technology, India

CERTIFICATE OF ACCREDITATION

SPECTRO ANALYTICAL LABS LTD.

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

E-41, Okhla Industrial Area, Phase-II, New Delhi

in the discipline of

BIOLOGICAL TESTING

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Certificate Number T-1073

Issue Date 02/03/2014

Valid Until 01/03/2016

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the additional requirements of NABL.

Signed for and on behalf of NABL

Prachi	[signature]	T Ramasami
Prachi Kukreti	Anil Relia	Dr T. Ramasami
Convenor	Director	Chairman

West Bengal State Electricity Distribution Company limited
(A West Bengal Government Enterprise)
Vidyut Bhavan (5th Floor), Block-DJ , Sector-II, Salt Lake ,Kolkata
West Bengal – 700091 (India)
Tel: 033-23345821/23197628
Fax.: 033-23345855
(April-2016)

WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED

(A Government of West Bengal Enterprise)

VOLUME- IV: REPORT ON PROCEEDINGS OF PUBLIC HEARING

TURGA PUMPED STORAGE PROJECT

(Previously known as Purulia Pumped Storage Extension Project on Turga Nala)

(4 X 250 MW)

APRIL 2016

DETAILS OF PUBLIC HEARING

1. INDTRODUCTION

An Environmental Public Hearing in respect of proposed 1000MW Turga Pumped Storage Project, executed by West Bengal State Electricity Distribution Company Limited (WBSEDCL), Purulia District, West Bengal was held on 2nd February 2016 at "Banabitan" Meeting Hall, Baghmundi, P.O- Baghmundi, District-Purulia, West Bengal. The Advertisements for conducting public hearing was published in following newspapers on 26.12.2015:

- The Telegraph
- Ananda Bazar Patrika

A copy of the advertisement published in the above referred newspapers is enclosed as Annexures-I

The hearing commenced from 12:00Noon onwards and was presided by Shri P.K.Maity, Addl. District Magistrate (Development), Dist.-Purulia, West Bengal.

Following panel members were present during the Public Hearing:

1. Shri P.K.Maity : Chairman
   Addl. District Magistrate (Development),
   District Purulia
   West Bengal

2. Shri S. Ganguly : Member
   EnvironmentalEngineer
   Representative of SPCB
   West Bengal Pollution Control Board (WBPCB)

3. Shri K.Sahoo : Member
   AEEr
   Representative of SPCB
   West Bengal Pollution Control Board (WBPCB)

4. Shri N.C. Barai : Member
   AEE
   Representative of SPCB
   West Bengal Pollution Control Board (WBPCB)

The following officials also attended the Public Hearing:

1. Mr. Surajit Chakrabortty, Chief Engineer, PSPD, WBSEDCL
2. Mr. Tarun K. Mitra, PM & CE, PSPP, WBSEDCL
3. Mr. Brata Narayan Sarkar, Advisor, WBSEDCL
4. Mr. Surajit Dutta, Advisor, WBSEDCL

5. Mr.Arup K Chattyopadhyaya, ACE, PPSP, WBSEDCL
6. Mr. Ashis K Bhowmick, ACE, PSPD, WBSEDCL
7. Mr. Sourav Chakraborty, A.E. (Civil), PSPD, WBSEDCL
8. Dr. S.K.Tyagi , Chief Scientist, WAPCOS Limited
9. Mr. R.V.Ramana, Chief, WAPCOS Limited
10. Mr. Manoranjan Mandal, Dy. CE, WAPCOS Limited
11. Mr. Malay Patra, Surveyor, WAPCOS Limited

The minutes of Public Hearing Meeting are enclosed as Annexure-II. A total of 43 persons attended the public hearing. The list of participants is also enclosed in the minutes of Public Hearing.The photographs of the public hearing are enclosed as Annexure-III

The hearing started with a welcome note from Sri S.Ganguly, Environmental Engineer, West Bengal Pollution Control Board. He explained about the provisions of the EIA Notification S.O. 1533 dt. 14.09.2006 and also informed the audience about the draft proposal of West Bengal State Electricity Distribution Company Limited (WBSEDCL) for the proposed Turga Pumped Storage (1000 MW) Project in Baghmundi, District - Purulia, West Bengal.

Sri P. K Maity, Additional District Magistrate (Development), Dist. Purulia then requested the Project Proponent (PP) to explain the proposed project in detail, giving emphasis on the environmental aspects in particular, for discussion among the panel members and others present in the hearing.

Sri S.Chakrabortty, Chief Engineer, Pumped Storage Project Department of West Bengal State Electricity Distribution Company Limited explained the details of the proposed Turga Pumped Storage Project and the detailed of field studies conducted to evaluate the impacts likely to accrue on account of the proposed project and measures recommended for amelioration of adverse impacts and enhancement of positive impacts. He mentioned about the baseline status of Air, Water & Noise Quality of the Area which are well within the standards. Thelocation details ofthe project, construction details water, land requirementetc. for the project, were also covered as a part of the project feature. He further elaborated on the steps to be takenfor developingthe society through activities under Corporate Social Responsibility of the company.

Sri P. K Maity, Additional District Magistrate (Development), District Purulia requested the audience to come up with their views and suggestions regarding the environmental impact of the proposed project.

Dr. S.K.Tyagi, Chief (Ecology) further presented procedure of Environmental Clearance/Public hearing. The details of the methodology adopted for conducting the EIA studies, impacts likely to accrue and the management measures as well. The Resettlement and Rehabilitation Plan along with Local Area Development Plan proposed as a part of the study were also presented and discussed during Public Hearing.

2. KEY ISSUES RAISED DURING PUBLIC HEARING

The key issues raised during public Hearing and their responses is given below:

1. Sri Ajoy Kumar of village Pathardih requested the project proponent (PP) to ensure appropriate compensation package to the land losers. He further requested the PP to ensure proper implementation of their CSR commitments.

2. Sri Sunil Mandi and Sri Pada Mandi of village Tnarpania requested the PP to ensure overall socio- economic development of the neighbouring area by generating direct as well as indirect employment opportunities for the local people and proper implementation of their CSR activities. Sri Mandi also requested the PP to arrange for potable water facility and dig new ponds and wells in the water-scarce villages of the surrounding area.

3. Sri Sikari Maji of village Pathardih requested the PP to give priority to land losers for direct as well as indirect employment in the proposed project and ensure proper compensation package for them. He also requested the PP to ensure proper implementation of their CSR commitments giving emphasis on development of local road condition, extensive plantation activity in and around the project site, rendering help to local schools and providing medical facility to local villagers, development of playground in the area etc. Sri Maji also requested the PP to relocate the two temples (Ram Mandir and Vaishno Devi Mandir) which will come under the area of the proposed project as both are integral part of the social as well as religious lives of the local residents. Finally Sri Maji assured the PP that the local people will extend all sorts of help towards them for an early implementation of the proposed project.

4. Sri P. K. Maity, Additional District Magistrate (Development),Dist. Purulia then requested the project proponent to address the issues raised in the public hearing.

5. Sri S.Chakraborty, Chief Engineer, Pumped Storage Project Department ofWest Bengal State Electricity Distribution Company Limited assured the gathering that they will implement all their CSR activities through the local administration for overall and inclusive development of the neighbouring area. He clearly stated that being a Government Organisation it is not possible for them to generate direct employment on priority basis for the local people as the same will violate the Government's employment policy, however he assured the gathering that once the project work is initiated there will be generation of significant number of indirect employment which ultimately will lead to overall socio-economic development of the locality around the project site. Finally Sri Chakraborty assured the local people that at present no private land will be taken for the project; however if any such land is taken in the future proper compensation package will be given to the land losers.

6. Sri S.Ganguly, Environmental Engineer, West Bengal Pollution Control Board, suggested that the project proponent should include all the issues discussed in the public hearing, in the final ElA/EMP report and address the issues properly during implementation of the project. Sri Ganguly also assured the audience that the deliberations presented by the audience in the hearing is being recorded and unedited videography of the whole proceedings will be forwarded to the appropriate authorities for their consideration.

7. Sri P.K.Maity, Additional District Magistrate (Development), Dist. Purulia requested the PPto strictly comply with the prevailing environmental norms and fulfil all their commitments regarding CSR activities. The ADM also mentioned that West Bengal Pollution Board will upload the proceedings of the public hearing in their website. Finally, Sri P. K. Maity, Additional District Magistrate (Development), Purulia expressed his gratitude to the audience for their active participation in this public hearing and concluded the session.

ANNEXURE - I

Ananda Bazar Patrika

The Telegraph

Anandabazar Patrika 26/12/2015

The Telegraph 26/12/2015

[illegible]

NOTICE

West Bengal Pollution Control Board

In compliance with Notification No. S.O. 1533 (E) dated [illegible] of Ministry of Environment & Forests Govt. of India, it is hereby notified that the Public Hearing for the proposed Turga Pumped Storage (1000 MW) Project in Baghmundi, Dist. Purulia, West Bengal, by M/s West Bengal State Electricity Distribution Company Limited is hereby scheduled on [illegible] at 12:00 hours at 'Baghmundi' Meeting Hall, Baghmundi, PO Baghmundi, Dist. Purulia, West Bengal.

Any person or association of persons who feel that he/ it might be affected or the local authorities involved, may consult the copies of Executive Summary of the project (English and Bengali) and draft EIA/ EMP report would be available at the (1) Office of the District Magistrate, Dist. Purulia, (2) Office of the Additional District Magistrate (Development), Dist. Purulia, (3) Office of the Sub-Divisional Officer, Purulia Sadar West Sub-Division, Dist. Purulia (4) Office of the Block Development Officer, Baghmundi Development Block, Dist. Purulia (5) Office of the General Manager, DIC, Purulia (6) Office of the Sabhadhipati, Purulia Zilla Parishad (7) Office of the Baghmundi Panchayat Samity, Dist. Purulia (8) Office of the [illegible] Panchayat, Dist. Purulia (9) Office of the Ajodhya Gram Panchayat [illegible] Senior Environmental Engineer, [illegible] Circle Office, Vill. [illegible], PO [illegible] 24 Parganas (N) (11) Office of the Environmental Engineer, Asansol Regional Office, ADDA, Commercial Market, 2nd Floor, Opp. Asansol Fire Station, G.T. Road, Asansol, Dist. Burdwan, Pin 713301 (12) Department of Environment, Govt. of West Bengal, Poura Bhavan, 4th Floor, FD-415/A, Sector III, Salt Lake, Kolkata-700106 (13) Ministry of Environment, Forests & Climate Change, Eastern Zonal Office, Bhubaneswar (14) Head Office of West Bengal Pollution Control Board, Paribesh Bhawan, 10A, Block LA, Sector III, Salt Lake, Kolkata [illegible]. Executive Summary of the application form of the project would also be available in the website of the [illegible] www.wbpcb.gov.in. Any person [illegible] who might be locally affected by the proposed project/ activity may participate in the public hearing to be held on [illegible] at 12:00 noon at "Baghmundi Meeting Hall", Baghmundi, P.O. Baghmundi, Dist. Purulia, West Bengal. They may make oral/ written suggestions/ objections in the matter in the public hearing meeting. Any other concerned persons having a plausible stake in the environmental aspect of the project or activity may send suggestions/ objections in writing to the [illegible]

ANNEXURE-II

SPEED POST

WEST BENGAL

WEST BENGAL POLLUTION CONTROL BOARD
(Department of Environment, Govt. of West Bengal)
Paribesh Bhawan, 10A, Block - LA, Sector-III
Bidhannagar, Kolkata-700 098, India
Tel : 2335 - 9088 / 7428 / 8211 / 6731 / 0261 / 8861 / 1625
Fax : 2335 - 2813
City Code : 33, Country Code : 91
Website: **www.wbpcb.gov.in**

C. S. C./LR/4545
Dated. 25/02/16
WBSE DCL

CE/PSPD

Memo No. **-2N-93/2012(E)** **Dated: .02.2016**

PSPD / WBSEDCL
Receipt No. 546
Date 25.02.16
Contents Not Verified

To,
The Member Secretary
Expert Appraisal Committee (River Valley & Hydroelectric Projects)
Ministry of Environment, Forests & Climate Change,
Govt. of India, Indira Paryavaran Bhawan,
Jor Bagh Road, New Delhi – 110 003.

Sub: Public Hearing for the proposed Turga Pumped Storage (1000 MW) project in Baghmundi, Dist – Purulia, West Bengal, by **M/s. West Bengal State Electricity Distribution Company Limited.**

Sir,

I am enclosing herewith the following documents for the above mentioned project towards environmental clearance by the State Environment Impact Assessment Authority, West Bengal.

1) Chronology of events leading to Public Hearing. (Annexure – I).
2) Minutes of Public Hearing dated 02.02.2016 at "Banabitan" Meeting Hall, Baghmundi, PO – Baghmundi, Dist – Purulia, West Bengal. (Annexure – II).
3) Copy of attendance of panel members and others in Public Hearing. (Annexure – III).
4) One CD containing the videography of the public hearing. (Annexure – IV).

Yours faithfully,

Sd/-
(D. Sarkar)
Senior Environmental Engineer (EIM Cell)
West Bengal Pollution Control Board

Enclo: As stated.

Memo No. 149(1)**-2N-93/2012(E)** **Dated:** 22 **.02.2016**

Copy to:
Shri S. Chakrabortty, Chief Engineer, M/s. West Bengal State Electricity Distribution Company Limited, Vidyut Bhavan, 5th Floor, Block DJ, Sector – II, Salt Lake, Kolkata – 700 091.

22/02/2016.
(D. Sarkar)
Senior Environmental Engineer (EIM Cell)
West Bengal Pollution Control Board

(1) AE (3) 25.02.16

(2) AE(I) Pl. [illegible] 27.02.16

Annexure-I

Chronology of events leading to Public Hearing

1) Copy of the letter from the Additional District Magistrate (Dev), Dist – Purulia dated 18.12.2015 (copy enclosed).

2) Letter of circulation of copies of Executive Summary and EIA / EMP of the project on 28.12.2015 (copy enclosed).

3) Notification of Public Hearing in two local dailies published on 26.12.2015 (copy enclosed).

4) Holding Public Hearing at "Banabitan" Meeting Hall, Baghmundi, PO – Baghmundi, Dist – Purulia, West Bengal on 02.02.2016.

Copies of Executive Summary with EIA/EMP report were available for public scrutiny in the offices of:

1. Office of the District Magistrate, Purulia, Govt. of West Bengal.
2. Office of the Additional District Magistrate (Development), Dist – Purulia.
3. Office of the Sub-Divisional Officer, Purulia Sadar West Sub-Division, Dist – Purulia
4. Office of the Block Development Officer, Baghmundi Development Block, Dist – Purulia
5. Office of the General Manager, D.I.C., Purulia.
6. Office of the Sabhadhipati, Purulia Zilla Parishad.
7. Office of the Baghmundi Panchayat Samity, Dist – Purulia
8. Office of the Baghmundi Gram Panchayat, Dist – Purulia.
9. Office of the Ayodhya Gram Panchayat, Dist – Purulia
10. Office of the Chief Engineer (O & E), Paribesh Bhawan, 10A, Block-LA, Sector-III, Salt Lake City, Kolkata – 700 098.
11. Office of the Senior Environmental Engineer, Kankinara Circle Office, Panpur More, Kalyani Expressway, PO – Narayanpur, Dist: 24 Parganas(N).
12. Office of the Environmental Engineer, Asansol Sub-Regional Office, ADDA, Commercial Market, 2nd Floor, Opp.– Asansol Fire Station, G. T. Road, Asansol, Dist – Burdwan, PIN – 713301.
13. Department of Environment, Govt. of West Bengal, Poura Bhavan, 4th Floor, FD-415/A, Sector – III, Salt lake, Kolkata 700 106.
14. Ministry of Environment, Forests & Climate Change, Eastern Zonal Office, Bhubaneswar.
15. Head Office of West Bengal Pollution Control Board, Paribesh Bhawan, 10A, Block-LA, Sector-III, Salt Lake City, Kolkata – 700 098.

PROCEEDINGS OF THE PUBLIC HEARING FOR THE PROPOSED TURGA PUMPED STORAGE (1000 MW) PROJECT IN BAGHMUNDI, DIST – PURULIA, WEST BENGAL BY M/S WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED HELD ON 02.02.2016 AT 12:00 NOON AT "BANABITAN" MEETING HALL, BAGHMUNDI, PO - BAGHMUNDI, DIST - PURULIA, WEST BENGAL

M/s West Bengal State Electricity Distribution Company Limited submitted an application to West Bengal Pollution Control Board for conducting Public Hearing for the proposed Turga Pumped Storage (1000 MW) Project in Baghmundi, Dist – Purulia, West Bengal. As per the EIA notification S.O. 1533 dated 14th September, 2006 of the MoEF, Govt. of India, Environmental Clearance of the said project is required to be obtained from the MoEF & CC, Govt. of India after conducting Public Hearing.

Accordingly, West Bengal Pollution Control Board after observing all formalities conducted the Public Hearing on 02.02.2016 at 12:00 Hrs. at "Banabitan" Meeting Hall, Baghmundi, PO - Baghmundi, Dist - Purulia, West Bengal. All the panel members were present in the hearing. Sri P. K. Maity, Additional District Magistrate (Development), Dist. Purulia presided over the hearing. List of the panel members and the others present in the public hearing is enclosed.

The hearing started with a welcome note from Sri S.Ganguly, Environmental Engineer, West Bengal Pollution Control Board. He explained about the provisions of the above stated MoEF notification and also informed the audience about the draft proposal of M/s West Bengal State Electricity Distribution Company Limited for the proposed Turga Pumped Storage (1000 MW) Project in Baghmundi, Dist – Purulia, West Bengal.

Sri P. K. Maity, Additional District Magistrate (Development), Dist. Purulia then requested the project proponent (PP) to explain in details about the proposed project, giving emphasis on the environmental aspects in particular, for discussion among the panel members and others present in the hearing.

Sri S.Chakraborty, Chief Engineer, Pumped Storage Project Department of M/s West Bengal State Electricity Distribution Company Limited narrated the details of the proposed project and the pollution control measures to be taken for the same through power point presentation. He explained the location details of the project, construction details of the same, basic requirements like water, land etc. for the project, environmental impacts arising out of the same as well as the mitigative measures proposed by M/s West Bengal State Electricity Distribution Company Limited to combat the effects. He mentioned about the baseline status of Air, Water & Noise Quality of the area which are well within the standards. He further elaborated on the steps to be taken for developing the society through activities under Corporate Social Responsibility of the company.

Sri P. K. Maity, Additional District Magistrate (Development), Dist. Purulia requested the audience to come up with their views and suggestions regarding the environmental impact of the proposed project.

During the discussion the panel members and the others present in the public hearing made queries / suggestions with respect to the proposed project, which are noted below:

Sri Ajoy Kumar of village Pathardih requested the project proponent (PP) to ensure appropriate compensation package to the land losers. He further requested the PP to ensure proper implementation of their CSR commitments.

Sri Sunil Mandi and Sri Pada Mandi of village Tnarpania requested the PP to ensure overall socio-economic development of the neighbouring area by generating direct as well as indirect employment opportunities for the local people and proper implementation of their CSR activities. Sri Mandi also requested the PP to arrange for potable water facility and dig new ponds and wells in the water-scarce villages of the surrounding area.

Sri Sikari Maji of village Pathardih requested the PP to give priority to land losers for direct as well as indirect employment in the proposed project and ensure proper compensation package for them. He also requested the PP to ensure proper implementation of their CSR commitments giving emphasis on development of local road condition, extensive plantation activity in and around the project site, rendering help to local schools and providing medical facility to local villagers, development of playground in the area etc. Sri Maji also requested the PP to relocate the two temples (Ram Mandir and Vaishno Devi Mandir) which will come under the area of the proposed project as both are integral part of the social as well as religious lives of the local residents. Finally Sri Maji assured the PP that the local people will extend all sorts of help towards them for an early implementation of the proposed project.

Sri P. K. Maity, Additional District Magistrate (Development), Dist. Purulia then requested the project proponent to address the issues raised in the public hearing.

Sri S.Chakraborty, Chief Engineer, Pumped Storage Project Department of M/s West Bengal State Electricity Distribution Company Limited assured the gathering that they will implement all their CSR activities through the local administration for overall and inclusive development of the neighbouring area. He clearly stated that being a Government Organisation it is not possible for them to generate direct employment on priority basis for the local people as the same will violate the Government's employment policy, however he assured the gathering that once the project work is initiated there will be generation of significant number of indirect employment which ultimately will lead to overall socio-economic development of the locality around the project site. Finally Sri Chakraborty assured the local people that at present no private land will be taken for the project, however if any such land is taken in the future proper compensation package will be given to the land losers.

Sri S.Ganguly, Environmental Engineer, West Bengal Pollution Control Board, suggested that the project proponent should include all the issues discussed in the public hearing, in the final EIA/EMP report and address the issues properly during implementation of the project. Sri Ganguly also assured the audience that the deliberations presented by the audience in the hearing is being recorded and unedited videography of the whole proceedings will be forwarded to the appropriate authorities for their consideration.

Sri P.K.Maity, Additional District Magistrate (Development), Dist. Purulia requested the PP to strictly comply with the prevailing environmental norms and fulfil all their commitments regarding CSR activities. The ADM also mentioned that West Bengal Pollution Board will upload the proceedings of the public hearing in their website. Finally, Sri P. K. Maity, Additional District Magistrate (Development), Purulia expressed his gratitude to the audience for their active participation in this public hearing and concluded the session.

S. Ganguly 02.02.16.

Sri S.Ganguly
Environmental Engineer
West Bengal Pollution Control Board

2/2/2016

Sri P.K.Maity
Additional District Magistrate (Development)
Dist – Purulia
Additional District Magistrate (Dev.)
PURULIA

Statement of attendance of the Panel Membe rs of the Public Hearing for the Proposed Turga Pumped storage (1000 MW) Project in Baghmundi, Dist- Purulia, West Bengal, by M/s. West Bengal State Electricity Distribution Company Limited.

Public Hearing held on 02.02.2016 at 12:00 Noon at "Banabitan" Meeting Hall, Baghmundi. Po- Baghmundi. Dist- Purulia, West Bengal.

SL NO.	Name of the Panel Members	Signature.
1.	Sri P.K. Maiti, WBCS (Exe.) ADM (Dev), Dist- Purulia	[signature] 02/02/16
2.	S. Ganguly, EE, WBPCB	[signature] 02/02/16
3.	K. Sahoo, AEE, WBPCB	[signature] 02.02.16
4.	N.C. Barai, AEE, WBPCB	[signature] 02/02/16

other Persons & Govt officials Present in the Public Hearing on 02.02.2016 at 12:00 noon

Sl No.	Name of the Persons with Address		Signature
1	Sib Shankar Kumar,	Pathardi	Sib Shankar Kumar
2	Balaram Mandi	Tar Pania	Balaram Mandi
3	Jagannath Kumar	Pathardi.	Jagannath Kumar
4	Sunil Mandi	Tar Pania.	Sunil Mandi
5	সুনীল মুর্মু	[illegible]	সুনীল মুর্মু
6	চন্দ্র মান্ডি	[illegible]	চন্দ্র মান্ডি
7	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	Tarapada Mandi
13	[illegible]	[illegible]	[illegible]
14	Ramesh kumar	Gobindapur	Ramesh kumar
15	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]
17	Kumbho Lohar	[illegible]	Kumbho Lohar
18	Shikari Majhi	Pathardi	Shikari Majhi
19	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]
21	Murali mohan Kuiry	Madla	Murali mohan Kuiry
22	Shashi Bhusan kumar	Chhatatar	Shashi Bhusan kumar
23	Balaram Lohar	Pratap pur	B. Lohar
24	Ashwini Kumar	Gobinda pur	Ashwini Kumar
25	[illegible]	[illegible]	[illegible]
26	[illegible]	[illegible]	[illegible]
27	[illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	[illegible]
29	[illegible]	[illegible]	[illegible]
30	Arun Kumar	Patharai	Arun Kumar
31	[illegible]	[illegible]	[illegible]
32	Subrata Chakraborthy, CE, PSPD, WBSEDCL		[illegible]

Other Persons & Govt officials Present in the Public Hearing on 02.02.2016 at 12:00 noon.

SL NO.	Name of the Persons with Address	Signature
33	Tarun Mitra PM&CE, PPSP.	[illegible]
34	Dr S.K. TYAGI Chief Scientist WAPCOS	[illegible]
35	R.V. Ramana, Chief, WAPCOS	[illegible]
36	Manoranjan Mondal, Dy. Chief Engineer, WAPCOS,	Mondal
37	Brata Narayan Sarkar, WBSEDCL	[illegible]
38	Surajit Dutta, Advisor, WBSEDCL	[illegible] 02/02/16
39	Arup Kr. Chattopadhyay ACE, WBSEDCL	[illegible] 02-02-16.
40	Ashis Kr. Bhowmick, WBSEDCL	Abhowmick 02-02-16
41	Sourav Chakraborty, WBSEDCL	[illegible] 02.02.16
42	Malay Patra, Surveyor (WAP COS)	
43	Buddha Rajak Palashi	Buddha Rajak
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		

EIM-D1935
23/12/15

Government of West Bengal
Office of the District Magistrate, Purulia
General Section.

Memo. No. 2822 /G

Dated 18.12./2015

To
The Sr. Environmental Engineer (E.I.M. Cell),
West Bengal Pollution Control Board,
Department of Environment,
Govt. of West Bengal,
Paribesh Bhawan,
10A, Block – LA, Sector – III,
Bidhannagar,
Kolkata – 7000098.

Sub:- Public Hearing for the proposed Turga Pumped Storage (1000MW) Project in Baghmundi, Dist-Purulia, West Bengal, by M/s West Bengal State Electricity Distribution Company Limited.

Ref:- Your Office Memo no 1048-2N-93/2012(E) dated 15/12/2015.

Apropos your letter under reference , Sri Prabal Kanti Maity WBCS(Exe), Additional District Magistrate (Dev), Purulia has been nominated for hearing on behalf of the District Magistrate, Purulia. You are requested to fix the date of hearing on 02/02/2016 at 12 noon at "Banabitan" meeting hall Baghmundi, P.O.- Baghmundi , District Purulia, West Bengal and inform all concerned accordingly.

This is for your information and necessary action.

18/12/15
Addl. District Magistrate (Dev),
Purulia.

Memo. No. 2822/1(3)/G

Dated 18.12./2015

Copy forwarded to:

1. The Block Development Officer , Baghmundi for information and necessary action.
2. C.A. to District Magistrate, Purulia for information.
3. C.A. to Addl. District Magistrate (Dev), Purulia for information.

28/12/15

18/12/15
Addl. District Magistrate (Dev),
Purulia.

O/C

(17)

WEST BENGAL POLLUTION CONTROL BOARD
(Department of Environment, Govt. of West Bengal)
Paribesh Bhawan, 10A, Block - LA, Sector-III
Bidhannagar, Kolkata-700 098, India
Tel : 2335 - 9088 / 7428 / 8211 / 6731 / 0261 / 8861 / 5868 / 1625
Fax : 2335 - 5868 / 2813
City Code : 33, Country Code : 91
Website: www.wbpcb.gov.in

Memo No. 1077 (1-15) -2N-93/2012(E) Dated: 28 .12.2015

CIRCULAR

It is hereby informed that a Public Hearing will be held on **02.02.2016** at **12:00 noon** at "Banabitan" Meeting Hall, Baghmundi, PO – Baghmundi, Dist – Purulia, West Bengal for the proposed Turga Pumped Storage (1000 MW) project in Baghmundi, Dist – Purulia, West Bengal, by **M/s. West Bengal State Electricity Distribution Company Limited.** Paper notification in this respect may kindly be seen in "The Telegraph" and "Ananda Bazar Patrika".

In this regard copies of the draft EIA / EMP report and Executive Summary of the project along with soft copies are sent herewith for record and for access to the general public for their information and participation of locally affected persons in the Public Hearing on 02.02.2016. Special care against any damage or pilferage of the draft EIA / EMP report and Executive Summary copies should be taken as these are very much limited in number.

28/12/2015

(D. Sarkar)
Senior Environmental Engineer (EIM Cell)
West Bengal Pollution Control Board

Memo No. 1077 (15) -2N-93/2012(E) Dated: 28 .12.2015

Copy forwarded with copies of draft EIA / EMP report, Executive Summary (English and Bengali) along with soft copies: -

1. Office of the District Magistrate, Purulia, Govt. of West Bengal.	1 Set of Executive summary in English & Bengali and one draft EIA / EMP report
2. Office of the Additional District Magistrate (Development), Dist – Purulia.	- Do -
3. Office of the Sub-Divisional Officer, Purulia Sadar West Sub-Division, Dist – Purulia	- Do -
4. Office of the Block Development Officer, Baghmundi Development Block, Dist – Purulia	- Do -
5. Office of the General Manager, D.I.C., Purulia.	- Do -
6. Office of the Sabhadhipati, Purulia Zilla Parishad.	- Do -
7. Office of the Baghmundi Panchayat Samity, Dist – Purulia	- Do -
8. Office of the Baghmundi Gram Panchayat, Dist – Purulia.	- Do -
9. Office of the Ayodhya Gram Panchayat, Dist – Purulia	- Do -
10. Office of the Chief Engineer (O & E), Parihesh Bhawan, 10A, Block-LA, Sector-III, Salt Lake City, Kolkata – 700 098.	- Do -
11. Office of the Senior Environmental Engineer, Kankinara Circle Office, Panpur More, Kalyani Expressway, PO – Narayanpur, Dist: 24 Parganas(N).	- Do -
12. Office of the Environmental Engineer, Asansol Sub-Regional Office, ADDA, Commercial Market, 2nd Floor, Opp.– Asansol Fire Station, G. T. Road, Asansol, Dist – Burdwan, PIN – 713301.	- Do -
13. Department of Environment, Govt. of West Bengal, Poura Bhavan, 4th Floor, FD-415/1, Sector – III, Salt lake, Kolkata 700 106.	- Do -
14. Ministry of Environment, Forests & Climate Change, Eastern Zonal Office, Bhubaneswar.	- Do -
15. Head Office of West Bengal Pollution Control Board, Paribesh Bhawan, 10A, Block-LA, Sector-III, Salt Lake City, Kolkata – 700 098.	- Do -

D. Sarkar 28/12/2015

(D. Sarkar)
Senior Environmental Engineer (EIM Cell)
West Bengal Pollution Control Board

Anandbazar
Patrika 26/12/2015

The Telegraph
26/12/2015

নোটিশ

নোটিস

পশ্চিমবঙ্গ দূষণ নিয়ন্ত্রণ পর্ষদ

ভারত সরকারের পরিবেশ ও বন মন্ত্রকের নোটিফিকেশন নং. এস.ও. ১৫৩৩ (ই) তারিখ: ১৪.০৯.২০০৬ অনুযায়ী এতদ্বারা জানানো যাইতেছে [illegible]

কোনও ব্যক্তি বা গোষ্ঠী যাঁহারা প্রস্তাবিত প্রকল্প বা কার্যাবলীর দ্বারা স্থানীয়ভাবে ক্ষতিগ্রস্ত হইতে পারেন, তাঁহারা ০২.০২.২০১৬ দুপুর ১২টায় "বনবিতান" মিটিং হল, বাঘমুন্ডি, পোঃ অঃ বাঘমুন্ডি, জেলা-পুরুলিয়া, পশ্চিমবঙ্গ-তে অনুষ্ঠেয় জনশুনানীতে অংশগ্রহণ করিতে পারেন। জনশুনানী সভার আলোচ্য বিষয়ে তাঁহারা তাঁহাদের পরামর্শ/ আপত্তি মৌখিক বা লিখিতভাবে জানাইতে পারেন। অন্য কোনও ব্যক্তি যাঁহাদের প্রকল্প বা কার্যাবলীর পরিবেশগত দিক হইতে কোনও যুক্তিসঙ্গত স্বার্থ আছে তাঁহারা জনশুনানী তারিখের পূর্বে সিনিয়র এনভায়রনমেন্টাল ইঞ্জিনিয়ার (ইআইএম সেল), পরিবেশ ভবন, ১০এ, ব্লক-এলএ, সেক্টর-III, সল্টলেক, কলকাতা-৭০০০৯৮ এর নিকট তাঁহাদের পরামর্শ/আপত্তি লিখিতভাবে জানাইতে পারেন।

সিনিয়র এনভায়রনমেন্টাল ইঞ্জিনিয়ার (ইআইএম সেল)
পশ্চিমবঙ্গ দূষণ নিয়ন্ত্রণ পর্ষদ

NOTICE

West Bengal Pollution Control Board

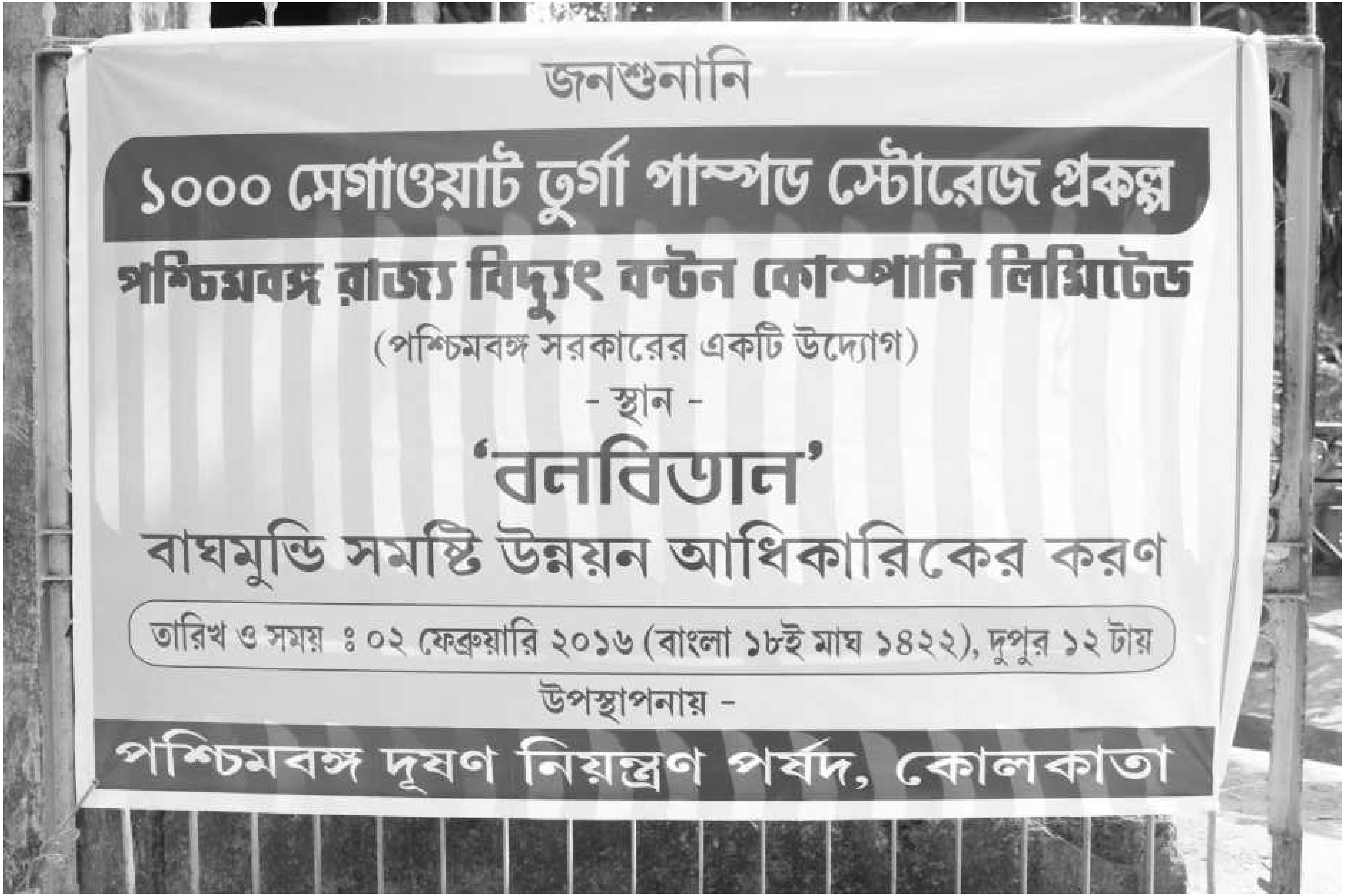
In compliance with Notification No. S.O. 1533 (E) dated 14.09.2006 of Ministry of Environment & Forests, Govt. of India, it is hereby notified that, the Public Hearing for the proposed Turga Pumped Storage (1000 MW) project in Baghmundi, Dist-Purulia, West Bengal by M/s. West Bengal State Electricity Distribution Company Limited is hereby scheduled on 02.02.2016 at 12.00 noon at "Baghmundi" Meeting Hall, Baghmundi, PO-Baghmundi, Dist-Purulia, West Bengal.

Any person or association of persons who feel that he/ it might be affected or the local authority involved, may consult the copies of Executive Summary of the project (English and Bengali) and draft EIA/EMP report would be available at the (1) Office of the District Magistrate, Dist-Purulia, (2) Office of the Additional District Magistrate (Development), Dist-Purulia, (3) Office of the Sub-Divisional Officer, Purulia Sadar West Sub-Division, Dist-Purulia (4) Office of the Block Development Officer, Baghmundi Development Block, Dist- Purulia (5) Office of the General Manager, D.I.C., Purulia (6) Office of the Sabhadhipati, Purulia Zilla Parishad (7) Office of the Baghmundi Panchayat Samity, Dist-Purulia (8) Office of the Baghmundi Gram Panchayat, Dist-Purulia (9) Office of the Ayodhya Gram Panchayat, Dist-Purulia (10) Office of the Senior Environmental Engineer, Kankinara Circle Office, Vill-Panpur, PO- Narayanpur, Dist-24 Parganas (N) (11) Office of the Environmental Engineer, Asansol Regional Office, ADDA, Commercial Market, 2nd Floor, Opp. Asansol Fire Station, G.T. Road, Asansol, Dist-Burdwan, Pin-713301 (12) Department of Environment, Govt. of West Bengal, Poura Bhavan, 4th Floor, FD-415/A, Sector-III, Salt Lake, Kolkata-700106 (13) Ministry of Environment Forests & Climate Change, Eastern Zonal Office, Bhubaneswar (14) Head Office of West Bengal Pollution Control Board, Paribesh Bhawan, 10A, Block LA, Sector III, Salt Lake, Kolkata-700098. Executive Summary and the application form of the project would also be available in the website of the Board www.wbpcb.gov.in.

Any person or groups who might be locally affected from the proposed project or activity may participate in the public hearing to be held on 02.02.2016 at 12:00 noon at "Banabitan" Meeting Hall, Baghmundi, P.O. Baghmundi, Dist- Purulia, West Bengal. They may make verbal or written suggestions/ objections in the matter in the public hearing meeting. Any other concerned persons having a plausible stake in the environmental aspects of the project or activity may make suggestions/ objections in writing to the Senior Environmental Engineer (EIM Cell), Paribesh Bhawan, 10A, Block LA, Sector III, Salt Lake, Kolkata 700098 before the date of public hearing.

Senior Environmental Engineer (EIM Cell)
West Bengal Pollution Control Board

ANNEXURE-III



ANNEXURE-III

ANNEXURE-III

West Bengal State Electricity Distribution Company limited
(A West Bengal Government Enterprise)
Vidyut Bhavan (5th Floor), Block-DJ , Sector-II, Salt Lake ,Kolkata
West Bengal – 700091 (India)
Tel: 033-23345821/23197628
Fax.: 033-23345855
(April -2016)

WEST BENGAL STATE ELECTRICITY DISTRIBUTION COMPANY LIMITED

(A Government of West Bengal Enterprise)

EXECUTIVE SUMMARY

TURGA PUMPED STORAGE PROJECT

(Previously known as Purulia Pumped Storage Extension Project on TurgaNala)

(4 X 250 MW)

APRIL2016

CONTENTS

EXECUTIVE SUMMARY

1. INTRODUCTION

The Turga Pumped Storage Project on Turganala is located in Purulia district of West Bengal. This is one of the four Pumped Storage Schemes initially identified by erstwhile WBSEB (now known as WBSEDCL). The Turga Pumped Storage Scheme envisages utilization of the waters of the river Turga in Ayodhya hills for peak power generation on a Pumped storage type development. The coordinates of Upper Dam site are 23°12'47"N and 86°04' 20"E. Likewise, coordinates of the lower Dam site are 23°11'49''N and 86°04'13"E. The project site is approachable by a jeepable road taking off from Balarampur – Baghmundi state highway. The nearest rail head is located at Barabhum and nearest airport is located at Ranchi. The project location map is enclosed as Figure-1.

Figure-1: Project Location Map

2. PROJECT PROFILE

The Turga Pumped Storage Project envisages utilization of hydro potentiality of Ajodhya Plateau, an extension of Chhota Nagpur Plateau. The project envisages the construction of Upper Dam (C.A. 8.29 Sq. Km) across TurgaNala, a tributary of Subarnarekha river and a water conductor system with an underground Power House on the downstream of Upper Dam and a Lower Dam having intermediate catchment of 4.37 sq. km (total C.A. 12.66 sq. km).

The Project is a Close Loop type Pumped Storage Scheme. It comprises two reservoirs at two different levels (the difference of water levels of the reservoirs will represent the effective "head" of the Project) and water conductor system will connect the two reservoir through an underground power house. During peak hours power will be generated by depleting the water reserve of the upper reservoir which will pass through the waterway and the generator and turbines installed at the power house and will be stored in the Lower Reservoir. During off peak hours the excess power from thermal stations will be fed back to pump the water from Lower Reservoir to Upper reservoir through power house where generators and turbines will then act as motors and pumps respectively. The same cycle of operation will be repeated during peak and lean period.

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

The total land required for the project is 292.0 ha. The details are given in Table-1.

Table-1: Land requirement for proposed project

S. No.	Component	Area (ha)
1.	Upper Reservoir submergence at FRL	87.10
2.	Lower Reservoir submergence at FRL	49.00
3.	Dam site and other structure	13.90
4.	Quarry Site	32.00
5.	Construction facility	15.00
6.	Clay core Area	20.00
7.	Roads	10.00
8.	Stockpile area for construction material, etc.	30.00
9.	Other miscellaneous requirement	35.00
	Total	**292.00**

As per the present status, about 234 ha of land is Forest land and the remaining (58 ha) is non-forest government land and /or Private Land. Out of 58 ha of non-forest government land and /or Private Land, 34 ha of land will be transferred from I& W Directorate, Government of West Bengal to Turga Pumped Storage Project. Remaining 24 ha of land to be arranged temporarily on leased basis. Appropriate compensation measures as per ownership status has been suggested as a part of the Environmental Management Plan.

3. STUDY AREA

The study area considered for the CEIA study is given as below:

- Submergence area of Upper and Lower Reservoir
- Area within 10 km of the periphery of the submergence area of Upper and Lower Reservoir
- Area to be acquired for locating the various project appurtenances
- Area within 10 km of various project appurtenances
- Catchment area intercepted at the upper and lower dam sites

The study area is enclosed as Figure-2.

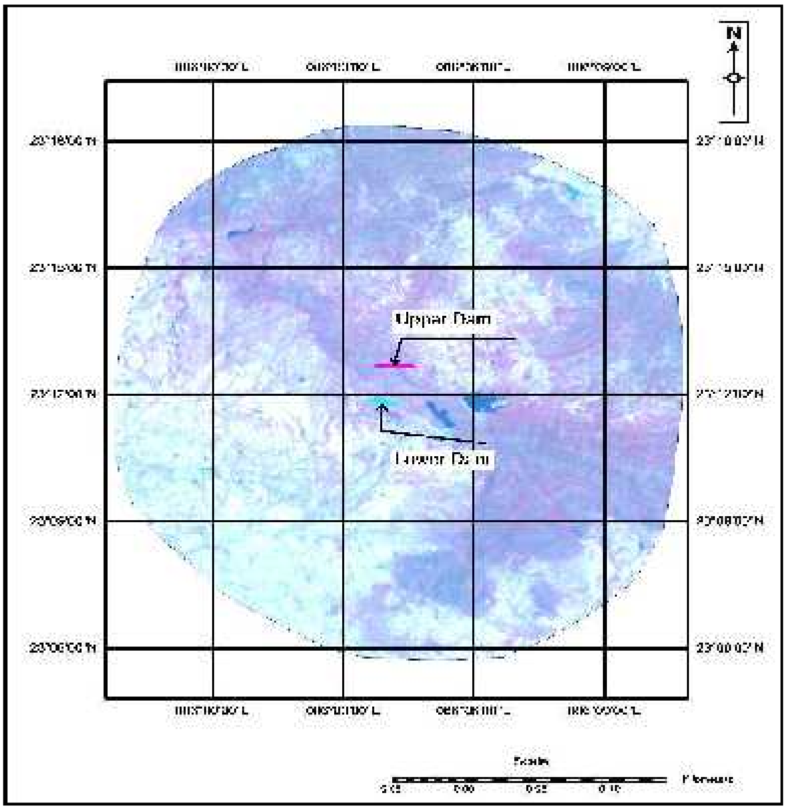


Figure-2: Satellite imagery of the Study Area for Turga Pumped Storage project

4. FIELD STUDIES

As a part of the EIA study, primary data has been collectedfor three seasons.. The details are given in Table-2.

Table-2: Details of field studies conducted as a part of CEIA studies

Season	**Months**
Winter	December 2013 – January 2014
Summer	April 2014
Monsoon	August-September 2014

5. ENVIRONMENTAL BASELINE STATUS

5.1 Physico-chemical Aspects

5.1.1 Meteorology

The project area generally has a dry climate with large variations in temperature and scanty rainfall. The climate of district Purulia can be divided into four distinct seasons. The winter season lasts from November to March which is followed by summer season from April to June. The monsoon season begins in July and ends by mid-September. The period from mid-September to October is the post-monsoon season or the retreating monsoon season.

5.1.2 Land-use pattern

The landuse pattern of the study area has been studied using satellite data and the details are given in Table-3.

Table-3: Land-use pattern of the study area based on satellite data

S. No.	Category	Area(ha)	Area(%)
1	River/ Water body	223	0.53
2	Vegetation	13189	31.13
3	Agricultural Land	12325	29.09
4	Barren Land/Rocky outcrops	10839	25.58
5	Scrub	5708	13.47
6	Settlements	83	0.20
	Total	**42367**	**100.00**

The major land-use category of land in the study area is under vegetation as it accounts for 31.13% of the study area. The area under agricultural land accounts for about 29.09% of the total study area. Barren land/ Rocky outcrops occupy about 25.58% of the total study area. Settlements and water bodies account for about 0.2% and 0.53%, respectively of the study area respectively.

5.1.3 Soils

The pH of soil at various sites lies within neutral range. The levels of NPK indicate moderate soil productivity. The CEC levels do not indicate any potential for soil salinization or adverse impacts on soil productivity

5.1.4 Water Quality

The pH level in the project area of Turga Pumped Storage project ranged from 7.1 to 8.4 at various sampling sites covered as a part of the study. The TDS level ranged from 87.13 to 109.63 mg/l, 58.7 to 69.4 mg/l and 48 to 54 mg/l in post-monsoon, summer and monsoon seasons respectively, which is well below the permissible limit of 500 mg/l specified for drinking water. The TDS level was found to be lowest in monsoon season. This trend was observed for various cations and anions monitored as a part of the study. This could be attributed to higher discharges in monsoon months.The concentration of various cations, e.g. sodium, potassium, calcium and magnesium was observed to be quite low which is also reflected by the low TDS level. Iron was found to be well below the permissible limit of 1 mg/l specified for drinking water purposes.The concentration of various heavy metals was found to be well below the permissible limits. Concentration of phenolic compounds and oil & grease as expected in a region with no major sources of water pollution from domestic or industrial sources was observed to be quite low.

The BOD values are well within the permissible limit, 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 indicate the absence of chemical pollution loading in the area. The marginal quantity of pollution load which entersTurganala, gets diluted. The DO level ranged from 5.2 to 7.23 mg/l at various sampling locations monitored for three seasons as a part of the study. The DO levels indicate low organic pollution in the catchment area. This is expected as the site has low population density and virtually no industries. Thus, pollution loading is low in the catchment area, which is reflected in low BOD and high DO Values the excellent quality of water in the study area.

5.1.5 Ambient Air Quality

Based on the findings of the ambient air quality survey, conducted for various seasons, it can be concluded that the ambient air quality is quite good in the area. The values of these parameters were well below the permissible limits specified for residential, rural and other areas. The absence of industries, low vehicular traffic and low population density can be attributed for good ambient air quality in the project area.

5.1.6 Ambient Noise Level

The day time equivalent noise level in various seasons at various sampling were well within the permissible limit specified for residential area.The absence of industries, low vehicular traffic and low population density can be attributed for low ambient noise level in the project area.

5.2 Ecological aspects

5.2.1 Vegetation

The forests in the proposed project area along the TurgaNalla fall in Purulia Forest Division of West Bengal. As per classification, the forest under this division is Northern tropical Dry Deciduous Forest (5B) typeand Dry peninsular sal forest (5B/C 1c). This is further classified as Reserved Forest, Protected forest, Unclassed state forest, khas forest, vested waste land, forest owned by corporate bodies and forest owned by private individuals as per the information available with Divisional Forest Office –Purulia division, Soil Conservation Division I & II & Extension Forest Division.

The major forest types found in study area are briefly described in the following paragraphs.

5B Northern Tropical Dry Deciduous Forests

This is a dry deciduous forest in which the upper canopy is light but continuous in the climax form. The second storey is rarely found and an irregular often broken canopy and smaller height. The undergrowth is generally thin and shrubby including some evergreen xerophytic species. These forests belong to the following forest types:

5B/C1 Dry Sal-bearing forest

This is a low quality forest dominated by *Shorearobusta*. It is often broken up into pure groups or mixed patches of varying extent in which either sal or its associates predominate. The canopy is irregular and tree is rarely over 18 m height. It may further be sub-divided into the following sub-types:

- 5B/C1c Dry Peninsular Sal Forest
- 5B/C2 Northen Dry Mixed Deciduous Forest

Endemic Species

With such a wide area and distinct biogeographic regions, West Bengal bound to have many endemic taxa. Chatterjee (1940) has discussed some new or endemic plant taxa from different districts of West Bengal such as *Cadentheraulginosa*var.*birbhumensis, Cuscutasharmanum, Hydrocotylehimalaica, Hypericumassamacum*and*Dalbergiaduarensis*. Besides these newly described endemic species, some endemic species viz., *Acer osmastonii, Begonia rubella, Calamusinermis, Cymbidium eburnum,* etc. are described from the extreme Northern boundary of West Bengal. Since entire Purulia district and Midnapur districts constitute the western undulating uplands and plateau, there is no possibility that these plants may occur in the project area.

Threatened flora

The project area is largely a degraded ecosystem due to high human pressure, large scale lopping and removal of fodder and timber species for preparation of agricultural fields, grazing, construction of road, etc. As per Red Data Book of India, no rare and endangered species are reported from the project area. However, Nayar and Sastry (1987-1990) have discussed some rare and endangered plant species viz., *Acer osmastonii, Begonia rubella, B. satrapsis, Calamusinermis, Codonopsisaffinis, Cymbidium eburnum, Phoenix rupicola*, etc. from northern part of West Bengal includes Darjeeling, Kurseong, Sewak and Jalpaiguri area. Since these species are distributed above 600 m elevation in northern and southern wet part of West Bengal, hence these species are not observed in the proposed project.

Parasitic flora

A long twining parasitic plant *(Cuscutareflexa)* was found growing on bushes of *Zizyphusmauritiana*, whereas *Loranthuslongiflorus* on trunks of some large tree species like *Buchnanialatifolia*, *Schleicheraoleosa,* etc.

Epiphytes

Epiphytes often grow attached to the trunks and branches of forest trees. The seedlings of *Ficusbengalensis* and *F. religiosa*are often seen growing on trunk of some talltree species in the area.A few orchids belonging to the genera*Bulbophyllumtriste, Dendrobiummoschatum,Vandaroxburghii,* etc.were also observed growing on thick kusum tree (*Schleicheratrijuga*). In addition to these, some non-vascular epiphytes such as lichens and mosses also occur on bark of some tree species.

Economically important plants

Since time immemorial the local people have been using large number of wild plant resources as medicinal value, edible plants, fodder, timber, etc. Comprehensive account of these plant resources is given in following paragraphs.

i) Medicinal Plants

The hills rising above Baghmundi and adjoining area in Purulia district are rich in diversity of medicinal plants. Many tribal population or local people inhabited in the various pockets of the forest areas, use these plants for curing their diseases. However, a literature survey reveales that the existing information is insufficiently documented with regard to their floral wealth used in curring diseases (Chakraverty*et al.* (1999); Mudgal&Hajra (1999). Different parts of medicinal plant species were used by local tribe as medicine. Some of the important medicinal and aromatic plants of the project area are given in Table-4.

Table-4: Some of the medicinal plants in the Turga pumped Storage Project area

Species	Local name	Family	Uses
Abelmoschusmoschatus	Mushkdana	Malvaceae	Tonic
Abromaangusta	Ulatkambal	Sterculiaceae	Abortifacient
Achyranthesaspera	Bankhat	Amaranthaceae	Skin disease
Andrographis paniculata	Kalmegh	Acanthaceae	Tonic
Artemisia nilagirica	Teetapati	Asteraceae	Asthama
Azadirachtaindica	Neem	Meliaceae	Skin disease
Bauhinia purpurea	RaktaKanchan	Caesalpiniaceae	Carminative
Buteamonosperma	Palash	Papilionaceae	Astringent
Cissampelospareira	Aknadi	Menispermaceae	Antiperiodic
Clerodendrumviscosum	Ghato	Vebenaceae	Vermifuge
Cuscutareflexa	Sarnalata	Cuscutaceae	Jaundice
Evolvulusalsinoides	Sankhpuspi	Convolvulaceae	Tonic
Helicteresisora	Marodphali	Sterculiaceae	Tonic
Holarrhenapubescens	Kuruchi	Apocynaceae	Antidysentric
Minthaarvensis	Carminative	Lamiaceae	Carminative
Phyllanthusemblica	Amloki	Euphorbiaceae	Astringent
Rubia cordifolia	Manjistha	Rubiaceae	Antiseptic
Semicarpus anacardium	Bhela	Anacardiaceae	Vermifuge
Terminalia bellirica	Bahera	Combretaceae	Purgative
T. chebula	Haritaki	Combretaceae	Laxative
Vitex negundo	Nishindha	Verbenaceae	Vermifuge
Woodfordia fruticosa	Dhai	Lythraceae	Seminal weakness

ii) Food Plants

A variety of wild edible plants occurs in the project and influence area. The cultivation of such plants is not practiced by local peple in the area and they rely on the forest around them for their supply. Some of the food plants occurring in and around the project area are given in Table-5.

Table-5: Some of the food plants observed in TurgaPumed Storage Project area

Species	Local Name	Family	Part used
Bauhinia purpurea	RaktoChandan	Caesalpiniaceae	Flower buds
Bombaxceiba	Simul	Bombacaceae	Fruits
Boswelliaserrata	Shalga	Burseraceae	Fruits
Carissa spinarum	Huka	Apocynaceae	Fruits
Chenopodium album	Bhetu	Chenopodiaceae	Leaves
Colocasiaesculenta	Kachu	Araceae	Tubers
Dioscoreabulbifera	Chuprialu	Dioscoreaceae	Fruits
Ficusauriculata	Dumur	Moraceae	Figs
Madhucaindica	Mohua	Sapotaceae	Seeds
Nymphaea nouchali	Shapla	Nymphaeaceae	Stem
Phyllanthus emblica	Amloki	Euphorbiaceae	Fruits
Randia dumatorum	Madan	Rubiaceae	Fruits
Schleichera trijuga	Kusum	Sapindaceae	Fruits
Spondias pinnata	Amra	Anacardiaceae	Fruits
Zizyphus mauritiana	Ber	Rhamnaceae	Fruits

iii) Oil Yielding Plants

The project area as well surrounding influence area exhibits good diversity of oil yielding plants. Some of such plants are *Brassica campestris*(Shoshey), *Linumusitatissimum* (Teeshi), *Sesamumindicum* (Til), *Madhucaindica* (Mohua), *Schleicheratrijuga* (Kusum), etc.

iv) Fodder Plants

Important and preferable fodder yielding plants of the area are *Bauhinia variegata, Desmodiumgangeticum, Echinochloacolona, Ficusauriculata, F. racemosa, Oryza sativa*, etc.

5.2.2 Fauna

Mammalian fauna of the surrounding areas of Turga Pumped Storage project comprises of more than 25 species that come from 16 families. Rhesus Macaque and Common Langur inhabit forested as well as settlement areas and are common in their presence. All the members of cat family mentioned below prefer to inhabit the lower and open areas in the region. Jungle Cat is sighted frequently by villagers near settlement area at day time. Jackal covers a wide range of habitat and spotted by villagers frequently in and around the settlement. Wild Boar is a nocturnal animal and raids agricultural fields at night. It is found in inner and open forest areas. Grey Mongoose, Brush-tailed Porcupine, Indian Hare prefer to inhabit scrub forests while Pangolin is predominant in the Sal and mixed forest to meet its food requirement, feeds on ants. Tree Shrew is widely distributed in the area, found in forest as well as settlement areas.

A total number of 66 species of birds were encountered during the present survey. The species belonging to families Anatidae, Ardeidae, Charadridae, Rallidae, Phalacrocoracidaeetc are common in lower region in open places and wetland while members of Picidae, Megailaimidae, Strigidae, etc are inhabitants of woody forests in the catchment. Dominant bird species observed during the survey are Blue jay, dove, myna, house crow, house sparrow, lapwing, little egret and grey wagtail etc.

The presence of a total of 18 species of Herpetofauna grouped under 10 families could be confirmed in the surrounding areas of proposed project from different sources including direct sightings and by interviewing local people. The present study area falls under the tropical limits and stands for the warm temperature for most of the months. The climatic condition seems highly conducive for herpetofaunal diversity. However, the area is considerably unexplored and very limited information is available on the herpetofaua. Out of 20, three species *Duttaphrynusmelanostictus*, *Laloulapulchera* and Rana /*Hoplobatrachustigerinus* belong to Amphibia, one species of pond turtle from Geomydidae family and remaining comes from Reptiles There is no Wildlife sanctuary, National park or Biosphere Reserve present within the study area.

5.2.3 Fisheries

Turga is a small river with shallow bottom, therefore, hardly harbours small species like *Bariliusbendelisis*, *Chela cachius*, *Puntius* spp. and *Nemacheilus* spp. Some of the species like *Labeorohita*, *L. calbasu*, *Catlacatla*, *Cirrhinusmrigala*, *Anabas testudineus, Badisbadis*, etc have been introduced in the existing Turga Reservoir of I & W Directorate, Govt. of West Bengal. In addition, species like *Puntius* spp. and *Macrognathusaral* also inhabit the reservoir.

6. PREDCTION OFIMAPCTS

6.1IMPACTS ON WATER QUALITY

a) Construction phase

Effluent from labour colony

The Project Construction is likely to last for a period of 63 months. The peak labour strength likely to be employed during project construction phase is about 800 workers & 200 Technical Staffs. The total increase in population is expected to be about 4000. The domestic water requirement has been estimated as 135 lpcd. Thus, total water requirements work out to 0.54 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 0.43 mld.

Effluent from crushers

The effluent from the crushers would contain high suspended solids level of 3000-4000 mg/l. It is proposed to treat the effluents from crushers in settling tanks.

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. It is proposed to treat the effluent before disposal to ameliorate even the marginal impacts likely to accrue on this account.

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 level. It is proposed to treat the effluent in oil & Grease separate unit from fabrication units and workshops prior to disposal.

b) Operation phase

Effluent from project colony

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

Impacts on reservoir water quality

In the proposed project, most of the land coming under reservoir submergence has tree cover. These trees shall be cleared before filling up of the reservoir after initial years of filling will have a diurnal variation of water level from FRL to MDDL in the upper reservoir. Significant variation in water level on a daily basis is also expected in the Lower Reservoir. Thus, due to significant diurnal variations in water level in Upper and Lower reservoirs, re-aeration from natural atmosphere shall take place, which will maintain Dissolved Oxygen in the water body. Thus, in the proposed project, no significant reduction in DO level in water of Upper and Lower Reservoir is anticipated.

6.2 IMPACTS ON AIR ENVIRONMENT

Ambient Air Quality

Pollution due to operation of construction equipment

The major construction equipment would be operated through electricity. However, in contingency Diesel would also be used. When Diesel would be used then the major pollutant will be SO_2. The SPM emissions are minimal due to low ash content in diesel. The short-term increase in SO_2, even assuming that all the equipment are operating at a common point, is quite low, i.e. of the order of less than 1 $\mu g/m^3$. Hence, no major impact is anticipated on this account on ambient air quality.

Emissions from various crushers

During crushing operations, there would be emissions of dust particles. These emissions would be controlled through cyclone. Further, the labour camps would be located on the leeward side at appropriate location.

Impacts due to vehicular Movement

The vehicular movement is likely to lead to entrainment of dust. However such ground level emissions do not travel for long distances. Thus, no major adverse impacts are anticipated on this account.

6.3IMPACTS ON NOISE ENVIRONMENT

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

6.4IMPACTS ON LAND ENVIRONMENT

6.4.1 Quarrying operations

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

6.4.2 Operation of construction equipment

The sitting of the construction equipmentslike crushers, batching plant, drillers, earth movers, etcwould require significant amount of space. In addition, land will also be temporarily acquired, i.e. for the duration of project construction for storage of quarried material before crushing, crushed material, cement, rubble, etc. Efforts shall be made for proper sitting of these facilities. The various criteria for selection of these sites would be:

- Proximity to the site of use
- Sensitivity of forests in the nearby areas
- Proximity from habitations

- Proximity to drinking water source
- Wildlife, if any, in the nearby area

6.4.3 Muck Disposal

The total quantity of muck expected to be generated has been estimated to be of the order of 32 lakh m^3. Considering, 25% swelling factor, the total muck to be handled is 40 lakh m^3. About 5o% material shall be used as construction material Thus, 20 lakh m^3 of muck is planned to be disposed.

6.4.4 Acquisition of land

The total land required for the project is 292 ha. As per the present status, about 234 ha of land is Forest land and the remaining (58 ha) is non-forest government land and /or Private Land. Out of 58 ha of non-forest government land and /or Private Land, 34 ha of land will be transferred from I& W Directorate, Government of West Bengal to Turga Pumped Storage Project. Remaining 24 ha of land to be arranged temporarily on leased basis.

6.5 IMPACTS ON TERRESTRIAL ECOLOGY

a) Construction phase

Increased human interferences

A large population (4,000) is likely to congregate in the area during the project construction phase. This population residing in the area may use fuel wood (if no alternate fuel is provided). Therefore, alternate fuel should be provided to such population. Further, community kitchens should be provided using LPG or diesel as fuel.

Acquisition of forest land

The total land required for the project is 292, About 234 ha is forest land and the balance land 58 ha is private land. *Buteamonosperma, Phoenix sylvestris, DiospyrosmelanoxylonShorearobusta,Semecarpusanacardium, Syzygiumcumini, Terminaliatomentosa*were the dominant tree species. The tree density in the submergence, dam and power house sites ranged from 230 to 410 per ha. The number of tree species observed at various sites ranged from 3 to 16. Normally in a dense forest, tree density is of the order of 1000-1200 trees/ha. Thus, in forest land to be acquired for the project, the tree density is low.

Amongst shrubs,*Chromolaenaodoratum, Lantana indica, Ipomoea carnea, Clerodendrumviscosum, Cassia tora, Woodfordiafruticosa, Combretumdecandrum, Strobilanthespectinatus* were the dominant species.

The dominant herbaceous species at various sampling sites were *Melilotusindica,Chrysopogonaciculatus, Mazusdelavayi,* *Oplismenuscomposites,Desmodiumdiffusum, ElephantopusscaberUrenalobata,Phyllanthusurinaria.* Thus, no endemic or RET species are reported in the land to be acquired for the project.

Disturbance to wildlife

The operation of various construction equipment, and blasting is likely to generate noise. These activities can lead to some disturbance to wildlife population. From the available data, the project area does not have significant wildlife population. Likewise, area does not fall in the migratory routes of animals.

Impacts on avi-fauna

The project area and its surroundings are quite rich in avi-fauna. The construction of Upper and Lower dams, a total reservoir area of about 136.1 ha will be created, with quiescent/tranquil conditions. The reservoir banks will have wet environment throughout the year which can lead to proliferation of vegetation e.g. grass, etc. along the reservoir banks. Such conditions are generally ideal for various kinds of birds, especially, water birds. This is expected to increase the avi-faunal population of the area.

b) **Operation phase**

Impacts due to increased accessibility

During 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. The increased accessibility to the area can lead to increased human interferences. However, considering, the manpower requirement in project operation phase, increase in human population is not expected to be significant. The manpower in project operation phase will be living in project colony, with all the modern amenities. Thus, pressure due to this project personnel on the forests of the area is not expected to be significant.

6.6 IMPACTS ON AQUATIC ECOLOGY

a) Construction phase

During construction phase wastewater mostly from domestic source will be discharged mostly from various camps of workers actively engaged in the project area. Around 0.54mld of water is required for the workers during the peak construction phase out of which 80% (i.e. about 0.43mld) will be discharged back to the river as wastes, more or less as a point sources from various congregation sites where workers will reside. The sewage shall be treated prior to disposal to minimize the adverse impacts.

b) Operation phase

The completion of the proposed Turga Pumped Storage Project would bring about significant changes in the riverine ecology during initial phases of reservoir impoundment, as it can lead to drying of river Turga downstream of Upper and Lower Reservoirs. It is proposed to release Environmental flows as per the norms of Ministry of Environment, Forests & Climate Change (MOEF&CC) to mitigate the adverse impacts on rivering ecology during reservoir impoundment.

On completion of reservoir filling, during project operation phase, the water stored in the upper Reservoir will be used for peaking power generation. The water will be stored in the Lower Reservoir and pumped back to Upper reservoir during non-peak hours. Thus, water flowing in river Turga will be allowed to be released during project operation phase.

6.7 IMPACTS ON SOCIO-ECONOMIC ENVIRONMENT

Immigration of labour population

The peak labour force & Technical Staff required is estimated as 800 & 200 respectively. Job opportunities will improve in this area. At present most of the population sustains by agriculture and allied activities. The project will open a large number of jobs to the local population both during project construction and operation phases.

7. ENVIRONMENTAL MANAGEMENT PLAN

7.1 Control of pollution from labour camps during construction phase

The aggregation of large labour population and technical staff during construction phase is likely to put significant stress on various facets of environment. The various issues covered in environmental management during construction phases are described in this section.

Facilities in labour camps

It is recommended that project authorities can compulsorily ask the contractor to make semi-permanent structures for their workers. These structures could be tin sheds. These sheds can have internal compartments allotted to each worker family. The sheds will have electricity and ventilation system, water supply and community latrines.

The water for meeting domestic requirements may be collected from the rivers or streams flowing upstream of the labour camps. The water quality in general is good and can be used after chlorination.

Sanitation facilities

One community latrine can be provided per 20 persons. The sewage from the community latrines can be treated in septic tanks prior to disposal.

Solid waste management from labour camps

For solid waste collection, suitable number of masonry storage vats, each of 2 m^3 capacity should be constructed at appropriate locations in various labour camps. These vats should be emptied at regular intervals and should be disposed at identified landfill sites. Suitable solid waste collection and disposal arrangement shall be provided. A suitable landfill site should be identified and designed to contain municipal waste from various project township, labour colonies, etc.

Provision of free fuel

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

7.2 ENVIRONMENTAL MANAGEMENT IN ROAD CONSTRUCTION

The approach roads will have to be constructed as a part of the proposed project. Steeply sloping banks are liable to landslides, which can largely be controlled by provision of suitable drainage. Landslides is proposed to be stabilized by several methods i.e. engineering or bio-engineering measures alone or a combination of these. Engineering solutions such as surface drainage, sub-surface drainage, toe protection and rock bolting can be used.

7.3 MANAGEMENT OF MUCK DISPOSAL SITES

In the hilly area, dumping is done after creating terraces; thus usable terraces are developed. The overall idea is to enhance/maintain aesthetic view in the surrounding area of the project in post construction period & avoid contamination of any land or water resource due to muck disposal. Suitable retaining walls shall be constructed to develop terraces so as to support the muck on vertical slope and for optimum space utilization. The muck disposal sites should be reclaimed with vegetation.

7.4STABILIZATION PLAN FOR QUARRY SITES

The measures adopted for landscaping of quarry sites are listed as below:

- The top 6-12” of soil will be removed before starting the quarrying activity or any other surface disturbance.
- Top soil will be kept separate and stock piled so that it can be reused after quarrying is over for rehabilitation of sites.
- Garland drains around quarry site shall be constructed to capture the runoff and divert the same to the nearest natural drain.
- Depression and/or craters will be filled by the dumping materials consisting of boulders, rock, gravel and soil from nearby plant/working sites.

- Retaining walls will be constructed at the filled up depressions of quarry sites to provide necessary support particularly where there are moderately steep slopes.
- Concrete guards, shall be constructed to check the soil erosion of the area.
- After the quarrying activities are over, these sites will be splattered with the leftovers of rocks and boulders, which will support growth of mosses and lichens, which will act as ecological pioneers and initiate the process of succession and colonization.
- The depressions/craters filled up with rock aggregates will be covered with top soil.
- Revegetation of the dumping sites through 'Integrated Biological and Biotechnological Approach'

7.5 RESTORATION AND LANDSCAPING OF PROJECT SITES

The beautification would be carried out by developing flowering beds for plantation ornamental plant and flower garden. The beautification in the colony area would be carried out by development of flowering beds for plantation of ornamental plant, creepers, flower garden and a small park, construction of benches for sitting, resting sheds, walk way and fountain.

7.6 GREENBELT DEVELOPMENT

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

7.7 PUBLIC HEALTH DELIVERY SYSTEM

A population of about 4,000 is likely to congregate during the construction phase. The labour population will be concentrated at two or three sites.It is proposed that during construction stage, the existing medical facilities of the Block Hospital at Baghmundi and the existing medical facilities of the nearby PPSP Project will be improved and upgraded to take care of the Health Care system of the Turga PSP working force.

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

The 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.

7.8 COMPENSATORY AFFORESTATION

The total land required for the project is 292 ha, of which 234 ha forest land. About 234 ha of Non-forest land would be acquired for compensatory afforestation purpose. The unit cost of afforestation on forest land is Rs. 96,200/ha. The cost for afforestation of 234 ha is Rs. 225.12 lakh. In addition to above the project proponent will pay for the NPV, which shall be estimated by the Forest Department. The indigenous species shall be used for afforestation, which shall be selected in consultation with the Forest Department.In addition, following measures are also recommended:

- Conservation of Avi-fauna
- Training & Publicity Programmes
- Anti-poaching measures

7.9 CONTROL OF AIR POLLUTION

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

7.10 CONTROL OF WATER POLLUTION

Construction phase

During construction phase of the proposed project, 2 or 3 crushers are likely to operate at major construction sites. The effluent generated from crushers will have high suspended solids. It is proposed to provide settling tanks for treatment of effluent from various crushers.

Operation phase

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 existing colony of Purulia Pumped Storage Project, with sewage treatment plant and other infrastructure facilities. Hence, problems of water pollution due to disposal of sewage are not anticipated.

7.11 FISH MANAGEMENT

a) Release of minimum flow

The dry segment of river between dam site and tail race at certain places may have shallow water subjecting the fish to prey by birds and other animals. It is therefore, considered to maintain a minimum flowto ensure survival and propagation of invertebrates and fish. For Turga Pumped Storage Project, the Environmental Flows for Upper and Lower Reservoir are given in Tables-6 and 7 respectively.

Table-6: Recommended Environmental Flows for Upper Reservoir

Month/Season	Flow in 90% DY (MCM)	Percentage of inflow as Environmental Flow	Environmental Release (MCM)
June	0.11	30%	0.03
July	0.38	30%	0.11

Month/Season	Flow in 90% DY (MCM)	Percentage of inflow as Environmental Flow	Environmental Release (MCM)
August	0.02	30%	0.006
September	1.55	30%	0.47
October	0.56	30%	0.17
Monsoon (Total)- **(A)**	2.63	30%	0.786
Non-Monsoon (Total)- **(B)**	0.29	25%	0.0725
Annual (A+B)	**2.92 MCM**		**0.8585, say 0.86 MCM**

Table-7: Recommended Environmental Flows for Lower Reservoir

Month/Season	Flow in 90% DY (MCM)	Percentage of inflow as Environmental Flow	Environmental Release (MCM)
June	0.17	30%	0.05
July	0.58	30%	0.17
August	0.04	30%	0.01
September	2.37	30%	0.71
October	0.86	30%	0.26
Monsoon (Total)- **(A)**	4.01	30%	1.20
Non-Monsoon (Total)- **(B)**	0.44	25%	0.11
Annual (A+B)	**4.45 MCM**		**1.31 MCM**

It is considered to release the environmental flow from very beginning of the construction of both the Dams, so that environmental and ecological aspects can be maintained properly in that area. The existing irrigation and drinking water requirements during filling period of reservoirs shall be met by diverting water from other sources e.g., Bamninala.

b) Sustenance of Endemic Fisheries

The commissioning of the proposed Turga Pumped Storage Project will increase the water availability in the project command area. It is proposed to stock the upper and lower reservoirs with fingerlings. Adequate infrastructure in terms of nurseries, rearing ponds, etc. shall be commissioned.

7.12 NOISE CONTROL MEASURES

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

- Equipment and machineries should be maintained regularly to keep the noise generation at the design level;
- Silencers and mufflers of the individual machineries to be regularly checked;
- Exposure of workers to high noise areas, should be limited as per maximum exposure periods specified by OSHA.

8. CATCHMENT AREA TREATMENT (CAT) PLAN

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 as per a SYI index is given in Table-8.

Table-8:Area under different erosion categories

Category	Area (ha)	Area (%)
Low	-	-
Medium	750	59.24
High	516	40.76
Total	**1266**	**100.00**

A CAT Plan comprising of following aspects is proposed:

- Afforestation
- Soil & Water Conservation Works
- Silt Observation Points
- Infrastructure Development
- Research Training & Capacity Building

9. LOCAL AREA DEVELOPMENT PLAN

The area development activities proposed as a part of the plan given in following paragraphs:

Upgradation of educational facilities

The following activities are proposed under Local Area Development Plan:

- Up-gradation of school fixtures, equipment
- Improvement of drinking water and sanitation facilities
- School bus service
- Scholarship to students

Improvement of Public Health Facilities

- Furniture, Beds and other items
- Up-gradation of Pathological laboratory
- Up-gradation of operation theater (labor room)

An amount of Rs. 2204.0 lakh is being made for implementation of the LADP Activities. The details are shown in Table-9.

Table-9: Budget for implementation of Local Area Development Plan

S. No.	Items	Budget (Rs. lakh)
1	Construction/Up-gradation schools in Study Area	554.0
2	Scholarships to students in the Study Area	160.0
3	Improvement of Public Health Facility	194.0

S. No.	Items	Budget (Rs. lakh)
4	Construction of Community Toilets	1200.0
5	Additional Infrastructural Facilities Sought for During Public Hearing	96.0
	Total	**2204.0**

10. DISASTER MANAGEMENT PLAN

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

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

11. SUMMARY OF ENVIRONMENTAL MONITORING PROGRAMME

An Environmental Monitoring Programme should be undertaken during construction and operation phase of the project. The details of environmental monitoring programme are given in Tables - 10 and 11 respectively.

Table-10: 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 every 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 every season	At major construction sites
5.	Meteorological aspects	Wind direction & velocity temperature humidity, rain	Once every season	At one of the ambient air quality sampling sites
6.	Ecology	Status of afforestation programmess of green belt development, Terrestrial Flora and fauna and aquatic ecology	Once every season	
7.	Aquatic ecology	Phytoplanktons, zooplanktons, benthic life,	Once every season	

S. No.	Item	Parameters	Frequency	Location
		fish composition		

Table-11: 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 every season	• 1 km upstream of submergence site. • Proposed Upper dam Reservoir. • 1km downstream of the Proposed Upper dam site • Proposed Lower dam Reservoir • 1, 3 and 5 km downstream of the Proposed Lower dam reservoir
2.	Effluent from Sewage Treatment Plant (STP)	pH, BOD, COD, TSS, TDS	Once every week	• Before and after treatment from Sewage Treatment Plant (STP)
3.	Ecology	Status of afforestation programmess of green belt development, Terrestrial Flora and fauna and aquatic ecology	Once every season	-
4.	Water-related diseases	Identification of water-related diseases, sites, adequacy of local vector control measures, etc.	Once every season	• Villages adjacent to project sites
5.	Aquatic ecology	Phytoplanktons, zooplanktons, benthic life, fish composition	Once every season	• 1 km upstream of submergence site. • Proposed Upper dam Reservoir. • 1km downstream of the Proposed Upper dam site • Proposed Lower dam Reservoir • 1, 3 and 5 km downstream of the Proposed Lower dam

S. No.	Items	Parameters	Frequency	Location
				reservoir
6.	Landuse	Landuse pattern using satellite data	Once in a year	Catchment area

The cost required for implementation of the Environmental Monitoring Programme is of the order of Rs. 187.23 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 63 months. The details are given **in Table-12.**

Table-12: Cost for Implementing Environmental Monitoring Programme during construction phase

S. No	Item	Cost (Rs. lakh/year)	Total cost for construction period of 63 months with 10% escalation per year (Rs. in lakh)
1	Water quality	0.96	6.25
2	Ambient Air quality	4.80	31.25
3.	Ecology	18.00	117.18
4.	Incidence of water related diseases	5.00	32.55
	Total	**28.76**	**187.23**

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-13.

Table-13: Cost for Implementing Environmental Monitoring Programme during operation phase

S. No.	Item	Cost (Rs. in Lakh/year)
1.	Water quality	1.26
2.	Ecology	18.00
3.	Incidence of water related diseases	5.00
4.	Land use pattern	5.00
	Total	**29.26**

12. COST FOR IMPLEMENTING ENVIRONMENTAL MANAGEMENT PLAN

The total amount to be spent for implementation of Environmental Management Plan (EMP) is Rs.4618.85 lakh or Rs. 46.19crore. The details are given in Table-14.

Table-14: Cost for Implementing Environmental Management Plan

S. No.	Item	Cost (Rs. Lakh)
1.	Catchment Area Treatment	409.65
2.	Compensatory Afforestation, & Bio-diversity Conservation	483.50
3.	Fisheries Management	88.70
4.	Greenbelt development	16.80
5.	Water, Air and Noise pollution control	20.00
6.	Environmental Management in labour camps	204.75
7.	Public health delivery system	308.23
8.	Muck management	120.00
9.	Restoration, Stabilization and Landscaping of Quarry sites	60.00
10.	Restoration and Landscaping of construction sites	20.00
11.	Environmental management in road construction	40.00
12.	Energy Conservation measures	312.37
13.	Disaster Management Plan	40.00
14.	Local Area Development Plan	2204.0
15.	Plan to preserve cultural identity of the locals	98.12
16.	Environmental Monitoring during construction phase	187.23
17.	Purchase of meteorological instruments	4.50
18.	Purchase of noise meter	1.00
	Total	**4618.85**

वाप्कोस लिमिटेड
WAPCOS LIMITED
(भारत सरकार का उपक्रम)
जल संसाधन, नदी विकास व गंगा संरक्षण मंत्रालय
(A Government of India Undertaking)
Ministry of Water Resources, River Development & Ganga Rejuvenation

Date: 27.11.2015

UNDERTAKING

As per MoEF Office Memorandum no. J-11013/41/2006/-IA-III, dated 5th October, 2011, M/s. WAPCOS Limited, Gurgaon, Haryana herewith declares ownership of the contents (information and data) of the EIA Study for Turga Pumped Storage Project, West Bengal.

Aman Sharma 27/11/15

(Authorised Signatory)

डॉ. अमन शर्मा/ Dr. Aman Sharma
वरि. महा प्रबंधक (गंगा संरक्षण एवं पर्यावरण)
Sr. General Manager (Ganga Rejuvenation & Envt.)
वाप्कोस लिमिटेड / WAPCOS LIMITED
(भारत सरकार का उपक्रम/A Govt. of India Undertaking)
76–सी, सैक्टर –18, गुड़गाँव –122015 (हरि०)
76 - C, Sector - 18, Gurgaon -122015 (Hr.)

76-C, Institutional Area, Sector - 18, Gurgaon - 122 015 (Haryana), INDIA
Tel. : +91-124-2399421 (16 Lines) Fax : +91-124-2397392
E-mail : ho@wapcos.gov.in ; mail@wapcos.gov.in Website : http://www.wapcos.gov.in
CIN NO. U74899DL1969G01005070

Accreditation Certificate of the EIA consultant as per the office memorandum issues by MOEF, GOI

NABET

National Accreditation Board
for Education and Training

NABET/EIA/RA068/085

Chairman cum Managing Director
WAPCOS Limited (A Government of India Undertaking)
Plot-76-C, Sector-18, Gurgaon – 122015, Haryana
(Kind Attention: **Mr. R.K. Gupta**)

Oct 09, 2015

Dear Sir,

Sub: Re-Accreditation

This has reference to your application to QCI-NABET for re-accreditation (RA) as EIA Consultant Organization and the assessment carried for same in your organization from Apr. 07-09, 2015.

We are pleased to inform you that based on the document and office assessments during RA, the Accreditation Committee has approved renewal of accreditation given to your organization for a period of three years from **Apr. 09, 2015 to Apr. 08, 2018** subject to coverage of balance Functional areas and specific response to NCs/Obs./Alerts issued, if applicable (Refer Annexure III) with the following details:

1. Annexure I - Scope of accreditation
2. Annexure II - List of experts with approved sectors/ functional areas
3. Annexure III - Non-Conformances/ Observations/ Alerts (NCs/ Obs./ Alerts)
4. Annexure IV - Observations on Quality Management System (QMS)
5. Annexure V - Terms and conditions of accreditation
6. Annexure VI - Result of assessment
7. Annexure VII - Guidelines for addressing Major Non-Conformances/ Observations/ Alerts
8. Annexure VIII - Format to be followed for mentioning the names of the experts involved in EIA reports prepared by **WAPCOS Limited.**

Result of RA including Non-Conformances/ Observations/ Alerts (NCs/ Obs./ Alerts) applicable to your organization as per RA are also posted on QCI website vide minutes of the Accreditation Committee meetings dated June 10, 2015. You are requested to take necessary actions to close the NCs/ Obs. as per guidelines and timeframe mentioned in Annexure VII of this letter. You are also advised to review eligibility of organization as per Version 3 of the Scheme (posted on NABET website) which has become effective from Sep 1, 2015 and meet its requirements by Dec. 31, 2015 positively.

You are required to make all payments to NABET as applicable, within one month from the date of invoice sent to you. Continuation of this accreditation of your organization is subject to the clearance of all dues by your organization, satisfactory compliance to Annexure III and V.

With best regards,

Yours sincerely,

(Abhay Sharma)
Assistant Director

Scope of Accreditation

Annexure I

NAME OF THE CONSULTANT ORGANIZATION: WAPCOS Limited (A Government of India Undertaking)
Plot-76-C, Sector-18, Gurgaon – 122015, Haryana

Sl. No.	Sector number		Name of Sector	Category A/B
	As per MoEF Notification	As per NABET Scheme		
1.	1 (a) (i)	1	Mining of Minerals- Open cast only	A
2.	1 (c)	3	River Valley, Hydel, Drainage and Irrigation projects	A
3.	1 (d)	4	Thermal Power Plants	A
4.	7 (e)	33	Ports, harbours, jetties, marine terminals, break waters and dredging	A
5.	8 (a)	38	Building and large construction projects including shopping malls, multiplexes, commercial complexes, housing estates, hospitals, institutions	B
Total = 05 Sectors *Individual EIA Coordinators approved for different sectors are mentioned in Annexure II*				

The ACO has overall obtained more than 60 % marks and therefore qualifies for Cat. A.

(Abhay Sharma)
Assistant Director

Accreditation Certificate of the laboratory

NABL

National Accreditation Board for Testing and Calibration Laboratories

(An Autonomous Body under Department of Science & Technology, Govt. of India)

CERTIFICATE OF ACCREDITATION

SPECTRO ANALYTICAL LABS LTD.

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

E-41, Okhla Industrial Area, Phase-II, New Delhi

in the discipline of

CHEMICAL TESTING

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Certificate Number T-0249

Issue Date 03/02/2015

Valid Until 02/02/2017

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the additional requirements of NABL.

Signed for and on behalf of NABL

N. Venkateswaran	Anil Relia	Prof. Ashutosh Sharma
Program Manager	Director	Chairman

Accreditation Certificate of the laboratory

NABL

National Accreditation Board for Testing and Calibration Laboratories

Department of Science & Technology, India

CERTIFICATE OF ACCREDITATION

SPECTRO ANALYTICAL LABS LTD.

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

E-41, Okhla Industrial Area, Phase-II, New Delhi

in the discipline of

BIOLOGICAL TESTING

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Certificate Number T-1073

Issue Date 02/03/2014

Valid Until 01/03/2016

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the additional requirements of NABL.

Signed for and on behalf of NABL

Prachi		
Prachi Kukreti	Anil Relia	Dr T. Ramasami
Convenor	Director	Chairman

West Bengal State Electricity Distribution Company limited
(A West Bengal Government Enterprise)
Vidyut Bhavan (5th Floor), Block-DJ , Sector-II, Salt Lake ,Kolkata
West Bengal – 700091 (India)
Tel: 033-23345821/23197628
Fax.: 033-23345855
(April -2016)