DRAFT ENVIRONMENTAL IMPACT ASSESSMENT REPORT AND ENVIRONMENT MANAGEMENT PLANT

FOR

ANUPPUR THERMAL POWER PLANT STAGE-II (2X800 MW)

Tehsil: Jaithari, District: Anuppur, Madhya Pradesh

Vol-I: EIA/EMP Report

Project Proponent

HINDUSTAN POWER

MB Power (Madhya Pradesh) Limited

ToR Ref No.: J-13012/99/2008-IA.II(T)

Project Cost- Rs. 19,200 Crores

Baseline Monitoring Period: October 2024 to December, 2024

Environment Consultant

Greencindia Consulting Pvt Ltd

Greencindia Consulting Private Limited

QCI-NABET Certificate No.- NABET/ EIA/2326/RA 0297 Valid up to 22.02.2026

February, 2025

NABET DISCLOSURE

DECLARATION BY EXPRETS CONTRIBUTING TO DRAFT EIA REPORT FOR PROPOSED EXPANSION BY ADDITION OF 2x800 MW COAL BASED ULTRA SUPER CRITICAL THERMAL POWER PLANT TO EXISTING 2x630 MW BY MB POWER (MADHYA PRADESH) LIMITED AT VILLAGE LAHARPUR, MURRA, GUWARI, BELIA & JETAHARI IN JAITHARI TEHSIL, ANUPPUR DISTRICT, MADHYA PRADESH.

I, hereby, certify that we were part of the team in the following capacity that developed the above EIA.

EIA CATEGORY	:	1(d) Thermal Power Plant
Name of EIA COORDINATOR	:	Nandini Choudhury, Category A
Signature & Date	:	Nandini Choudhury 26.02.2025.
Period of Involvement	:	August, 2024 To Till Date
Contact Information	:	608-611, Level-5, Shopprix Mall, Vaishali, Ghaziabad, UP

Sl. No.	Name of Expert	Functional Area	Task	Signature
1	Shyam Sundar	Water Pollution-WP	▪ Selection of Monitoring location for ground water and surface water ▪ Assessment of Impact associated with the project operation activities ▪ Preparing cost estimate for treatment of waste water. ▪ Development of Water	26.02.25.

Sl. No.	Name of Expert	Functional Area	Task	Signature
			Management Plan.	
2	Nandini Choudhury	Socio-economy-SE	▪ Assessment of impact associated with the project. ▪ Interpretation of primary and secondary data to derive socio-economic status of study area and related stakeholders. ▪ Assessment of social changes arising out of the project. ▪ Suggesting measures to enhance the socio-economic status of the people living in and around the project.	Nandini Choudhury 26.02.2025.
4	Dr. Sangeeta Verma	Ecology & Biodiversity-EB	▪ Survey of existing flora & fauna in the study area ▪ Assessment of impact associated with project ▪ Selection of species for greenery development. ▪ Preparation of conservation plan for scheduled species ▪ Assistance during development of project management plan.	S Verma 26.02.25

Sl. No.	Name of Expert	Functional Area	Task	Signature
		Soil Conservation -SC	▪ Baseline data generation for soil sampling analysis and characterization of soil. ▪ Assessment of fertility/productivity of soil. ▪ Suggesting soil conservation measures.	
5	Nandini Choudhury	Land-use	▪ Development of Land-use Map ▪ Impact of project on surrounding land use ▪ Assistance during development of project management plan. ▪ Suggestion of mitigation measures due to change in land uses by the project.	Nandini Choudhury 26.02.2025
6	Shyam Sunder	Air Pollution-AP	▪ Assessment of impact associated with the project operation activities ▪ Assessment of impact associated with vehicle movement operation ▪ Development of management plan to control the air pollution & its mitigation.	26.02.25
7		Air quality modeling-AQ	▪ Developing micro-	

Sl. No.	Name of Expert	Functional Area	Task	Signature
			meteorological data for use in modeling. ▪ Quantitative assessment of project impact associated with project activities using AERMOD.	
8		Solid & Hazardous Waste-SHW	▪ Identifying source of waste generation. ▪ Quantitative assessment of hazardous and industrial solid waste likely to be generated. ▪ Development of management, handling and disposal techniques. ▪ Suggesting measures for minimization of waste generation.	
9	Gokul Chandra Pattnaik	Risk & hazard-RH	▪ Assessment of risk likely to be generated from the project activities. ▪ Preparation of emergency preparedness plan. ▪ Development of disaster management plan for the project.	G C Patnaik 26/02/2025

Sl. No.	Name of Expert	Functional Area	Task	Signature
10	Nirzar Ajay Lakhia	Geology-Geo	▪ Study of geological and rock structure of the study area based on secondary data and literature survey.	26.02.2025
11		Hydrogeology-HG	▪ Study of hydrogeological study of the study area. ▪ Study rainwater harvesting and groundwater fluctuation in the study area.	
12	Rahul Singh	Noise & Vibration	Assessment of noise and vibration likely to be generated from the project activities. • Assessment of impact associated with project. • Assistance during development of project management plan.	Rahul 26/2/2025

Declaration by the Head of the Accredited Consultant Organization

I, **Nandini Choudhury**, hereby, confirm that the above-mentioned experts were involved in preparation of **DRAFT EIA REPORT FOR PROPOSED EXPANSION BY ADDITION OF 2x800 MW COAL BASED ULTRA SUPER CRITICAL THERMAL POWER PLANT TO EXISTING 2x630 MW BY MB POWER (MADHYA PRADESH) LIMITED AT VILLAGE LAHARPUR, MURRA, GUWARI, BELIA & JETAHARI IN JAITHARI TEHSIL, ANUPPUR DISTRICT, MADHYA PRADESH.** I also confirm that I shall be fully accountable for any misleading information mentioned in this statement.

Signature:

Nandini Choudhury

Greencindia Consulting Private Limited

Name	:	**Nandini Choudhury**
Designation	:	**EIA Coordinator**
Name of the EIA Consultant Organization	:	**Greencindia Consulting Private Limited**
NABET Certificate No. & Issue Date	:	**NABET/EIA/2326/RA 0297, August, 2023**
Validity	:	**Feb 22, 2026**

NABET DISCLOSURE

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Period of Involvement	**:**	**August, 2024 To Till Date**
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Signature:

Nandini Choudhury

Greencindia Consulting Private Limited

Name	:	**Nandini Choudhury**
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Validity	:	**Feb 22, 2026**

Registered Office: 607-611, Level-5, Shopprix Mall, Sector-5, Vaishali, Ghaziabad-201010,

Landline-0120-4111527, 4291470, 4296535

Email id: information@greencindia.com

Project Office: 10, Armstrong Avenue, Opposite Bank of India, Bidhan Nagar, Durgapur-12, Voice Contact: 9930136376

UNDERTAKING

Subject: Environment Clearance for the proposed Expansion by Addition of 2x800 MW Coal based Ultra Super Critical Thermal Power Plant to Existing 2x630 MW by MB Power (Madhya Pradesh) Limited at Village Laharpur, Murra, Guwari, Belia & Jethari in Jaithari Tehsil, Anuppur District, Madhya Pradesh.

Proposal no.- IA/MP/THE/ 502449/2024

This is to inform you that, we M/s Greencindia Environmental Impact Assessment Study for the subject job, as per the EIA Notification, 2006 amendment till date in compliance with the Terms of Reference issued by Ministry of Environment, Forest and Climate Change, vide its letter No.- J-13012/99/2008-IA.II(T), dated 28th December, 2024. We hereby undertake that prescribed ToRs have been complied with and the data submitted are factually correct to the best of our knowledge.

For Greencindia Consulting Private Limited

(Nandini Choudhury)

Managing Director

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1. INTRODUCTION

1.1 BACKGROUND & INTRODUCTION

MB Power (Madhya Pradesh) Limited (MBPMPL), a 100% subsidiary of Hindustan Powerprojects Private Limited (HPPPL)is operating a 2x630 MW coal based sub-critical power plant on the left bank of Sone River near village Laharpur, Murra, Guwari, Belia & Jethari in Anuppur district of Madhya Pradesh in an area of 417.996 hectares which is under possession of MBPMPL.

Initially MBPMPL planned to set up 2x600 MW subcritical power plant. Environment Clearance for 2x600 MW in the name of M/s Moser Baer Power & Infrastructure Ltd. was obtained vide letter no.- J-13012/99/2008-IA.II(T) dated 28.05.2010. Transfer of EC - From "M/s Moser Baer Power & Infrastructure Ltd.," to "M/s. MB Power (Madhya Pradesh) Ltd" vide letter no. J-13012/99/2008-IA.II(T) dated 23.11.2010. Forest clearance for 37.875 ha (93.6 acres) forest land coming under revenue forest land was obtained in two stages, Stage 1 vide letter no. 6MPCo51/2009-BHO/1032 dated 04.06.2010. and Stage 2 vide letter no. 6MPC051/2009-BHO/3598 dated 17.08.2011. Environment Clearance (Under clause 7(ii)(a)) - for 2 x 630 MW in the name of M/s MB Power (Madhya Pradesh) Ltd. vide letter no. J-13012/99/2008-IA.II(T) dated 07.05.2024. The EC letters and the Forest Clearence are enclosed as **Annexure 1.3, Annexure 1.4 , Annexure 1.5 and Annexure 1.6.**

MB Power (Madhya Pradesh) Limited (MBPMPL) is now proposing to expand 2x630 MW Sub-Critical Coal Based Thermal Power Plant by adding 2x800 MW Ultra Super Critical unit, which is based on Ultra Super Critical Technology. Total capacity after proposed expansion would be 2860 MW.

A total of **451.202 hectares** of land is under possession of MBPMPL, in which approximately 417.996 hectares of land was utilized to accommodate existing Anuppur TPP Stage-I (2x630 MW) project components i.e. Main Plant, Ancillary Facilities, Ash Disposal Area, Green Belt Township and unused area for Stage II TPP. The Stage II (2x800 MW) project including main plant equipment, ancillary facilities and ash disposal facility will be developed within the existing plant boundary. While additional 33.206 hectares of acquired land will be used for development of incoming railway line for coal transportation and green belt development.

1.2 PURPOSE OF THE REPORT

As per Environment Impact Assessment Notification dated 14th September 2006, and amended from time to time, commissioning or operation of thermal power plants (>500 MW) falls under category 'A' under project type 1(d) and requires prior Environmental Clearance (EC) from MoEF&CC before the commencement of ground activity.

In line with the said Notification, Terms of Reference (ToR) application was filled to MoEF&CC vide proposal No.- IA/MP/THE/502449/2024 dated 22.10.2024. The proposed project was under examination and EDS was raised against the submitted information on 07.11.2024. On the submission of the EDS reply on 26.11.2024 the proposed project was accepted and referred to EAC during the period of 27.11.2024 to 23.12.2024. A presentation was made to the Expert Appraisal Committee (Thermal), MoEF&CC in the 16th EAC meeting held on 23.12.20224 MoEF&CC has examined the proposal in accordance with the provisions contained in the Environment Impact Assessment (EIA)

Notification, 2006 & further amendments there to and based on the recommendations of the EAC, accorded Standard Terms of Reference (ToR) along with Specific/additional ToR vide ToR identification No.- TO24A0601MP5776563N, File No: J-13012/99/2008-IA.II(T) Dated 28.12.2024 to MB Power (Madhya Pradesh) Limited for expansion of Anuppur Ultra Super Critical Thermal Power Plant, Stage II (2x800 MW) (A copy of MoEF&CC approved ToR is enclosed as **Annexure-1.1).** Based on the TOR conditions stipulated by MoEF&CC, the present EIA/EMP report has been prepared. This report has been prepared for assessing the environmental impacts on the study area (10-km radius around the plant) due to the proposed power plant on the basis of approved ToR issued by MoEF&CC. The TOR compliance is enclosed as **Annexure 1.2.** This includes a cumulative Impact Assessment Study, considering a buffer area of 10 km, to assess the potential impacts of the proposed expansion activities. Draft EIA-EMP Report including ToR Compliances will be submitted to Madhya Pradesh Pollution Control Board (MPPCB), Madhya Pradesh for conducting Public Hearing.

1.3 IDENTIFICATION OF PROJECT AND PROPONENT

Hindustan Powerproject Private Limited, headquartered in New Delhi is a leading IPP with diversified assets in Renewable and Thermal energy. global technology company. Hindustan Power has diversified in hydroelectric power, thermal power, infrastructure development and other fields. MB Power (Madhya Pradesh) Limited (MBPMPL); a 100% subsidiary of Hindustan Powerprojects Private Limited (HPPPL) is in the process of entering in to power sector, both generation and distribution. The strategy of the company is to execute Greenfield projects in various states through separate Special Purpose Vehicle (SPV) Companies.

1.3.1 DESCRIPTION OF THE PROJECT

The current proposal aims to establish MBPMPL's Anuppur TPP Stage-II (2x800 MW) as a regional power project to serve the multiple Region's states and union territories.

Table 1-1: Details of the Project

Particulars	Details
Location	Anuppur Super Thermal Power Project is located on the left bank of Sone River near village Laharpur, Murra, Guwari, Belia & Jethari in Anuppur district of Madhya Pradesh

Particulars	Details		
Co-ordinates	**Point**	**Latitude**	**Longitude**
	A	23°4'26.01"N	81°46'24.16"E
	B	23°4'33.83"N	81°46'43.33"E
	C	23°4'31.71"N	81°47'5.72"E
	D	23°4'18.91"N	81°47'26.59"E
	E	23°4'31.21"N	81°47'47.48"E
	F	23°4'42.33"N	81°48'0.23"E
	G	23°4'34.40"N	81°48'21.17"E
	H	23°4'15.43"N	81°48'20.61"E
	I	23°04'1.40"N	81°48'17.87"E
	J	23°3'53.38"N	81°48'0.61"E
	K	23°3'48.83"N	81°47'36.15"E
	L	23°3'39.39"N	81°47'24.95"E
	M	23°3'29.16"N	81°47'45.76"E
	N	23°3'15.58"N	81°47'33.29"E
	O	23°3'14.09"N	81°47'26.06"E
	P	23°3'25.63"N	81°47'17.5"E
	Q	23°3'34.11"N	81°47'8.316"E
	R	23°3'41.08"N	81°46'48.34"E
	S	23°3'54.51"N	81°46'41.47"E
	T	23°04'4.27"N	81°46'27.95"E
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	III	23°3'39.16"N	81°49'13.33"E
	IV	23°3'38.05"N	81°48'59.32"E
	V	23°3'40.99"N	81°48'51.94"E

Particulars	Existing	Proposed	Total
Site Elevation (Approx) / Topography	Site elevation 502 m. Plain		
	Existing	**Proposed**	**Total**
Plant Capacity	1260 MW (2x630) MW	1600 MW (2x800) MW	2860 MW (1260+1600) MW
Adopted Technology	Sub-Critical Technology	Ultra Super Critical Technology	Sub-Critical & Ultra Super Critical
Land Area	417.996 Ha	33.206 Ha	451.202 Ha
Greenbelt Area	110.33 Ha	45.991Ha	148.629* Ha (33%)
Land area & status	417.996 Ha -within plant boundary and 33.206 Ha outside plant boundary. Acquired		
Main Fuel/ Coal Consumption	6.17 MTPA (with GCV of 3,364 kcal/kg and 85% PLF)	7.36 MTPA (with GCV of 3,350 Kcal/kg at 85% PLF considering)	13.53 MTPA
Source of Fuel	Coal for the proposed project will be domestic and sourced from CIL and other subsidiaries, as per Shakti Policy/ Commercial Mines.		
Coal Transportation	Indigenous Coal to be transported mainly through Railways.		
Water Requirement	68,400 KLD	95,808 KLD	1,64,208 KLD.
Water Cooling System	Water Cooled Condenser System	Water Cooled Condenser System	-
Water Source	The source of water for the project is Son River.		

Particulars	Details
	-36 MCM Water allocated by WRD vide letter ref: पत्र.क्र.वृ.प.नि.मं./31/तक/रा.स्त.-160/2008/589 dated 29/11/2024.
Nearest Town (Road Distance)	Anuppur town lies around 20 Km from the project location in North-West direction.
Railway Connectivity	The nearest railway station is Jaithari Railway station, 1.15 km away from the site.
Nearest Sea port	Nearest Seaport is at Vishakapatnam, 1250 km by road and 800 km by rail.
Nearby Airport	The closest commercial airport is Jabalpur, positioned about 200 Km away
Approach Road	The site can be accessed from National Highway 43 via Pendra Road.
Project Cost	Rs 19,200 Crores (Approx.) (EPC cost for Main plant & equipment is Rs. 13,593.6 Cr, incl Taxes & Duties. i.e: Rs. 8.496 Cr/MW)

1.3.2 THE PROJECT PROPONENT

The proposed project Anuppur TPP, Stage-II shall be constructed and operated by MB Power (Madhya Pradesh) Limited.

1.3.3 LOCATION OF THE PROJECT

MBPMPL is proposing to expand 2x630 MW Sub-Critical Coal Based Thermal Power Plant by adding 2x800 MW Ultra Super Critical units. Which is based on Ultra Super Critical Technology. Anuppur Super Thermal Power Project is located on the left bank of Sone River near village Laharpur, Murra, Guwari, Belia & Jethari in Anuppur district of Madhya Pradesh. The site is at a distance of about 20 km from Anuppur and is approachable from NH 43 (Gulganj to Chaibasa). Shahdol town is about 47.6 km from the project. The details of the proposed locations are provided in **Table 1.1** and the location map is given as **Figure 1.1**.

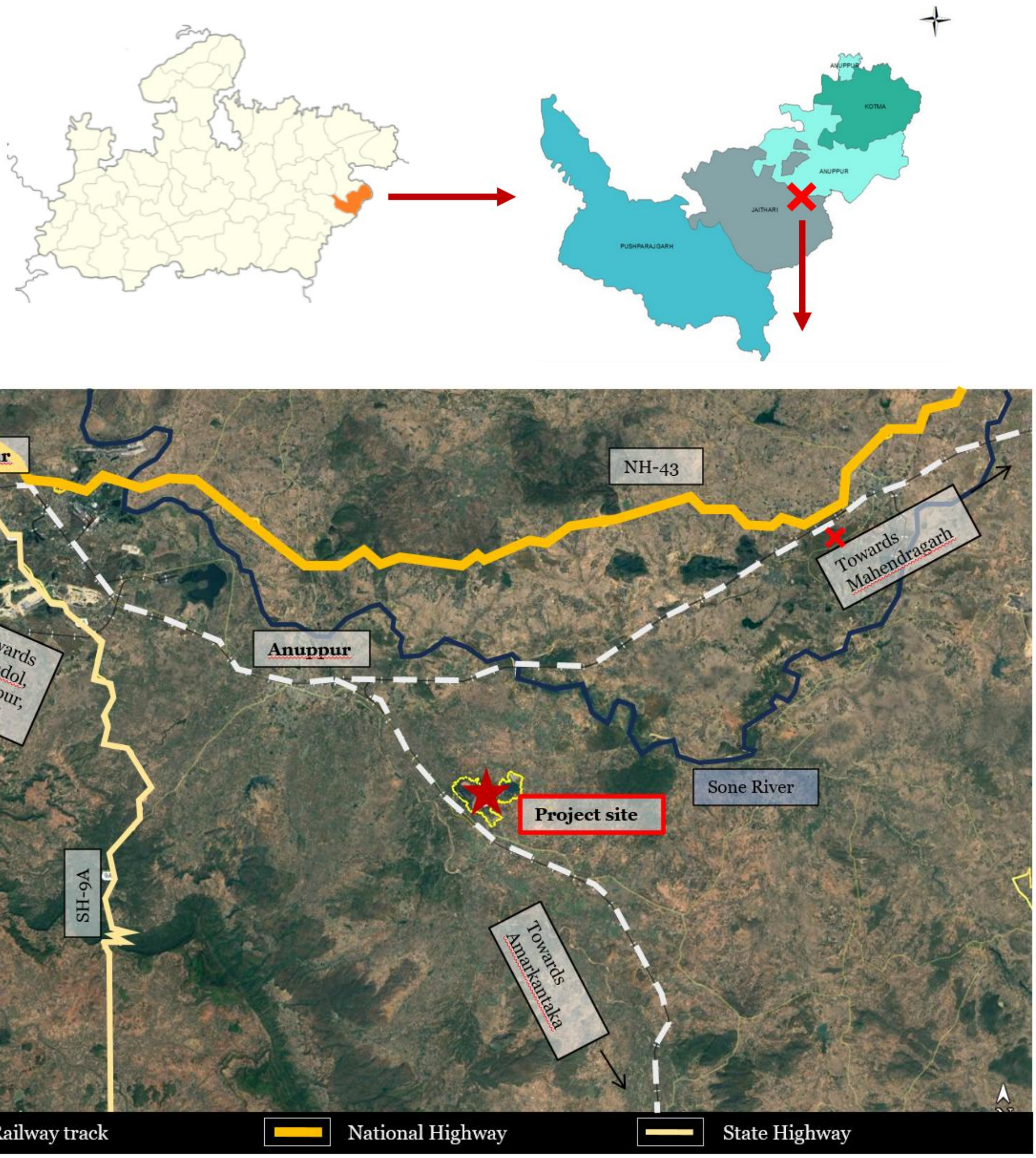

Figure 1-1: Location Map of the Project.

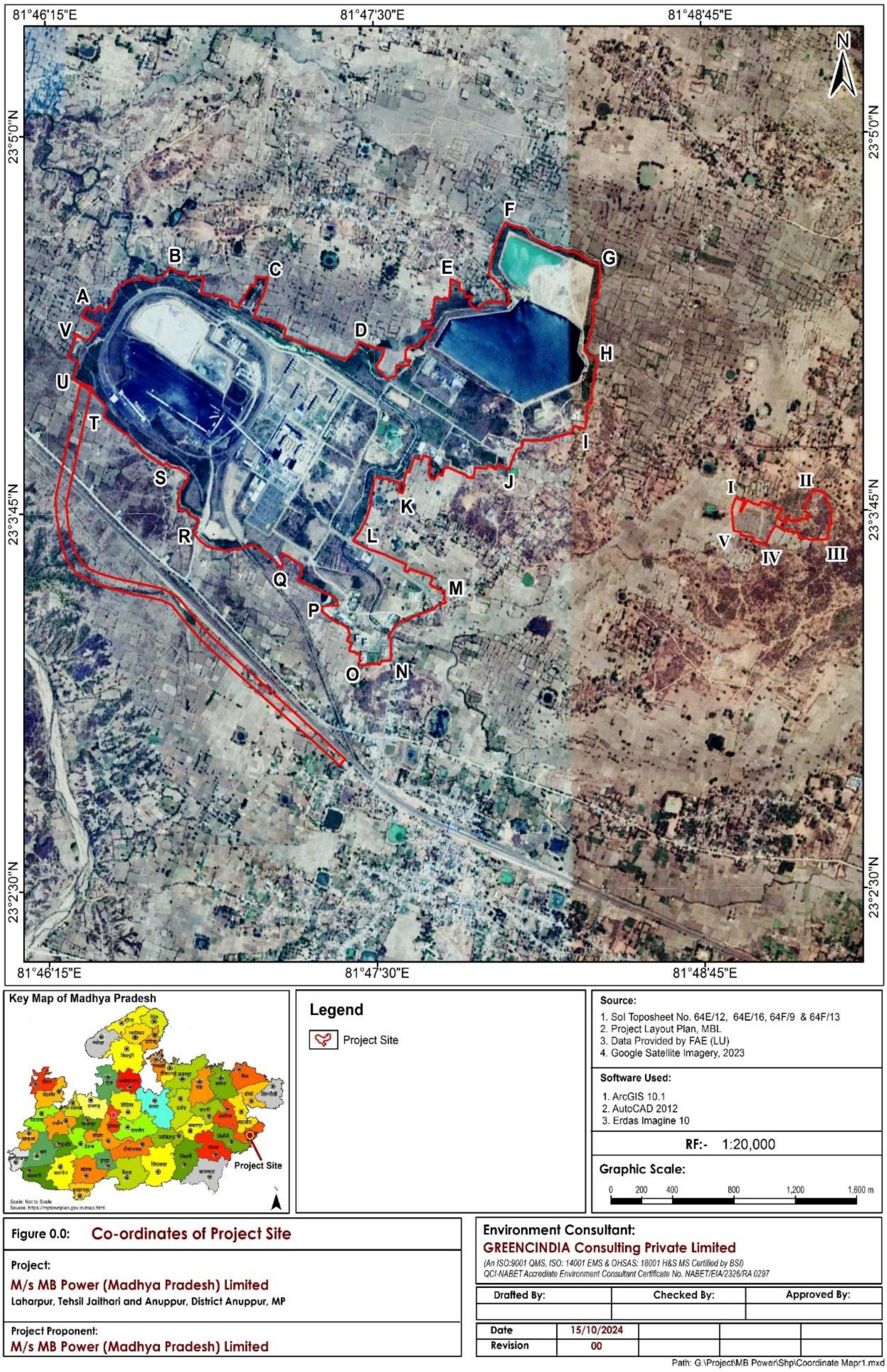

Figure 1-2: Coordinate Map for the Proposed Project.

Table 1-2: Project Site Coordinates.

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1.4 DEMAND JUSTIFICATION

Development of power sector plays an important role in the all-round growth of a country. The development level of a country can be best judged by the amount of power it consumes. Presently the per capita consumption of electricity in India is only about 1395 kWh, which is far below the world average of about 3070 kWh. The electric power industry is a highly capital-intensive sector with electric power projects having long gestation periods.

To accelerate the growth of power sector, Government of India (GOI) allowed private participation in early nineties, which was hitherto confined to erstwhile State Electricity Boards and Public Sector utilities. However, in spite of high initial response from private developers, there was no substantial addition of capacity by the private sector utilities because of various reasons.

The installed capacity of the country has increased to 4,46,190 MW in June 2024. Similarly, the electricity generation increased from about 5.1 Billion units in 1950 to 1,739.09 BU by Mar' 2024.

There is an acute shortage in the certain areas of the country. Keeping the present scenario of shortages in energy and peak demand in view and to maintain a GDP (Gross Domestic Product) growth of 8% to 10%, the Government of India has very prudently set a target of adding about 3,37,900 MW of power generation capacity by March 2032. Of the total anticipated capacity addition, 80,000 MW will be thermal, 25,010 MW hydropower, 14,300 MW nuclear and 50,760 MW of pump storage plants (PSP) capacity.

The peak demand shortage on all-India basis for this period was nearly 6,103 MW. It may be noted that the peak demand is actually restricted demand and is likely to be much higher.

1.4.1 DEMAND SUPPLY

All India Installed Capacity (Fuel-Wise) as on 31.10.2024.

Table 1-3: All India Installed Capacity (Fuel-Wise)

Category		Installed Generation Capacity (MW)
Fossil Fuel (A)	Coal	2,11,029
	Lignite	6,620
	Gas	24818.21
	Diesel	589.20
	Total	2,43,056.91
Non-Fossil Fuel	**Hydro (B)**	**46,968.17**
	Wind, Solar & Other RE	
	Wind	47,716.72
	Solar	92119.18
	Bio-Mass power/Cogen.	10,728.21
	Waste to Energy	605.74
	Small Hydro Power	5077.25
	Total Wind, Solar & Other RE (C)	1,56,247.10
	RES (incl. Hydro) (B+C) = D	**2,03,215.27**
	Nuclear (E)	**8180**
	Total Non-Fossil Fuel: (D+E)	**2,11,395.27**
	Total Installed Capacity (A+D+E)	**4,54,452.18**

Based on data gathered by the Central Electricity Authority (CEA) as on 30.10.2024[1], power generation has shown an increase over the past years, as outlined below

The electricity generation target (Including RE) for the year 2024-25 has been fixed as 1900 Billion Unit (BU). i.e. growth of around 9.3% over actual generation of 1738.828 BU for the previous year

[1] https://cea.nic.in/installed-capacity-report/?lang=en

(2023-24). The generation during 2023-24 was 1738.828 BU as compared to 1624.465 BU generated during 2022-23, representing a growth of about 7.04%.

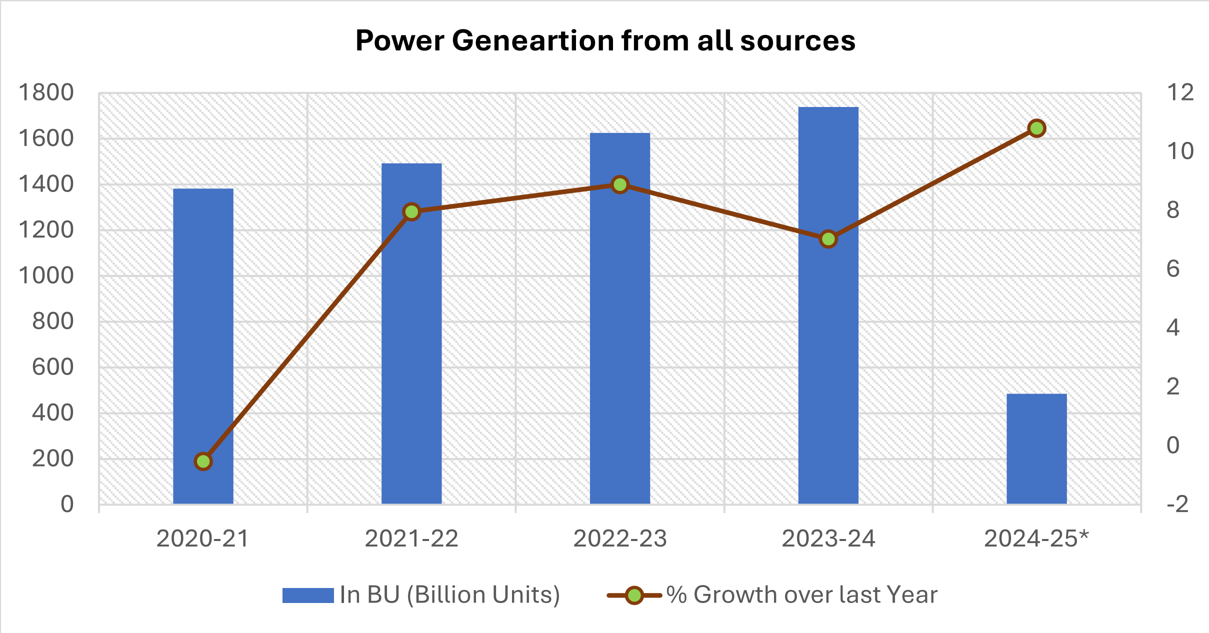


Figure 1-3: Power Generation from all sources over previous seven years

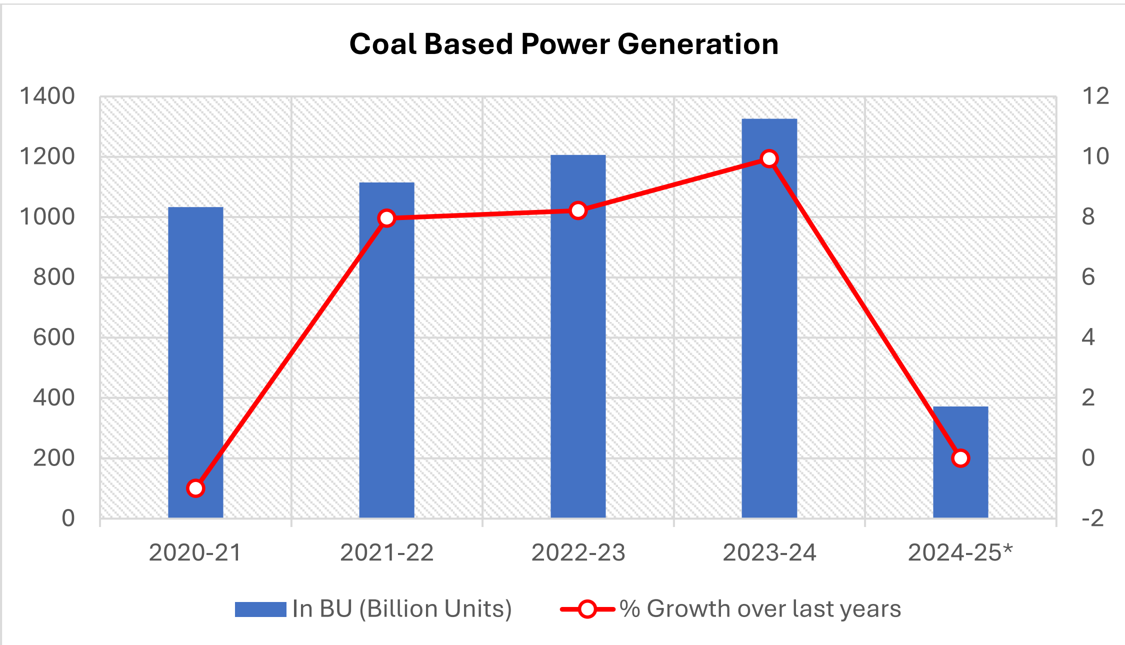


Figure 1-4: Coal Based power generationover previous seven years

Table 1-4: All India power generation over previous five years

Year	Power Generation from all sources		Coal Based Power Generation	
	Billion Units	% Growth	Billion Units	% Growth
2020-21	1381.855	-0.52	1032.51	-1.0
2021-22	1491.859	7.96	1114.71	7.96
2022-23	1624.465	8.89	1206.21	8.21
2023-24	1738.828	7.04	1326.09	9.93
2024-25*	485.34	10.8	372.28	--

** Up to June 2024 (Provisional), Source: CEA*

1.4.2 PEAK DEMAND AND ENERGY REQUIREMENT FORECAST FOR 2029-30

The studies have incorporated the projections from the 20th Electric Power Survey (EPS) regarding peak electricity demand and electrical energy requirement for the country. The table below presents the projected region-wise and national peak electricity demand (in gigawatts, GW) and electrical energy requirement (in billion units, BU) for the year 2029-30.

Table 1-5: Peak Demand and Energy requirement forecast for 2029-30

Region	Peak Demand (GW)	Electrical Energy Requirement (BU)
Northern	116.7	707.55
Western	107	713.08
Southern	97.4	547.4
Eastern	45.7	282.26
North-Eastern	5.8	29.35
All India	334.8*	2279.64
** Summation of al regional peaks to all India peak may differ due to diversity factor*		

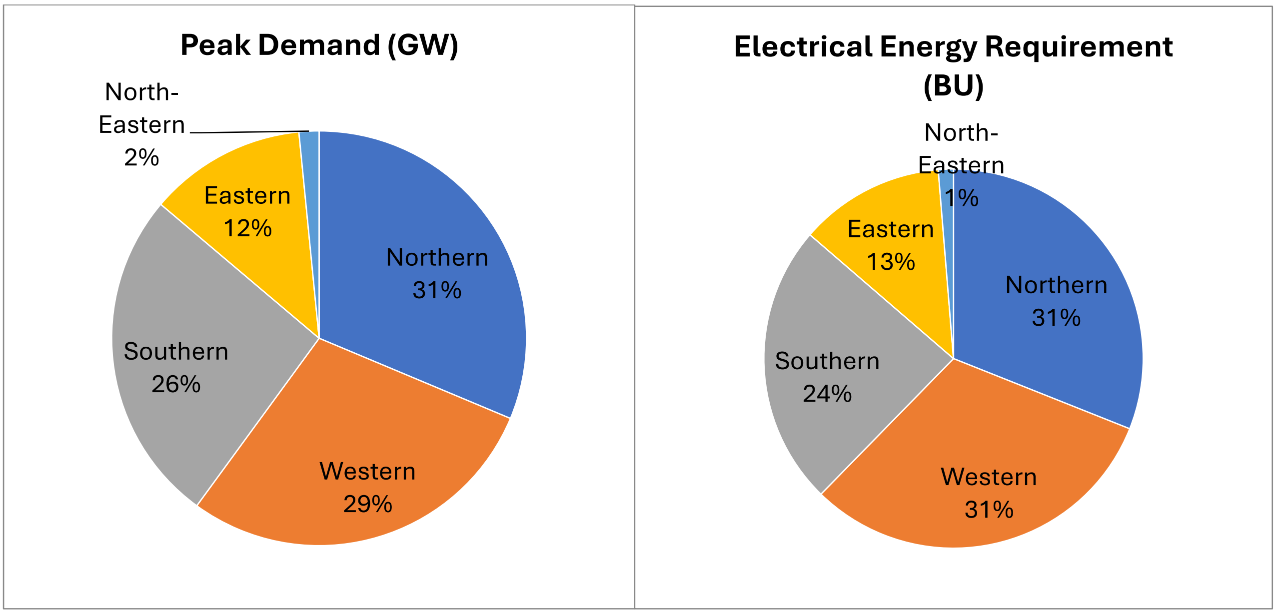


Figure 1-5: Peak Demand and Energy requirement forecast for 2029-30

According to a recent study conducted by the Central Electricity Authority (CEA) on the optimal generation capacity mix for the year 2029-30, the estimated total installed capacity for India in 2029-30 is projected to be 8,17,254 megawatts (MW).

Fuel Type	Capacity (MW) by 2029-30
Hydro	60,977
PSP	10,151
Small Hydro	5,000
Coal + Lignite	2,66,911
Gas	25,080
Nuclear	18,980
Solar	2,80,155
Wind	1,40,000
Biomass	10,000
Total	**8,17,254**

According to the Central Electricity Authority (CEA), the likely installed capacity for Coal & Lignite based power generation is estimated to be 266.9 GW by end of year 2029-30, which was about 217 GW by February 2024.

1.4.3 SAUBHAGYA' SCHEME

The Government of India (GOI) initiated the Pradhan Mantri Sahaj Bijli Har Ghar Yojana – Saubhagya in October 2017 with the aim of achieving universal household electrification. This program seeks to provide electricity connections to all willing unelectrified households in rural areas and all willing poor households in urban areas across the country. Since the launch of Saubhagya, a total of 2.86 crore households have been electrified up to 31.12.2023.

1.4.4 CONCLUSIONS

Electricity is a cornerstone of national infrastructure, driving economic development and enhancing quality of life. The proposed Anuppur TPP Stage-II aims to support this growth by providing a significant boost to the power supply in the Central Region and beyond. As of October 2024, India's total installed power generation capacity stands at 4,54,452.18 MW, with substantial contributions from both fossil fuels and renewable sources.

The Central Electricity Authority (CEA) has observed a consistent increase in power generation, with notable growth in both overall and coal-based electricity production over recent years. Projections for 2029-30 indicate that India’s installed capacity could reach approximately 2,66,911 MW, with significant expansions in solar and wind energy, alongside traditional coal and hydro power.

Programs like the Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya) have been instrumental in expanding electricity access, achieving significant milestones in household electrification. These developments underscore the crucial role of electricity in supporting India's economic progress and the need for continued expansion and diversification of the energy sector to meet future demands.

1.5 SCOPE OF THE STUDY

MBPMPL has appointed M/s Greencindia Consulting Private Limited (formerly GIS Enabled Environment & Neo-graphic Centre), Ghaziabad to prepare the Environment Impact Assessment report for the proposed expansion project to facilitate & obtain Environment Clearance for the same from Ministry of Environment, Forest & Climate Change (MoEF&CC), Government of India. The report is prepared for various environmental components including air, noise, water, land and biological components along with parameters of human interest which may be affected and to prepare an EIA&EMP for mitigating adverse impacts. The steps involved in conducting the EIA&EMP Study are as follows:

- Conduct literature review, collate and compile secondary data including socio-economic data from published literature / government publications.
- Undertake environmental monitoring through field sampling so as to establish the baseline environmental status of the study area.
- Identify existing pollution source and load due to various activities in the ambient levels.
- Identify the basic environmental status including the meteorological parameters and socioeconomic environment of the proposed study area.
- Predict incremental levels of pollutants in study area due to the proposed plant activities.
- Evaluate the predicted impact on the various environmental attributes in the study area by using scientifically developed and widely accepted environmental impact methodologies.
- Prepare an environmental management and monitoring plan outlining the measures for improving the environmental quality for environmentally sustainable development.
- Prepare Risk Assessment and Disaster Management Plan and undertake Additional studies if required.

Table 1-6: Baseline Study Parameters & their frequency

Attributes	Parameters	Source and Frequency
Ambient Air Quality	Particulate Matter (PM_{10}, $PM_{2.5}$), SO_2, NO_X, Hg, Ozone and all other parameters of NAAQS, 2009	24 hourly samples twice a week for one season at 8 locations.
Meteorology	Wind speed and direction, temperature, relative humidity and rainfall	Near project site continuous for one season with hourly recording and from secondary sources of IMD station at Narsinghpur.
Water quality	Physical, Chemical and Bacteriological parameters	Samples have been collected at 7 ground water (including locations within 2 km radius of site) and 10 surface water locations once.
Ecology	Existing terrestrial and aquatic flora and fauna within 10-Km radius circle.	Primary Survey conducted by ecological experts. Secondary data have been collected from the Forest Department.
Noise levels	Noise levels in dB(A)	At 8 locations data monitored once for 24 hours during study season
Soil Characteristics	Physical and chemical parameters	Grab sample once at 8 locations
Land use of India topo-sheet and latest satellite imagery	Trend of land use change for different categories	Based on Survey of India topo-sheet and latest satellite imagery
Socio-Economic aspects	Socio-economic and demographic characteristics, worker characteristics	Based on primary limited survey and secondary sources data like primary census abstracts of Census of India 2001 & 2011.
Need-assessment & CSR/CER Plan	Village-level information Village Level Survey	Village Level Survey and Public Consultation for villages within 10-km radius
Hydrology	Drainage area and pattern, nature of streams, aquifer characteristics, recharge and discharge areas	Based on data collected from secondary sources as well as hydrology, hydro-geology study report prepared separately
Risk Assessment and Disaster Management Plan	Identify areas where disaster can occur by fires and explosions and release of toxic substances	Based on the findings of Risk Modelling done for the risk associated with LDO storage.

1.5.1 PROCESS OF OBTAINING THE ENVIRONMENT CLEARANCE

As per the EIA Notification 2006, projects are classified into Category A or Category B projects based on spatial extent of potential impacts on human health and natural and man-made resources. 'Category A' projects require prior environmental clearance by the Expert Appraisal Committee, MoEF&CC, and Government of India while Category B projects have to get prior environmental clearance from the

State Level Expert Appraisal Committee. The environmental clearance process for new projects will comprise of a maximum of four stages. The four stages in sequential order are:

- Stage (1) Screening (only for Category 'B' projects and activities)
- Stage (2) Scoping
- Stage (3) Public Consultation
- Stage (4) Appraisal

1.5.1.1 STAGE (1)

Screening: It refers to the definite assignment of environmental category to projects or activities where the same is not completely specified. In case of Category 'B' projects scrutiny of application is done at State level to categorize project in 'B1' or 'B2'. The 'B2' projects do not require detailed EIA study and preparation of EIA Reports. Since the present project comes under category 'A' so it doesn't need screening.

Table 1-7: Project Categorization

Project or Activity		Category with threshold limit		Conditions if any
		A	**B**	
1 (d)	Thermal Power Plants	≥ 500 MW (coal/lignite/naphtha & gas based);	Not required as the project falls in Category A	General Condition shall apply Note: 1. Thermal Power plants up to 25 MW based on biomass or non-hazardous municipal solid waste using auxiliary fuel such as coal, lignite / petroleum products up to 15% are exempt. 2. Thermal power plants using waste heat boilers without any auxiliary fuel are exempt.

1.5.1.2 STAGE (2)

Scoping: It refers to the process by which the Expert Appraisal Committee (for Category 'A' projects) and State Level Expert Appraisal Committee (for Category 'B1' projects), determines detailed and comprehensive Terms of Reference (TOR) for all Greenfield or expansion projects. The ToR addresses all relevant environmental concerns for the preparation of an Environment Impact Assessment (EIA) report in respect of the project or activity for which prior Environmental Clearance is sought.

1.5.1.3 STAGE (3)

Public Consultation: It refers to the process by which the concerns of local affected persons and others who have plausible stake in the environmental impacts of the project or activity are ascertained with a view to taking into account all the material concerns in the project or activity design as appropriate. The public consultation takes part in two steps: Pubic Hearing and written responses.

1.5.1.4 STAGE (4)

Appraisal: This process refers to the detailed scrutiny of the application for Environmental Clearance, EIA Report and other related documents by the Expert Appraisal Committee or State-level Expert Appraisal Committee

1.5.2 ENVIRONMENT LEGISLATIONS

The environmental regulations, legislations and policy guidelines and control that may impact the project are the responsibility of a variety of Government agencies. The principal environmental regulatory agency in India is the MoEF&CC, Govt. of India. MoEF&CC formulates environmental policies and also accords Environmental Clearance for different category projects.

Many State and Central legislations have a bearing on environment but laws on environment protection have been notified recently. These legal enactments can be broadly classified in the terms of focus areas, viz. pollution, natural resources and linkages between pollution and natural resources. The important environment legislations related to Environmental Clearance for Expansion of projects are briefly described in the **Table 1-8.**

Table 1-8: List of Environment Legislations

Name	Scope and Objectives	Key Areas	Operational Agencies
Water (Prevention and Control of Pollution) Act 1974	To provide for prevention & control of water pollution and enhancing water quality	Control of sewage and industrial effluent discharges	Central and State Pollution Control Boards
Air (Prevention and Control of Pollution) Act 1981	To provide for prevention and control of air pollution	Controls emission and air pollutants	Central and State Pollution Control Boards
Forest Conservation Act 1980	To halt rapid deforestation and resulting in environmental degradation	Restriction on de-reservation & using forest for non-forest purpose	Central Government
Environment Protection Act 1986; Environment Protection Rules 1989.	To provide for protection and improvement of environment	An umbrella legislation; supplements pollution laws	Central Govt. MoEF&CC, can delegate power to Department of Environment
Noise Pollution (Prevention & Control) Rules 2000	To control and take measures for abatement of noise and ensure that level remain within standard	Noise in urban area and around industrial sites	Central Government, nodal agencies MoEF&CC, State governments
Wildlife Protection Act 1972	To provide for protection of wild animals, birds and	Wildlife protection in forest areas	Central Govt.

Name	Scope and Objectives	Key Areas	Operational Agencies
	plants; and for matters connected therewith		
Hazardous Waste Management and Handling Rules 2016	To impose restrictions and prescribe procedures for management, handling and disposal of hazardous waste	Any facility producing hazardous waste	Central and State Pollution Control Boards
Public Liability Insurance Act, 1991	To provide for public liability insurance for the purpose of providing immediate relief to the persons affected by accident occurring while handling any hazardous substance and for matters connected therewith or incidental thereto.	To provide public liability insurance during risk material handling	Central Government, Nodal Agencies MoEF&CC, State Govt.
Plastic waste Management (Amendment) Rules, 2024	To impose restrictions and prescribe procedures for management, handling and disposal of plastic waste	To apply every waste generator	Central & State Pollution Control Board
E-Waste (Management) Rules, 2024	To impose restrictions and prescribe procedures for management, handling and disposal of E-waste	To apply everyone who generates e-waste	Central & State Pollution Control Board
Solid waste management rule, 2016 and latest amendment, 2022	To impose restrictions and prescribe procedures for management, handling and disposal of solid waste	To apply every waste generator	Central & State Pollution Control Board
Battery Waste Management Rules, 2022 and their amendments	To impose restrictions and prescribe procedures for management, handling	To apply everyone who generates batteries waste	Central & State Pollution Control Board

Name	Scope and Objectives	Key Areas	Operational Agencies
	and disposal of Biomedical Waste		
Ash Utilisation Notification, 2021 and their amendments	To impose restrictions and prescribe procedures for Management & Utilization of Fly Ash	To apply every coal or lignite based thermal power plant (including captive or co-generating stations or both)	Central & State Pollution Control Board

1.5.3 POLLUTION STANDARDS

The MoEF&CC is the nodal agency to set up policy, Guidelines, and standards for the protection of environment, along with Central Pollution Control Board (CPCB). This includes air, noise, water, solid waste, e-waste, battery waste and hazardous waste standards etc. MBPMPL's Anuppur shall follow all the acts, its rules, pollution/emission standards guidelines prescribed by MoEF&CC & MPPCB as applicable.

1.5.4 ORGANISATION & CHAPTERIZATION OF REPORT

The chapters of the Draft EIA&EMP Report are based on EIA Notification, 2006 & amendments.

Chapter 1: Introduction: The present chapter gives brief outline of the project and its proponent, power scenario in India, brief description of the nature, size, and location of the project and its importance, and extent of the EIA study, including the scope of the study.

Chapter 2: Project Description: The description of the power generation process and the various features of the proposed power plant incorporating utilities, water, fuel requirements are described in this chapter.

Chapter 3: Description of the Environment: This chapter presents the methodology and finding of the field studies covering physical, biological and socio-economic environments, carried out to ascertain the baseline environmental condition of the study area. It includes the information regarding physical condition, water and air environment, soil characteristics, noise level, ecology and the socio-economic status of the area.

Chapter 4: Impacts Assessment & Mitigation Measures: This chapter provides details of the impact assessment of the project during construction and operational phase. It expresses the impacts of the proposed project on the various components of environment. The mathematical modelling exercise pertaining to prediction of ground level concentration of air pollutants have also been dealt in this chapter. Mitigation measures are suggested along with the impact prediction.

Chapter 5: Analysis of Alternatives: This chapter describes systematic comparisons of feasible alternatives for the proposed project site, technology, and operational alternatives. Alternatives have been compared in terms of their potential environmental impacts, suitability under local conditions, and institutional training and monitoring requirements.

Chapter 6: Environmental Monitoring Programme: The monitoring of environmental parameters in construction as well as operation phase of the project for assessing the impact and the organization structure, which will be responsible for environment monitoring have been detailed in this chapter.

Chapter 7: Additional Studies: This chapter provides details of the additional studies conducted as per the stipulation of the ToR as well as the details of the public hearing. The risk assessment included in this chapter provides information regarding the activities associated with the project likely to pose a risk to man, environment or property. Computation of risk assessment has been covered in this chapter. It also provides details regarding precautionary measure to be taken. This section also presents a brief outline of Hydrogeological study and Rainwater harvesting plan as per the requirement of this study.

Chapter 8: Project Benefits: This chapter includes the benefits likely to accrue and improve the physical & social infrastructures for the local community in particular and region in general.

Chapter 9: Environmental Cost Benefit Analysis: This chapter evaluates the economic pros and cons of projects affecting the environment by comparing costs like pollution with benefits such as improved air quality.

Chapter 10: Environment Management Plan: This chapter deals with the management plan and enhancement measures incorporating recommendations to mitigate the adverse impact likely to occur on environmental parameters during construction and operation phase. Post project monitoring and organization structure for environment management have been also provided in the chapter.

Chapter 11: Summary & Conclusion: This chapter will constitute the summary & conclusion of the EIA & EMP Report

Chapter 12: Disclosure of the Consultant Engaged: The detailed profile of the consultants along with their capabilities and experience are highlighted in this chapter.

2. PROJECT DESCRIPTION

2.1 Project Features

MB Power (Madhya Pradesh) Ltd is planning to expand the Anuppur Thermal Power Plant by adding 1600 MW (2x800 MW) of Ultra Super Critical Technology to the existing 1260 MW (2x630 MW) capacity within the current plant boundary in Village Laharpur, Murra, Guwari, Belia & Jethari in Jaithari Tehsil, Anuppur District, Madhya Pradesh. Details of the project features and related information are provided in **Table 2.1**, and the layout for the existing and proposed plant is illustrated in **Figure 2.1**.

Table 2-1: Project Design Features

Item	Main Design Parameters
Capacity & Unit Configurations:	Under Operation: Stage-I: 1260 MW (2x630 MW) Sub Critical Technology Proposed Expansion: Stage-II: 1600 MW (2x800 MW) Ultra Super Critical Technology
Location of the Project	MBPMPL's Anuppur Thermal Power Project is located on the left bank of Sone River near village Laharpur, Murra, Guwari, Belia & Jethari in Anuppur district of Madhya Pradesh
Land	A total of 451.202 Ha of land has been acquired to accommodate the MBPMPL's Anuppur Thermal Power Plant. Out of that, 417.996 hectares of land is within Plant boundary and has been utilized for Stage-I and some un-used area The Stage-II of the project will be accommodated within the existing Plant boundary and the remaining 33.206 hectares of land outside the plant boundary will be used for incoming railway line and green belt development for the Stage-II expansion.
Primary Fuel & Requirement	MBPMPL's Anuppur TPP Stage-I operates with Sub-Critical Technology. The annual coal requirement for Stage-I is estimated at 6.17 MTPA, based on a Gross Calorific Value (GCV) of 3,364 kcal/kg and a Plant Load Factor (PLF) of 85%. MBPMPL's Anuppur TPP Stage-II utilizes Ultra Super Critical Technology, offering higher efficiency compared to Super Critical Technology. The estimated coal requirement for Stage-II is approximately 7.36 MTPA, with an 85% Plant Load Factor (PLF) and a Gross Calorific Value (GCV) of 3350 kcal/kg.

Item	Main Design Parameters
Fuel Transportation	Indigenous Coal to be transported through Railways.
Support Fuel	The boiler will be designed for cold start-up and initial warm-up using Light Diesel Oil (LDO). LDO will be received to the proposed plant by means of the road tankers. The annual requirement of secondary fuel-Light Diesel Oil (LDO) for startup and low operations is estimated to be around 6,000 KL per annum.
Water Requirement	The water requirement for Stage-I of the project is approximately 68,400 KLD. For the MBPMPL's Anuppur TPP Stage-II (2x800 MW) project, the water requirement is expected to be around 95,808 KLD.
Source of Water	The source of water for the project is Son River. 36 MCM Water allocated by WRD vide letter ref: पत्र.क्र.वृ.प.नि.मं./31/तक/रा.स्त.-160/2008/589 dated 29/11/2024.
Power Generating Unit	MBPMPL's Anuppur TPP Stage-II will be a pulverized coal-fired thermal power project utilizing Ultra Super Critical boiler technology. The plan includes building and operating two units, each with a capacity of 800 MW.
Cooling System	MBPMPL's Anuppur TPP Stage-I utilizes a close cycle cooling system with cooling towers for the condenser and auxiliary cooling. In MBPMPL's Anuppur TPP Stage-II, Water Cooled Condenser System is planned,
Coal Handling System	Coal handling facility, which comprises receipt of coal through Rail, crushing house and stacking by stacker-cum-reclaimer in the coal yard and finally feeding the bunker level conveyors.
Ash Disposal System	Normal plant operations- Bottom ash disposal: During normal plant operation Bottom ash will be transported to the decantation bins. There will be 3 Nos hydrobinds which will be used for filling, decantation and evacuation operation. Water from bottom ash will be separated/ decanted upto 20% moisture content. De-canted moist bottom ash from the hydrobins will be recycled back to the ash plant system after treatment in the clarifier. Fly ash disposal: The fly ash will be evacuated necessarily pneumatically in dry mode. The dry fly ash will be stored in the remote silos and will be loaded into wagons for further transportation to cement plant.

Item	Main Design Parameters
	Slurry disposal to emergency ash dyke: In case of emergencies the fly ash and bottom ash will be disposed in medium/ lean slurry from to the ash dyke. The ash dyke is equipped with a full fledged decantation well and a ash water recovery system (AWRS). The water recovered from the ash dyke will be sent to the AWRS clariflocculator, dosed, treated for impurities and then sent back to the ash slurry sump for further use.
Power Evacuation	At 400 kV/756 kV level.
Rehabilitation Requirement	Nil. Proposed Expansion is within the existing plant boundary.
Seismological Information	Zone-II (Low Damage Risk Zone)
Project Time Frame	The schedule of commissioning of first unit is envisaged as 48 months from the NTP (Notice to Proceed) to EPC Contractor or the Main Plant (BTG Contractors) and second unit shall be commissioned within a gap of 6 months thereafter.

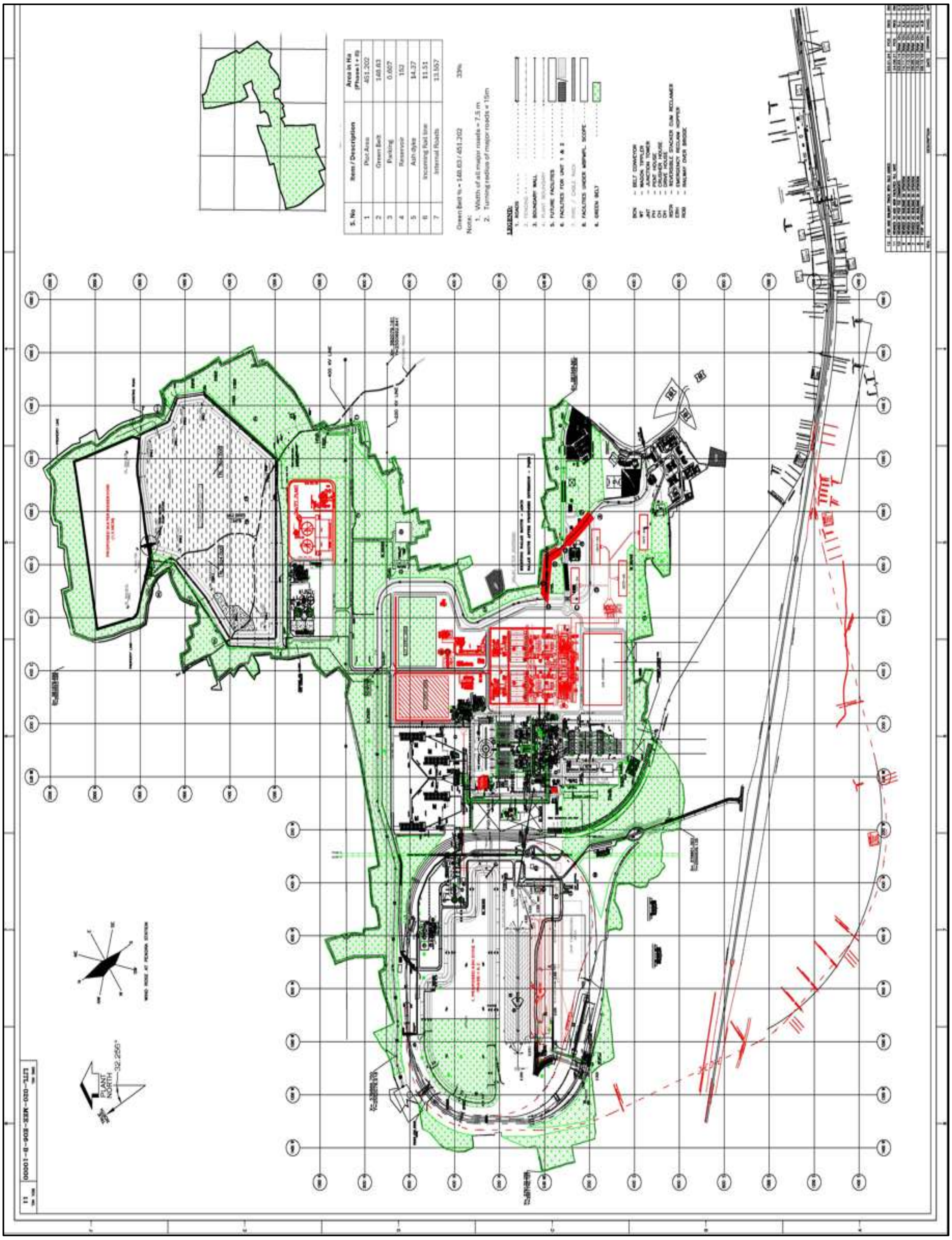


Figure 2-1: Plant Layout (Existing & Proposed)

2.2 Basic Resource- Requirement, Source & Availability

2.2.1 Land Requirement and Availability

A land area of 451.202 Ha. has been acquired for the project which includes the existing 2x630 MW unit, land area for accommodation of coal stockyard, water reservoir, township and roads, green verge, etc. The land requirement envisaged for the expansion project considers installation of 2 x 800 MW pulverized coal based Ultra Super-Critical Thermal Power Project. Detailed land breakup is furnished in **Table 2.2.**

Table 2-2: Land details for Anuppur TPP (Ph-I& Ph-II)

Description	Area in Hectares			
Land use type	Existing Phase I	Area break-up for expansion project (Phase II)		Total (Phase I + Phase II)
		Un-used Area within boundary	Additional Land outside boundary (Acquired & Available)	
Plant Area	109.717	69.506	-	179.223
Reservoir	44.534	22.081	-	66.615
Ash Pond	6.68	7.692	-	14.372
Green Belt	110.33	24.291	21.7	148.629*
Misc.	8.097	2.024	-	10.121
Colony	16.599	-	-	16.599
Un-used Area	122.04	4.138	-	4.138
Additional Area - Railway	-	-	11.506	11.506
Total	**417.996**	**33.206**		**451.202**

**148.629 Ha will be the final green belt coverage for Phase I & II*

2.2.2 Fuel Requirement and Source

2.2.2.1 Main Fuel- COAL

MBPMPL's Anuppur TPP Stage-I utilizes Sub Critical Technology. The annual coal requirement for Stage-I was calculated at 6.17 MTPA based on a Gross Calorific Value (GCV) of 3400 kcal/kg and a Plant Load Factor (PLF) of 85%. Raw coal serves as the primary fuel, sourced likely from the SECL/MCL mine.

The coal demand for Stage-II of the project is projected to be approximately 7.36 (MTPA) assuming an 85% Plant Load Factor (PLF) with a Gross Calorific Value (GCV) of 3,350 Kcal/kg. The anticipated coal supply for this project is expected to come from the CIL and other subsidiaries, as per Shakti Policy and other commercial mines, however allocation of coal mine is yet to be decided. This coal will be instrumental in meeting the energy requirements of the project, ensuring a reliable and sustainable source of fuel for power generation. The coal analysis report is attached in **Annexure-2.2.**

Table 2-3: Coal Characteristics for MBPMPL's Anuppur TPP

Coal Specifications	Existing (2x600 MW)	Proposed (2x800 MW)
Fixed Carbon	26.12%	26.12%
Volatile Matter	21.08%	21.08%
Ash	39.22%	39.22%
GCV (kcal/kg)	3,364	3,350
Total Moisture	13.49%	13.49%

2.2.2.2 Auxiliary Fuel:

The boiler will be designed for cold start-up and initial warm-up using Light Diesel Oil (LDO). LDO will be received to the proposed plant by means of the road tankers.

The annual requirement of secondary fuel-Light Diesel Oil (LDO) for cold start up for load stabilization is estimated to be around 6,000 kL per annum.

Table 2-4: Specific Diesel Consumption.

S. N0.	Material	Unit	Quantity Required			Type of storage	Storage Capacity	Distance from Source
			Existing	For Expansion	Total			
1	Light Diesel Oil (LDO)	KLD	4.93	5.53	11.46	Tanks	1x1000 kL 2x2000 kL	50 km

2.2.2.3 Fuel Transportation:

The coal from SECL / MCL mine for operating the power plant shall be transported through railway rakes to the Plant site in Madhya Pradesh. Coal will be unloaded in wagon tippler or Track Hopper respectively at site.

The secondary fuel for the proposed Power Project i.e. LDO/ shall be sourced from the refineries located nearer to the Project by road tankers.

2.2.3 Water Requirement and Source

In a conventional fossil fuel-fired thermal power Project, water is used to meet the following basic consumptive requirements: -

a) To meet cooling requirement for steam condenser which acts as a heat sink for the thermodynamic cycle and other auxiliary cooling such as, bearing/lube oil coolers, compressors, generator stator, etc.
b) To meet the heat cycle make-up and other process requirements.
c) Flue Gas Desulfurization (FGD) and Selective Catalyst Reduction (SCR) / Low NOx burners system as per New MoEF& CC guidelines
d) For miscellaneous services viz.
   - Fire fighting
   - General services viz. A/C and ventilation, floor washing etc.

- Sealing and cooling water for equipment of ash handling system
- Dust extraction and dust suppression in coal yard
- Potable use in the Project and housing complex
- Transport media for ash in case of wet disposal of ash (under exigency condition)
- Horticulture

MBPMPL's Anuppur Thermal Power Plant (STPP) Stage-I employs a Water Cooled Condenser System (WCC) integrated with Cooling Towers, necessitating a substantial water demand of approximately 68,400 KLD (2850 m^3/ hour).
Similar arrangement of Water cooled condenser integrated with cooling towers is proposed for the Stage-II project. The projected water demand for MBPMPL's Anuppur TPP Stage-II, a 2x800 MW expansion, is estimated at around 95,808 KLD (3,992 m^3/ hour).

The water will be extracted from Son River Barrage. Permission of 72,328.77 KLD / 26.40 MCM per year water have been granted by Govt of Madhya Pradesh vide letter no.- वृ प नि मं/ 31/तक /रा. स्त-160/2008/353 dated 16.05.2018 for the phase I of the project.. For the Stage-II expansion project 36 MCM Water has been allocated by WRD vide letter ref: पत्र.क्र.वृ.प.नि.मं./31/तक/रा.स्त.-160/2008/589 dated 29/11/2024, enclosed in **Annexure 2.1.**

2.2.4 Power Evacuation

It is proposed to evacuate the power through dedicated Transmission lines to STU and/or CTU at 400/765 kV level.

2.3 Project Cost

The estimated Cost of the proposed Expansion Project is Rs. 19,200 Crores. (EPC cost for Main plant & equipment is Rs. 13,593.6 Cr, incl Taxes & Duties. i.e: Rs. 8.496 Cr/MW).

2.4 Technology & Process Description

The power generating units will be of Ultra Super-critical steam parameters utilizing domestic coal.

It is proposed to use river water from Son River as cooling water for condenser. The condenser cooling circuit shall operate on 'closed cycle system'.

The bottom ash will be collected in wet form and fly ash in dry/wet form. Fly Ash extracted in dry form and stored in storage silos for the purpose of utilization. Unutilized fly ash will be converted into slurry form and will be disposed to the ash dyke along with bottom ash.

Switchyard will be located near the power block. The power generated at the plant will be evacuated at 400/765 kV level to STU and/or CTU through proposed dedicated transmission line..

Design requirements envisaged in "Central Electricity Authority" (Construction of electrical Plant & electrical lines) Regulations: 2007 shall be complied with.

The plant will be designed in compliance with applicable National and International Codes and Standards such as ASME, ASTM, DIN, BS, IEC, IEEE, IS, etc. The plant will comply with all local statutory regulations and requirements, such as Indian Boiler Regulations (IBR), CCOE, Indian Factories Act, Indian Electricity Act, Environmental Regulations, etc.

2.4.1 Plant Performance

Plant gross heat rate with performance coal, design ambient conditions and cooling water temperature is considered to be 2070 kcal/kWh on GCV basis, 85% PLF and the auxiliary consumption is considered as 7.5% of the gross power generated. Availability of the plant of similar size and type is above 85%.

The steam parameters will be selected considering the parameters offered by different manufacturers for equipment of similar type and rating, to get the advantage of standard proven design at competitive cost.

2.4.2 Plant Layout

The Main Plant building arrangement for the proposed plant envisages longitudinal disposition of TG set. Lay down and Maintenance Bay has been provided at the centre. The main power house consist of TG bay and heater bay. Administrative building cum service house has been provided adjacent to TG bay near start of unit number one. Boiler, air pre-heater, ID/FD/PA fans, ESP, mills and chimney are located as indicated in layout drawing. The bunker bay located adjacent to boiler building is house mills and blowers at ground level. There are floors at higher levels for the feeders and bunker feeding conveyors provided with trippers. Bunker ventilation system is provided on the roof of the bunkers. Distance of 10 m between last row of powerhouse columns and 1st row of Boiler columns, has been kept to facilitate the movement during erection and operation phase of the plant. One common coal handling transfer towers for both units are be provided in boiler area feeding to mill / bunker bays of respective unit. Dry ash transport air compressor house, ash water pump house and bottom ash overflow water settling facilities are located by the side of Chimney. The ESP control room house the controls for ID fans, control panels and MCCs for ESP along with air conditioning and ventilation equipment for the same. ESP Control Rooms have been located on either side of the chimney. The plant layout is depicted in **Figure 2.1**. The process flow diagram is provided in **Figure 2.2.**

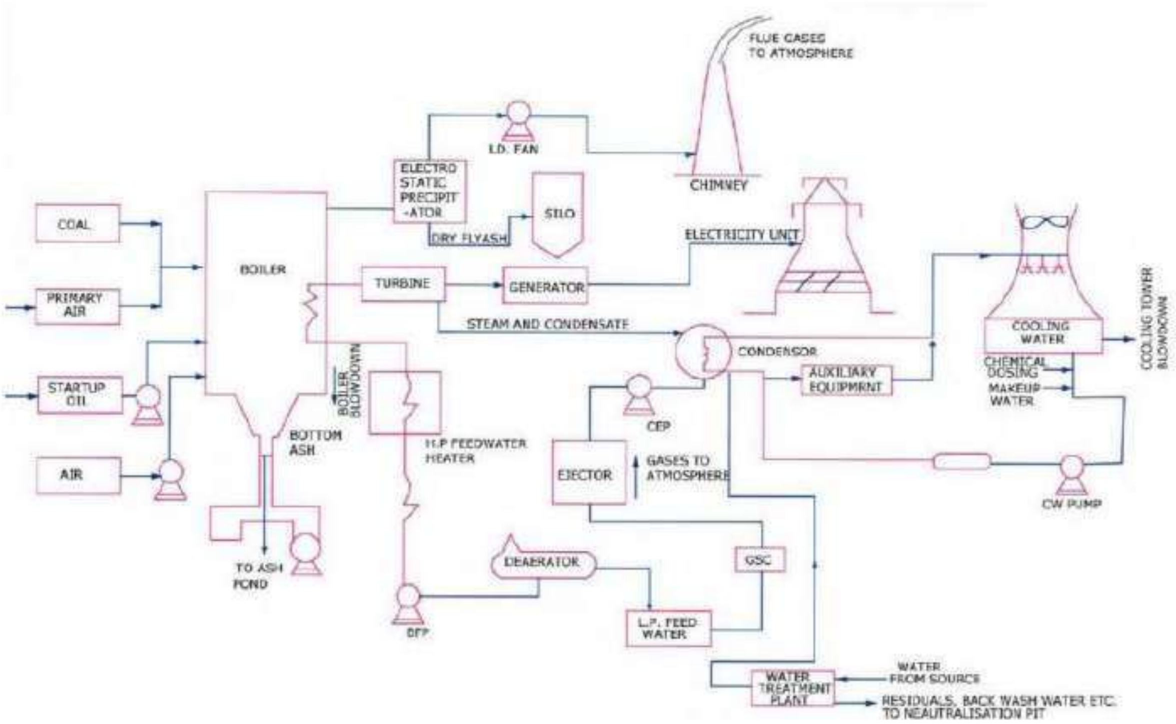


Figure 2-2: Process Flow Diagram.

2.4.3 Mechanical Equipment and System

2.4.3.1 Steam Generator and Accessories: Steam Generator:

The steam generator units proposed for the station will be ultra super-critical, once through, outdoor, pulverized coal fired, balanced draft, single reheat, dry bottom type with two pass or tower type arrangement as per manufacturer's standard. For improved efficiency at part loads and flexible operability, boiler capable of sliding pressure operation is favoured. An added advantage in these type of boilers is feature of Boiler circulation pumps which shorten the start-up time and heat loss during start-up period.

The combustion system will be provided for pulverised coal firing with Low NOx type coal burners. The steam generators will be designed for continuous satisfactory operation with the range of coal. The furnace would be conservatively designed for fuel to burn completely and to avoid any slagging in the furnace and excessive fouling in the superheater sections of the boiler. The design flue gas velocities would be carefully selected to minimize erosion of pressure parts and other vital components on account of ash. The steam generators would be designed in accordance with the latest provisions of Indian Boiler Regulations.

Capacity of steam generating units would be so selected as to ensure adequate margin over the requirement of Turbine at 100% MCR in order to cater to auxiliary steam requirement for soot blowing operation and also for start-up of the adjacent unit and de-aerating of the steam generating units after prolonged use. The steam generators would be designed to operate with "the HP Heaters out of service" condition (resulting in lower feed water temperature at Economiser inlet) and deliver steam to meet the turbo- generator requirement at base load. Economiser section of the boiler would be non- steaming type with provision for recirculation during start-up, chemical cleaning etc. Super heater section would be divided in convection and radiant zones and designed so as to maintain rated steam temperature at outlet over the range of 60% to 100% MCR load. Main steam de-superheating stations with provision for spraying water tapped off from feed water piping would be provided. Air preheaters, preferably of rotary type would be provided with a set of soot blowers of automatic sequential electrically operated type, arranged for on-load cleaning of the heat transfer surfaces.

Draft system of each boiler would be provided with Forced draft and Induced draft fans with suitable capacity and control arrangement, each independently capable of meeting the requirement at 60% boiler MCR load. The forced draft fans would control total airflow to boiler and the induced draft fans will control furnace draft of the boiler through automatic control loops. The coal will be received to the coal bunkers of about 16 hours storage capacity and the same will be fed to the coal pulverizes utilizing gravimetric feeders. The pulverised and conditioned coal will be then distributed to the Low NOx coal burners from each mill for combustion in the furnace of the boiler thro' coal conveying pipes.

LDO will be required for start-up, low load operation and flame stabilization at low load condition.

The complete boiler will be top supported type and would be provided with all supporting steel structures, platforms, galleries, elevator and stairways for easy approach and maintenance of the unit. Adequate weather protection would be provided for instruments and operating personnel.

Necessary lining and insulation along with fixing materials to limit outside surface temperature to a safe level would be provided. Monorails and hoists required for handling heavy equipment, motors, fans, etc. would be supplied along with the steam- generating units for ease of maintenance.

Electrostatic Precipitator:

Each steam-generating unit would be provided with electro-static precipitators. Each precipitator will have four parallel gas paths, any of which can be isolated for maintenance when required, keeping the other path in operation. Each path will have fields in series for collection of fly ash. The ESP will be designed for outlet dust burden not exceeding 30 mg/Nm3 at 100% MCR.

2.4.3.2 Steam Turbine:

The steam turbine would be 3000 rpm, tandem compound, single reheat, regenerative, condensing, horizontally split, three-cylinder machine with extractions for regenerative feed heating. The turbine would be designed for main steam parameters of corresponding to the boiler output pressure and temperature, before emergency stop valves of HP turbine and reheat steam parameters to IP turbine. The LP turbine will exhaust to condenser. At turbine valve wide open (VWO) condition the turbo-generator set will be able to operate continuously with a throttle steam flow of about 105% turbine MCR condition.

The bypass station will act not only as a protection to the unit during pressure rise resulting from sudden load throw off but also enable operation of the unit at loads lower than the controllable range of load. This will also permit quick, repeated hot starts of the unit on its tripping.

A fully automatic gland sealing system will be provided for the turbine which will have provision for receiving steam from auxiliary steam header during start-up and low load operation. The turbo-generator will be equipped with electro-hydraulic governing system ensuring stable operation under any grid fluctuation and load throw off condition. The turbo-generator will be equipped with turning gear. The unit will also be provided with self-contained lubricating oil system for supplying oil to turbine and generator bearings and also to hydrogen seal oil system of the generator. The lubricating oil will be cooled by Closed Circuit Cooling Water System utilizing river water as cooling medium.

Generator will be connected to it's unit step up transformer. The auxiliary power requirement of the unit will be drawn from its unit auxiliary transformer tapped off from the generator bus duct. All auxiliaries like turbine oil purification system, generator seal oil system etc. as well as necessary protective and supervisory system will be provided to ensure trouble-free, safe and efficient operation of the turbogenerator. The unit will be guaranteed to generate required output at generator terminals continuously. The turbine will be suitable for wet steam washing for which set of auxiliary equipment necessary for the units will be provided.

2.4.3.3 Condensing Equipment:

Double pass surface condenser capable of maintaining the required vacuum while condensing steam at the maximum rating of the turbine will be provided. The condenser will be of divided water box design with rolled steel construction of body and water chamber. Condenser with Stainless Steel heat exchanger tubes, with steel tube sheet, baffles plates, etc. is envisaged for clarified water application. The condenser will be designed as per HEI code or equivalent. The condensers will have integrated air cooling zone and it should be designed so as to accept full quantity of steam during turbine HP and LP bypass operation without any undue vibration, thermal stress etc. The condenser axis will be at right angle to the turbogenerator axis.

Necessary controls for Oxygen content of condensate leaving the condenser hot well will be provided. The condensate temperature will not be less than the saturation temperature corresponding to condenser back pressure. The water boxes will be protected by a suitable protection system. The maximum heat load of the condenser will correspond to turbine operating with valves wide open condition.

Vacuum pumps will be provided to maintain the vacuum in the condenser by expelling the non-condensable gases. One vacuum pump would operate during normal plant operation and during start-up, both the units may be operated such that the desired vacuum can be pulled within a short time.

2.4.3.4 Coal Unloading, Transportation and Feeding System:

Coal for this Project would be domestic coal. The annual requirement of Coal for the Power Plant would be about 7.36 MTPA considering Average Gross Calorific value of 3,350 kCal/Kg and PLF of 85%. Domestic Coal would be transported to proposed site through Railway wagons. The wagons shall be unloaded in the Power plant by Wagon Tipplers and Track Hopper, as per requirement. The Coal shall be normally transported to Main Plant bunkers / stockyard through belt conveyor. The Coal received at the Plant Site would be stacked by Stacker Reclaimers for further conveying either to the Plant Bunkers or to the Plant Stock-yard through a series of Conveyors. Provision will be made to keep 20 days stocks at the Plant Stockyard.

a) **Conveying system:** The rated/ design capacity of coal conveying system shall be 1600 TPH. Two (2x100%) coal conveying streams shall be provided. All conveyor belting shall be of the fire-resistant plied construction type.

b) **Crushing & Screening:** Suitable coal crushing equipment shall be included. This shall crush the delivered coal to a suitable size for use by the boiler coal milling plant. Dust suppression equipment shall be included to ensure a safe working environment and to limit the release of dust to the external environment to acceptable levels. In-line magnetic separators shall be provided to protect the crushing equipment, the main boiler bunkers and coal milling plant from damage or poor operation due to any tramp metal. Screening equipment shall be included to ensure that only correctly sized coal is fed to the main boiler bunkers and coal milling plant.

c) **Stacking and Reclaiming:** A complete, fully operational and safe working coal storage stockyard with all associated equipment and environmental controls shall be provided to meet the functional requirements of the power station. The facilities of the coal storage stockyard shall include:
   - Fully automatic stacking and reclaiming facilities
   - Bull dozers
   - All environmental controls including dust suppression sprays and waste water treatment.
   - Auxiliaries like Dust extraction system, ventilation system, metal detector, inline magnetic separator, belt scale, Coal sampling unit, Elevator, Material handling system, Bunker ventilation system, Bunker sealing system, V-plough tripper, service water & drinking water shall be included.

   The coal handling system shall be designed based on the following parameters:
   - Average GCV of coal 3,350 kCal/kg
   - MCR fuel consumption- 20,174 TPD (Considering coal Average GCV 3,350 kCal/kg)
   - Hours of operation considered- 13 hrs
   - Rated/ Design capacity required- 1600 TPH

2.4.3.5 Fuel Oil Handling System

The fuel oil system shall be meant for start-up of the plant and to provide support in flame stabilization while firing coal at and below 30% BMCR capacity. The Light Distillate Oil (LDO) shall be used for boiler light up and flame stabilization during low load operation. The LDO unloading and storage system shall receive LDO from road tankers and unload it to the LDO tanks. The road tanker unloading station shall be designed to unload 08 road tankers simultaneously. The oil shall be unloaded through neoprene hoses. The LDO from unloading header shall be pumped to the LDO storage tanks. LDO storage tanks shall be surrounded by dyke of sufficient capacity to hold the entire contents of the largest fuel storage tank.

Two (2) nos. of LDO storage tank of 2000 KL will be constructed. From the storage tank LDO will be forwarded to LDO burners by means of 3 x 50% forwarding pumps. The pumps shall be fitted with duplex suction filters with all necessary piping, valves and instruments etc.

2.4.3.6 Ash Handling System

System Description and Capacity:

Ash formed due to combustion of coal in the pulverized coal steam generator will be collected partly as bottom ash in bottom ash hopper and partly as fly ash in the fly ash hoppers. The major sub systems are as under:

Bottom Ash handling System:

The bottom ash shall be collected from the boiler in a water impounded bottom ash hopper placed below the furnace of each boiler. Bottom ash from the bottom ash hopper of each unit shall be removed in 2.0 hours per shift of 8 hours. Bottom ash shall be conveyed through jet pumps in wet slurry form from water impounded hoppers to the bottom ash slurry sump. Further, bottom ash slurry pumps shall convey the bottom ash slurry from slurry pump house to dewatering hydro bins. Decanted water from hydro bins shall be fed to settling tank & surge tank; clear water from surge tank shall be circulated back to ash handling system for re-use. Provision shall be provided for unloading of semi-wet bottom ash from hydro bins to open trucks for disposal to ash dyke. Bottom ash shall also be conveyed in lean slurry form from the slurry sump to the ash dyke. Ash from economizer hoppers shall be conveyed in to bottom ash hopper in slurry form by means of flushing apparatus.

- The bottom ash from the Bottom ash hopper will be evacuated in wet slurry mode.
- Wet slurry will be sent to the decantation bin / hydrobin.
- 3 Nos. hydrobins of 1000 T capacity will be provided.
- The decantation process in the hydrobin will remove the water from the slurry. The moisture content in the dried bottom ash will be around 20%.
- Hydrobin will have opening at the bottom for loading the dried bottom ash onto trucks for further disposal.
- Hydrobin will also have a provision for bottom ash disposal to temporary ash dyke during emergency condition
- Decantation system shall have adequate facility including surge tank, settling tank, clarifier, etc., for reuse of the recovered ash water

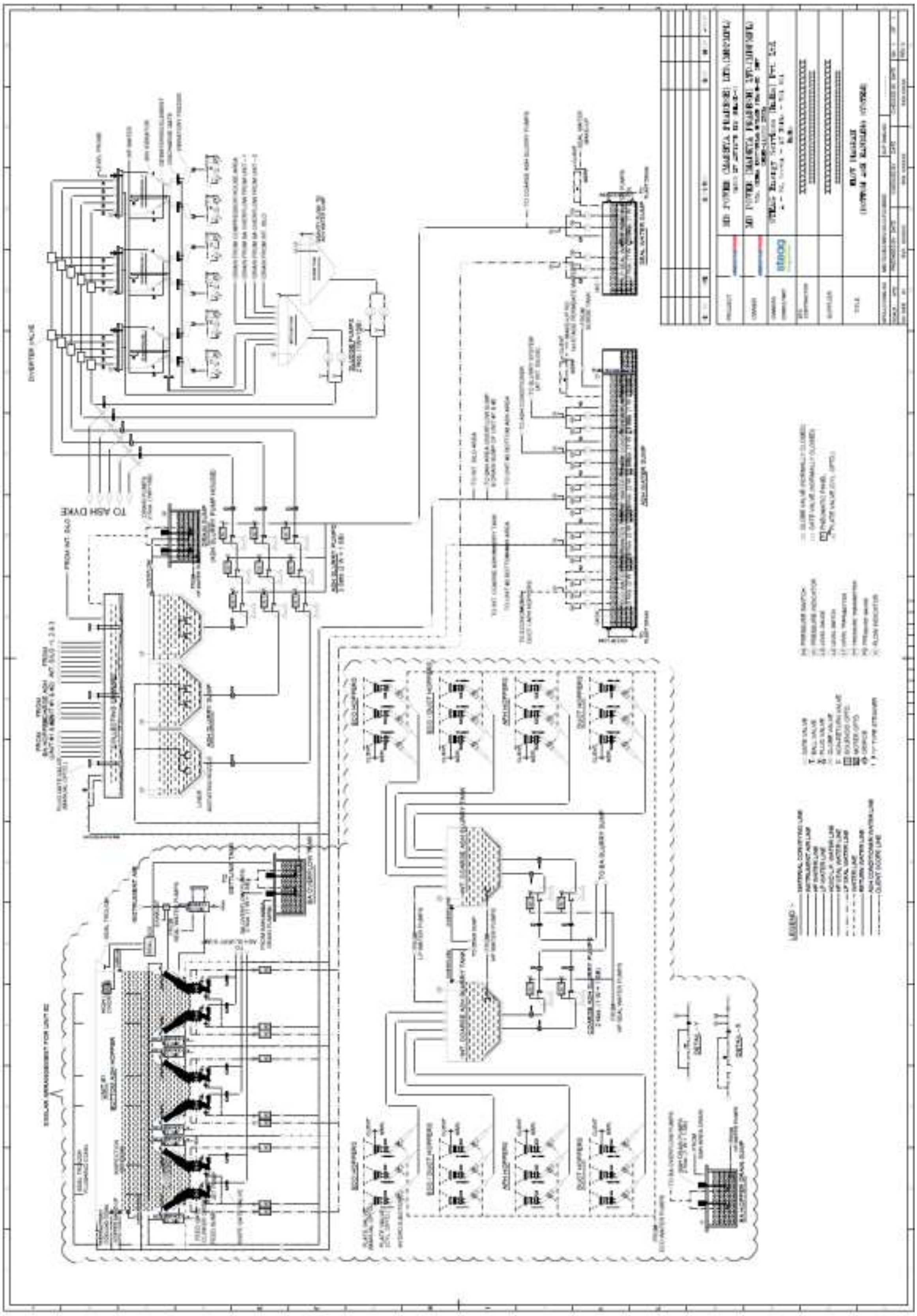


Figure 2-3: Bottom Ash Handling and Collection System.

Fly Ash Handling System:

The fly ash handling system will extract fly ash pneumatically from electrostatic precipitator (ESP) & Air Preheater hoppers and store fly ash in intermediate surge hoppers. From surge hoppers fly ash will be conveyed pneumatically under pressure to ash storage silos. Four (4) ash silos shall be provided common for 2X800MW Units. Combined storage capacity of all the silos shall be considered as 16 hours minimum. One boiler unit will be provided with one pneumatic conveying system for handling of fly ash collected in the fly ash hoppers. Fly ash from the ESP and APH hoppers of each unit shall be removed in 5.0 hours per shift of 8 hours.

The fly ash handling system will include Compressors/vacuum pumps, aeration blowers and heaters, intermediate surge hopper, air compressors and dryers, fly ash transmitter, all valves, piping, supports, platforms, access stairs and ladders, all control & instrumentation, electrical equipment, power and control cable and cabling etc. The bends with wear resistant linings will be provided for fly ash conveying pipelines.

- The dry fly ash handling system shall be of pressure / vacuum type pneumatic conveying system.
- The fly ash collected in the ESP hoppers & air preheater hoppers shall be evacuated pneumatically in dry mode.
- The fly ash will be conveyed in two stages. In stage-I fly ash from ESP hopers will be transported to 3 nos Buffer silos (2000 T capacity each). In Stage-II fly ash will be transported from Buffer silo to Remote FA silos (04 Nos of 1000T capacity each).
- Six nos (4W+2S) Conveying air compressor for Stage-I and 8 Nos (6W+2S) air compressor for Stage-II will be provided. Three nos (2W+1S) Instrument Air compressors will be installed to provide the transport air and the instrument air for both the units.
- Buffer silos and the Remote silos shall be provided with all necessary accessories such as pressure relief valve, Bag filter, platform etc.
- Total storage capacity (Buffer silo and Remote silo) will be 10000 T which is sufficient for around 30 hrs of ash generation.
- ESP hopper fluidizing blower will be designed considering fluidizing of all ESP hoppers. Remote silos and the Buffer silos will have fluidizing pads.
- One(1) outlet for Conditioned ash disposal into open trucks through rotary feeder and paddle type ash conditioner shall be provided in each Buffer silo and Remote silo.
- Two (2) outlets for dry disposal into closed trucks through motorised telescopic spout shall be provided in each Buffer silo.
- Wagon loading shall take place from Remote silo.
- Buffer silo shall have the following provision:
    a) Dry fly ash loading into bulkers
    b) Conditioned fly ash for loading into trucks, brick manufacturers
    c) Provision for other utility consumers
    d) Ash disposal to temporary ash dyke during emergency condition

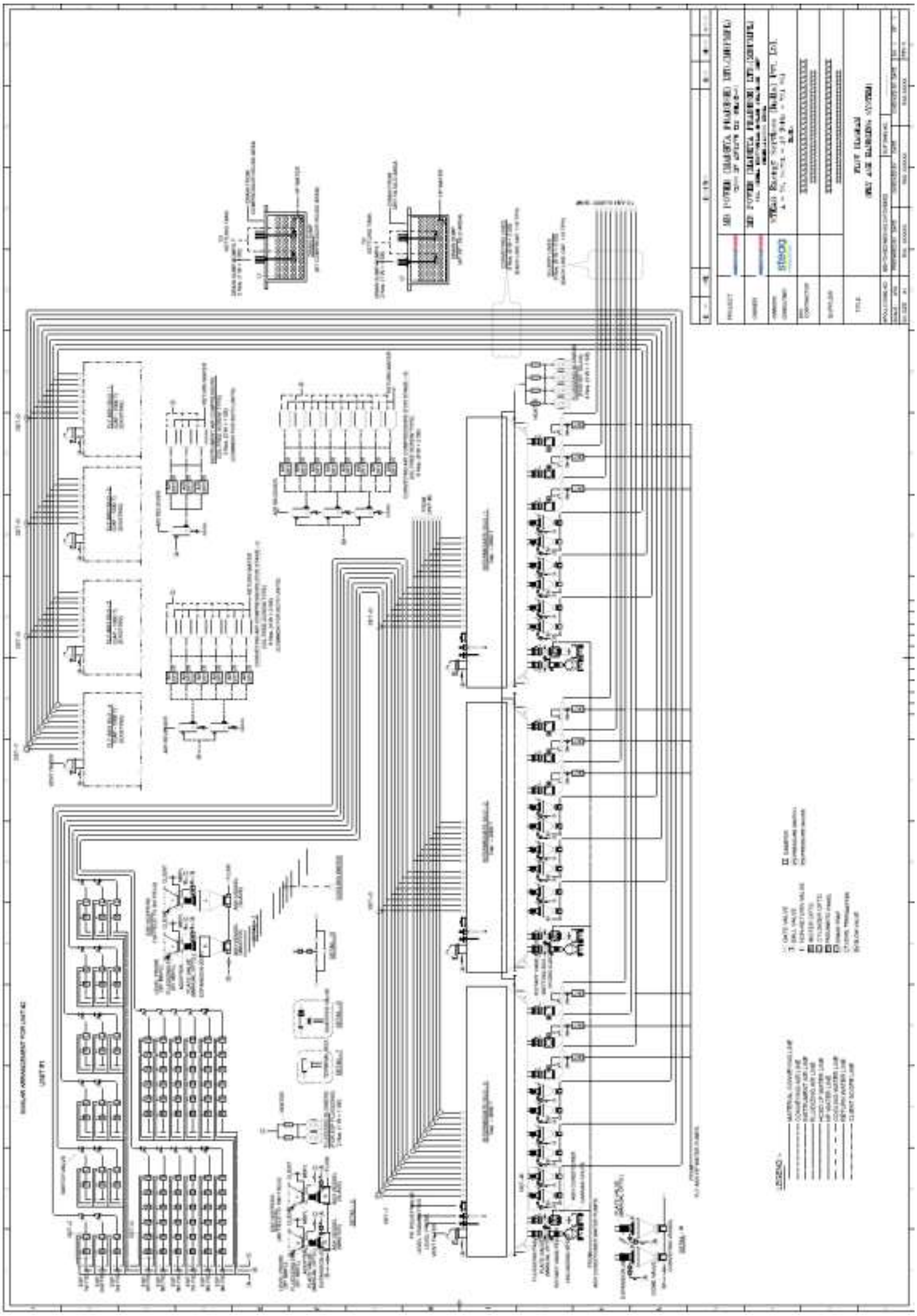


Figure 2-4: Fly Ash Handling and Collection

2.4.3.7 Ash Disposal

The fly ash generated from these units will be either used in cement industries around the plant area or exported for its utilization by end users. Fly ash will be collected in RCC silos. Fly ash removal from Silos will be thru' various mode i.e. Dry ash to trucks /bulkers , Conditioned ash to cement industries.

There will be provision for ash evacuation through railway wagon also. Fly ash can also be utilised in Brick industries, in construction of roads, in making fly-ash bricks. In case of exigencies, fly ash from the silos shall be disposed to ash dyke through lean slurry disposal system. Fly ash from the buffer silo shall be mixed with water in a controlled manner to form ash slurry. The so formed slurry shall be disposed to the slurry sump. Further the ash slurry will be mixed with water to form lean slurry and conveyed to the ash dyke through slurry pumps and pipes lines.

100% Ash shall be utilized from 4th year onwards as per MoEF norms. However, fly ash generated during first 3 years of plant operation shall be disposed to ash dyke through Lean/medium concentration Slurry Disposal System along with Bottom Ash.

2.4.3.8 Plant Water System

Water drawl:

The river water will be drawn from the barrage constructed on the River Son and pumped to the plant through an existing pipeline. The total make-up water requirement would be around 3992 m3/hr (35 MCM).

Water Pre-treatment System

Pre - Treatment plant will be designed to treat raw water drawn from raw water reservoir. Raw water will be pumped to cascade aerator through a centric pipe and will be allowed to flow down in steps. In this process entrapped gas in water is allowed to escape into the atmosphere.

The dissolved iron in raw water is oxidized and precipitated by aeration which gets settled in the stilling chamber. De Aerated water will further flow into the stilling chamber by gravity. The water from stilling chamber will flow to Parshall flume zone. Flow measuring transmitter instrument mounted in Parshall flume zone will indicate the flow of raw water. Then water then will enter the flash mixer were Alum/ PAC/ polyelectrolyte/lime/ Sodium Hypo chlorides will be dozed in the flash mixer.

The dosing of these chemicals will be regulated according to raw water quality & quantity to be treated which is based on "JAR TEST ". Alum/PAC dosing will lead to formation of heavy flocks, Polyelectrolyte dosing will facilitate the clogging of lighter suspended impurities into heavier particles which will be settling down due to gravity, whereas lime dosing will be done to increase the PH to the required level.

The chemically mixed water thereafter will flow into three nos. clariflocculators designed for settlement of heavy solid particles. The clear water will overflow leaving behind the settleable solid. The sludge will be removed periodically by opening of DE sludge valve. Overflowing water of clariflocculators will be conveyed to the clarified water storage tank.

Makeup Water System

Re-circulating cooling water system using wet evaporative Induced Draft cooling towers will be deployed for the proposed station. It will be used for the condenser and auxiliary equipment cooling in a semi-open cooling water circuit. The choice of cooling water system is guided predominantly by the GOI guidelines on use of sweet water for cooling purposes.

Raw water at the plant end will be received in raw water reservoir, which will have an overall storage capacity of about fifteen (15) days' raw water requirement of the Plant. Raw water will thereafter, be pumped to the Raw water pre-treatment plant and Ash handling plant by 3x50% capacity Raw water pumps and Ash water make-up pumps.

Two (2) clariflocculator units of adequate capacity is considered. Normally both the clariflocculators will be running at part load condition. However, when one clariflocculator is under maintenance then the other clariflocculator will run at overload condition to cater to the total clarified water requirement. Lime, alum and other coagulant aids will be dosed in the clariflocculator to accelerate the coagulation.

Clarified water will, thereafter, be used as make-up for the Circulating water system directly and also stored in a twin chamber RCC reservoir (semi-underground) having a storage capacity of about 4-hours clarified water requirement for the proposed power station. Clarified water will also be used for following systems/Equipment:

Air Compressor coolers, Air Conditioning and ventilation plant, service water for washing, cleaning and other housekeeping needs and for Ash Handling Plant for sealing and cooling purpose, etc. which will be met by three (3) nos. of Service water pumps (2W +1S) each having 50% capacity to meet the requirement of both units.

As feed water to meet the requirement of DM plant which will be met by three (3) nos. of DM Plant feed water pumps (2W +1S) each having 50% capacity to meet the requirement of both units.

As feed water to meet the requirement of Potable water which will be met by two (2) nos. of Potable water feed pumps (1W +1S), each having 100% capacity to meet the requirement of both units.

In addition, clarified water will also be used for off-load Air preheater and ESP washing which will be met by three (3) nos. of Air Preheater Wash water pumps (2W +1S) each having 50% capacity to meet the requirement of one unit.

The system design will take into consideration recycling of waste water and aim at minimum liquid effluent discharge. Sludge water from the clariflocculator will be recovered in a thickener and reused in the Plant. Regeneration effluent from DM plant will be neutralized before discharge to Central Monitoring Basin (CMB). The water from CMB after suitable treatment will be recycled for use in Ash water sump, CHP dust suppression, AHP and Horticulture and gardening system.

Demineralisation Plant & Heat Cycle Make-up System

Assuming average 2% make-up for the heat cycle and accounting for three hours regeneration time, demineralising chains of approximately 100 m3/hr capacity has been envisaged for the proposed units. DM plant will supply heat cycle make-up, the make-up requirement for primary water circuit in heat exchangers for the auxiliary cooling system of boiler, turbine generator and other common auxiliaries.

Clarified water will be pumped to the DM plant for demineralisation. In the DM plant, the water will be first filtered through dual media filters installed within the DM plant building. Filtered water will subsequently be passed through Ultrafiltration, Reverse Osmosis units, degassifier towers and mixed bed exchangers and the demineralised water will be stored in DM water storage tanks. Acid and alkali unloading, storage and feeding system will be installed for the DM plant resin regeneration. DM water will be stored in DM water storage tanks.

DM water from the storage tanks will be transferred to unit condensate storage tanks by three (3) nos. DM transfer pumps (2W +1S) each having 100% capacity to meet the requirement of one unit.

There will be one common DMCCW circuit for each unit - for both TG auxiliaries and SG auxiliaries. DMCCW system will have 2x100% capacity DMCCW pumps, 2x100% capacity Plate type Heat Exchangers, 2x100% Filters and one expansion tank.

Circulating and Auxiliary Cooling Water System

The river water will be sourced to meet the water requirements for condenser cooling and also for cooling the plant auxiliaries. The plant cooling water system will be of re-circulating type cooling system with Induced Draft Cooling Towers, which consists of 2 numbers of Concrete Volute Circulating Water pumps per unit.

Circulating Water pump house shall consist of five (5) nos of CW pumps for both the units. Two (2) pumps will be under operation for each unit, one will remain as common standby. Type of pumps will be Concrete Volute casing type or any other proven design of OEM. Circulating Water pumps for each unit to circulate cooling water to condenser and plant auxiliaries. The capacity of each pump would be 48000 cum/hr approximately.

The hot water return from condenser and auxiliaries will be routed through CT for cooling and will be recirculated through Cooling Water Pumps via fore bay channel.

It is proposed to install Two (02) Induced draft cooling towers, one for each unit and of approx. capacity 100000 m3/hr per tower. The cooling tower would be designed for a cooling range of 10°C. The design hot and cold-water temperatures of the cooling towers would be 43°C and 33 °C respectively. In order to prevent/minimise growth of algae in the CW system, Chorine dosing system is envisaged.

Clarified water will be used as makeup water for the cooling tower. Make-up water to the CW system will be by gravity/ or pumped from the clarifier outlet.

Closed Cycle Cooling Water System

Closed circuit cooling water system would be adopted for steam generator and turbine generator and common auxiliaries like air compressors, ash handling plant equipment etc. DM water would be used in the primary circuit, which in turn will be cooled by circulating water in plate type heat exchangers. Make up to the primary side closed loop would be from unit DM makeup system. For the secondary side, cooling water would be tapped from CW inlet to condenser and discharged into the discharge duct downstream of the condenser.

Condensate Polishing Plant (CPU)

For maintaining the feed water purity condensate polishing plant will be provided in the feed water cycle at the downstream of condensate extraction pumps. The function of the CPU will be to purify the condensate from the condenser by removing solids and dissolved salts with the intent of reducing corrosion and depositions in the steam-water cycle.

The condensate polishing plant will be 2x60% capacity mixed bed trains, consisting of service vessels for each unit. The resins to be used would be strong acid cation and strong base anion type appropriate for the influent condensate quality. The resins will be separated and regenerated externally by transferring to a dedicated regeneration station. A common external regeneration facility will be provided for both units.

The CPU will be provided with associated chemical feed system for preparing, measuring and dosing the required chemicals.

Service Water & Potable Water System

Drinking water requirement for the plant will be met from the output of potable water plant receiving stock from fresh water system after proper filtration and treatment. Potable water thus generated shall be stored in a potable water tank of capacity 100 M^3. There will be 2x100% drinking water pumps, which will supply drinking water to various facility area overhead tanks. Plant service water requirement will be met from the Overhead Service water tank and 2x100% Service water pumps, which will supply service water to various facility areas.

Waste water Treatment Plant

The liquid waste shall be collected and treated/recycled generally as per the following way:

The waste water from neutralization pits of condensate-polishing plant, DM plant shall be collected in the respective neutralization pits and neutralized before pumping to the central monitoring basin before final disposal.

The oily waste from main plant area shall be treated using oil water separator and the treated water shall be led to the tube settler provided for service water waste for further treatment. Similarly separate system shall be provided for oily water in fuel oil unloading and storage area.

Rain Water

Rainfall run-off from the coal pile will contain mainly suspended solids. This runoff will be routed to the settling basin for retention and settling of suspended solids, and the clear water from there may be used for dust suppression system. The rain water is collected in the storm water drain running all around the project. Rain water harvesting pit is connected to the storm water drain.

Excess rain water will flow to common collection pit from where water can be pumped for use in the ash handling system.

Action Plan for Waste Water Management

- Total industrial effluent generated from the plant is being and will be treated in ETP. Treated effluent is being and will be reuse in the process, ash slurry preparation, dust suppression, for cooling and for green belt devolvement/gardening within premises.
- Total domestic sewage generated is being and will be treated in STP (DM Plant STP of 1 KLD, STP near MGR of 15 KLD, Fire Station STP of 5KLD). Domestic sewage of Colony is being treated in STP (2x120 KLD). Treated water will be utilized in dust suppression during coal handling, fly ash unloading & on roads; ash handling; Floor washing & horticulture purposes.
- No wastewater is being and will be discharged outside the plant. The Plant will follow “Zero Liquid Discharge”.
- Closed Cycle Cooling System is being and will be adopted.
- Cooling blow down is being and will be reused in firefighting, service water, coal handling plant and ash handling after proper treatment.
- No hazardous substance of any type is being and will be discharged in the natural water bodies.
- Optimization of Cycles of Concentration (COC) will be done by opting following measures:
- Condensate will be collected and then it will be completely recycled.
- Biocides will be added to avoid scaling, for maintaining 7 COC.
- Apart from these measures like enhancing recycling/reuse of waste water, latest technologies for reduction of evaporation losses etc. will be adopted.

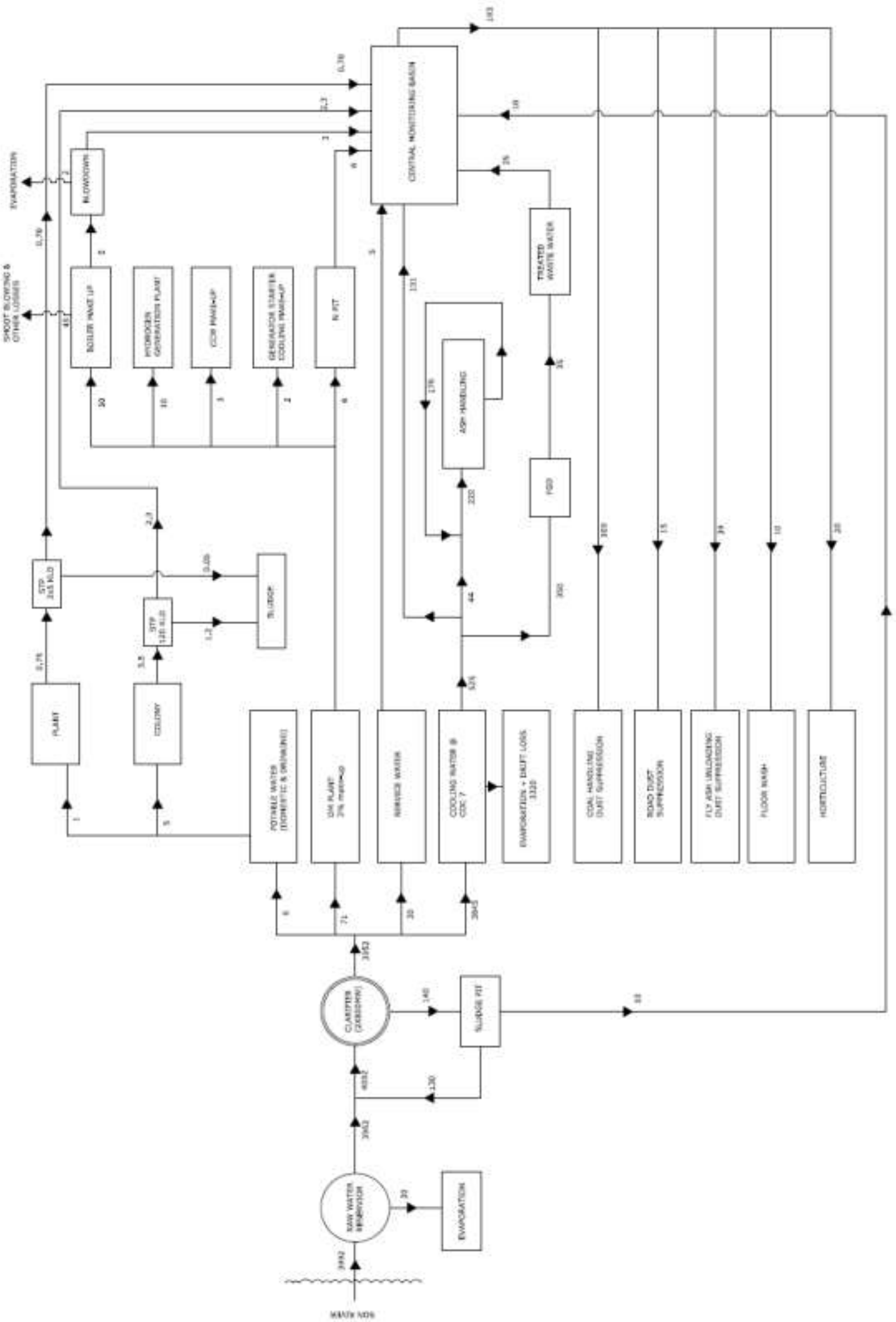


Figure 2-5: Water Balance Diagram

Action Plan for using Treated Sewage/Domestic Wastewater:

- The raw sewage collected in a collection sump will be pumped to a mechanical bar screen chamber for removal of large floating matter followed by grit removal in Grit Chamber.
- The raw sewage will then be collected in an equalization tank for homogenization of hydraulic load.
- The tank contents will be kept in suspension by means of course bubble serration through pipe grid.
- The equalized effluent will then be pumped to 2 Fluidized Aerobic Bio Reactors (FAB) in series where BOD/COD reduction can be achieved by virtue of aerobic microbial activities. The oxygen required will be supplied through coarse air bubble diffusers.
- The bio-solids formed in the biological process will be separated in the downstream Tube Settler.
- The clear supernatant will gravitate to the chlorine contact tank where sodium hypochlorite will be dosed for disinfection of treated water prior to disposal.
- The biological sludge generated in the FAB and settled in the tube settlers will be collected in a sludge sump and then pumped to sludge drying bed for de watering.
- The dried sludge will then be disposed to suitably as manure.
- The total domestic wastewater generated from plant and colony is 261 KLD. Domestic sewage from the plant is being treated in the following STP's
    - 1 KLD near DM Plant
    - 15 KLD near MGR
    - 5 KLD near Fire Station
    - 2x120 KLD near the Township.
- In the expansion stage it is proposed to install an additional 2x5 KLD STP at project site and an additional 1x120 KLD capacity for the colony.
- Treated water from the STP will be utilized in dust suppression of coal handling plant, fly ash unloading, dust suppression in plant roads, Floor washing & horticulture purposes.

2.4.3.9 Fire Detection and Protection System:

General:

The Fire Detection and Protection system will be designed in conformity with the recommendations of the Tariff Advisory Committee of Insurance Association of India. While designing the fire protection systems for this power station its extreme ambient conditions need special attention. Codes and Standards of National Fire Protection Association (NFPA), USA will be followed, as applicable.

The Power Plant is classified as Ordinary Hazard Occupancy as per TAC. Hence, the entire system will be designed accordingly. The different types of fire protection/detection system envisaged for the entire power plant are described below.

The water shall be drawn from the Clarified water storage tank in which reserve capacity of 2000 cum shall be provided.

Fire Water Tank

The water required for firefighting system would be drawn from the clarified water storage Tank and reserve capacity would be ear marked for the system. Volume of the tank will be designed to satisfy the fire water demand of plant in the worst assumed scenarios as per TAC/NFPA requirement. A reserve water level will be maintained in the water storage reservoir as per TAC/NFPA requirements.

Fire Water Pumps

The fire water pump capacity and head will be designed as per the system requirement. The fire hydrant system will have a dedicated fire water main pump. The adequate number of main fire pumps will be motor driven and one standby diesel engine driven pump. A separate motor driven fire pump of adequate capacity including one standby diesel engine driven pump will serve the HVWS/MVWS system. The entire fire water network will be pressurised and maintained by the hydro pneumatic tank along with common jockey pumps and with air compressors functions to make up the system leakage losses.

All the main and standby pumps will be capable of operating at 150% flow with a head drop less than or equal to 65% of the operating head. The shutoff head of the pump will not be more than 140 % of operating head in the case of vertical pumps.

Fire pumps will conform to IS: 5120 and will be certified by TAC as approved Fire pumps.

Fire Detection and Alarm System

A microprocessor-based Fire Detection and Alarm system will be provided for the entire plant area consisting of Intelligent Analogue Addressable type detectors. The system will consist of a central monitoring station and the main Fire Alarm Panel (FAP) located in unit control room and one fire alarm and control panel and repeater panel provided in the fire station office. Manual Call point (MCP) shall be provided at different strategic location in the entire power plant as per TAC/ NFPA 72.

2.4.3.10 Plant Air & Instrument Air System

For instrument/service air requirement of main plant and auxiliaries, air compressors having a required capacity and a discharge pressure of 8 bar (g) with Air Drying Plants of same capacity will be provided. For the complete plant, Four (4) numbers (2W+2S) of Instrument air compressors will be provided. These compressors will be oil-free screw type provided with all accessories such as suction filters, inter-coolers, after coolers etc.

The air-drying plants will be capable of achieving a dew point of (-)40 deg. C at atmospheric pressure. Individual air receiver will be provided near each air compressor and further unit air receivers will be provided near main plant of each unit.

2.4.3.11 Air Conditioning System

Inside design conditions of 24.1 degree C dry bulb temperature and relative humidity not exceeding 60% is proposed to be maintained in all air-conditioned areas.

Air Conditioning system will be provided for all those areas, which require close control of environment conditions and will cover the following areas:

Central Control Room consisting of Control Rooms, Control Equipment rooms, Telecommunication Rooms, Microprocessor, Computer and Programmers Rooms, Data Storage Rooms, UPS Rooms and Steam & Water Analysis Rooms, Conference Room, Shift Charge Engineer's Room (if applicable), Relay Rooms. A centralised chilled water system is envisaged for air-conditioning the above areas. This system will consist of three (3) nos. (2W+1S) screw chilling units. This system also consists of 2 x 60% capacity chilled water pumps, 2 x 60% capacity condenser cooling water pumps, 2 x 60% capacity induced draft FRP cooling towers, adequate number of air-handling units for circulating the conditioned air through air distribution system.

In addition to the above area, Air Conditioning System will be provided for ESP Control Room, Coal Handling Plant Control Room, Switchyard Control Room including Computer Rooms, Telemetry Room, PLCC & Telex Room, Required areas in Service / Facilities, Building / Administration Building, Plant/Demineralization plant Control Rooms, Water and Fuel Analysis Room, Instruments Room and any other area, which contains control and instrumentation equipment requiring Space Conditioning or otherwise required to be air conditioned.

For the above areas, either package type air-conditioning unit or D-X type air conditioning unit will be provided as per requirement.

2.4.3.12 Ventilation System

Ventilation system will be designed to supply fresh outdoor air and will be selected for maintaining inside conditions for those areas where close control of temperature is not required, but nevertheless have a stipulated maximum temperature.

For Ventilation of Station building, forced ventilation system is envisaged. The exhaust of hot air out of the station building will be achieved by provision of roof extractors and wall mounted exhaust fans. With this system the dry bulb temperature (DBT) within the turbine building will be maintained at a temperature not exceeding 40 degree C at all times of the year.

The following areas will be provided with forced ventilation system with filtered supply air and exhaust fans / roof exhausters:

- All other rooms of turbine building which are not air-conditioned.
- Switchgear rooms and cable galleries of main plant.
- Non-air-conditioned area of ESP control room.
- Any other areas where equipment heat load is high.

Battery rooms, Chemical stores and toilets will be provided with exhaust ventilation with minimum 20 air changes. All other buildings / areas will be ventilated by mechanical ventilation process using combination of filtered supply air fans and roof exhausters or wall mounted exhaust fans.

2.4.3.13 Piping System

Piping, valves, fittings, supports, for steam, condensate, water, oil, air and others etc. will be provided as per the requirement of the systems. Pipelines running outside the powerhouse will be routed on pipe -racks to the extent possible. However large diameter raw water and cooling water pipes will be buried. Proper protection by wrapping coating and/ or other necessary corrosion protection devices will be taken. For high temperature steam line ASTM A -106 Gr. B, ASTM A-336, P22, P91 shall be used.

2.4.3.14 Chemical Feed System

Although high purity water will be used as heat cycle makeup, careful chemical conditioning of the feed steam condensate cycle is essential as a safeguard against corrosion and possible scale formation due to ingress of contaminants in the makeup system.

Normally All Volatile Treatment (AVT) chemistry is adopted for Once through supercritical boiler. AVT is the traditional water treatment method where Hydrazine and ammonia or amine is injected upstream of Low-Pressure heaters of the condensate system or down stream of condensate Polishing plant. As high purity of feed water is required and no additional conditioning chemicals can be fed to the boiler, the use of condensate polishing is required with once through units.

Now another system which is known as Oxygenated water treatment (OWT) has been applied by few manufacturers to overcome the problem faced in AVT.

In OWT system, ammonia and oxygen will be injected upstream of Low-Pressure heaters of the condensate system. Also, oxygen can be injected in the Boiler Feed pump suction.

The Chemical Feed System shall consist of two independent systems of Low Pressure (LP) Dosing Systems for AVT system. The LP dosing system shall be designed on unit system i.e. each power generation unit shall have its own chemical dosing system and thus shall be independent of other units in the station. The chemical feed systems shall be self-contained and complete.

2.4.3.15 Condenser On-load Tube Cleaning System:

Two (2) nos. 2x100% Condenser on Load Tube Cleaning System complete with ball recirculation units, pumps, drive motors, ball collectors, debris filter etc. and appurtenances matching the requirements of the Condenser.

2.4.3.16 Hydrogen Generation Plant

Hydrogen required will be met either from existing Hydrogen generation plant or Hydrogen generation plant of adequate capacity shall be installed to cater the requirements of 2x800 MW units.

2.4.3.17 Thermal Insulation

All equipment / pipes / ducts whose surface temperature is higher than 60°C, will be provided with thermal insulation for personnel protection and heat conservation. The insulation material will be chemically inert, non-combustible and will be harmless. Outer surface of the insulation will be covered with aluminium cladding of 22 BWG. Materials and thickness of insulation will be selected so as to limit the surface temperature to 60°C with an ambient temperature of 47°C and wind velocity of 3.4 m/s.

Steam turbine and also, BFP drive turbine shall have spray insulation to maintain differential expansion of turbine within permissible limits apart from conserving heat.

2.4.3.18 Cranes & Hoists

EOT Crane in the Turbine Hall will be used for lifting/unloading of heavy equipment from Trucks at the unloading bay and also for erection and maintenance of equipment. Two EOT cranes of 160 Tons / 35 Tons are considered in Turbine hall block of two units. One number EOT crane of 25 Ton capacity shall be provided for boiler feed pumps in BC bay.

2.4.3.19 Chimney
One (1) no Wet Flue gas Chimney per unit of suitable height in compliance to MOEF guide lines of RCC construction is envisaged for 2X800 MW Units. The chimney will be provided with lightning arrestors and aviation warning lights. System design will include on-line Opacity/Suspended Particulate matter monitoring system, SO2 and NOx monitoring system, CO monitoring and Flue Gas Oxygen analysers etc. The Chimney will be provided with rack & pinion type elevator to facilitate maintenance.

2.4.3.20 Elevators
One (1) goods-cum-passenger elevator of about 2000 kg carrying capacity will be provided for each of the steam generating units. Another two (2) passenger elevators will be provided at the entrance of the power house building for movement of personnel.

2.4.3.21 Painting and Corrosion Protection
All mechanical and electrical equipment including piping system and structures will be painted with international standards / IS standard colour code for ease of identification. All steel structures will be painted with epoxy resin-based paints. Galvanised structures will have minimum 610 mg/m2 zinc coating. Suitable allowance on thickness will be provided for the surfaces, which cannot be protected by application of painting. All buried piping will be provided with bitumen paint-based coating and wrapping. Cathodic protection system shall be provided for all underground structures wherever it will be felt necessary.

All equipment, buildings, structures etc. exposed to the atmosphere shall be painted suitably to prevent from rusting and climatic conditions.

2.4.3.22 Workshop & Laboratory
The power plant shall be equipped with a work shop capable of catering to the routine maintenance requirements of the plant. A central chemical laboratory adjacent to the DM plant buildings shall also be established for the station. This would have necessary equipment and facilities to test and analyse steam, water, oil, coal etc. required to ensure satisfactory operation and maintenance of the station.

2.4.4 Electrical System & Equipment

2.4.4.1 Generator and Excitation System
The Generator shall be three phase, two pole, cylindrical rotor, wye connected machine with phase and neutral terminals brought out for connection to isolated phase bus duct. Generator Neutral will be grounded through a dry type Distribution Transformer having Secondary loaded by resistor to limit the Ground Fault current.

It shall be ensured that when the Generator is working at this capability and Cooling Water Temperature is 39 deg C, no part of Generator shall attain a Temperature Limit specified for Thermal class 130(B) insulation as per IEC-60034.

The Generator shall have the following rating:

Table 2-5: Rating for Generators.

Sr No	Description	Rating
1	Rated output excluding excitation power	945 MVA

Sr No	Description	Rating
2	Power Factor	0.85 lagging
3	Terminal Voltage	21-27 kV
4	Frequency	50 Hz
5	Short Circuit Ratio	Not less than 0.48
6	Efficiency	98%
7	Minimum Capacitive MVAR rating at zero	Minimum 30% of rated MVA
8	Maximum Hydrogen Pressure	4.5 bar
9	Class of Insulation	Class F but limited to Class B temperature rise

The maximum permissible temperatures of different parts of the generator shall be as per IEC 34-1, 34-3 as applicable.

The Generator rating listed above shall be guaranteed on the basis of continuous operation without exceeding the temperature limits at rated hydrogen pressure.

Voltage Variation	+/-5% continuously at rated power factor Reduced MVA operation at 110% of the rated voltage. (to be indicated by the Bidder)
Frequency Variation	47.5 HZ to 51.5 HZ (+3% to -5%)
Combined voltage and frequency variation	5%
Power factor variation	0.85 (lag) to 0.95 (lead)
Operation under unbalanced load	As specified in IEC 34-1
Operation under unsymmetrical short circuit	Negative sequence current I2 expressed in per unit of rated unsymmetrical short current for a duration of 't' second such that the value of I2t circuit current shall comply to IEC 34-1.
Voltage Wave form	The telephone harmonic factor (T.H.F) shall be within the limit specified in IEC 34-1.
Short Circuit withstanding capacity	Capable of withstanding of 3 phases short circuit at the generator terminals when operating at rated MVA and power factor with 5% over voltage for a period of not less than 3 secs.
Special operating conditions	Capable of withstanding the electrical, mechanical and thermal stresses developed during fast reclosing of high voltage line, transmission line switching, faults, out of step operation and out of phase synchronization etc.
Line charging Capability	Not less than 30% of its rated MVA at zero pf. leading
Operation with one gas cooler out of service	The generator shall be capable of delivering at least two thirds of the rated output.
Generator Neutral	Non-effectively earthed through a distribution transformer loaded with a resistor. The core design to permit the flow of earth fault of at least 15 amperes for one (1) second without any core damage.

Lightning arrestor of suitable rating shall be provided for the surge protection of generator winding. In case surge capacitors are recommended, the same shall also be provided.

The Excitation system may be static or brushless as per OEM's proven standard. The excitation system shall meet the performance requirements specified hereinafter.

a) The Generator and its Excitation system shall be capable of continuous stable operation without any excessive Temperature rise at the peak output of the associated Steam Turbine under VWO and HP heater condition etc. as available for secondary Cooling Water Temperature of 39 deg C.
b) Maintain the Generator terminal Voltage constant within +5% of the preset value over the entire load range of the machine.
c) The response time must be short so that the Automatic Voltage Regulator (AVR) can control the Generator during system disturbances or transients in which rapid changes in Excitation are required to maintain system stability margins both in steady state and transient condition.
d) Brushless or Static Excitation system is envisaged for the Generator.
e) The reference voltage set point shall be adjustable over a range of 85 to 110% of the nominal rated voltage under all load conditions.
f) The rated current and voltage of the excitation system shall be 110% of the machine excitation requirements at rated output. The ceiling voltage shall not be less than 150% of the machine excitation voltage.
g) The system shall be capable of supplying the field forcing requirement for at least 30 seconds. The nominal exciter response ratio shall not be less than 3 per second.
h) If brushless excitation system is adopted, sufficient parallel diodes to allow for 20% failure without de-rating exciter
i) The Excitation system shall have matching characteristics suitable for satisfactory parallel with other Generators.
j) The necessary inputs and interface equipment shall be provided with Generator Excitation and Automatic Voltage Regulator for hooking up with Turbine Automatic run-up system and Electro Hydraulic System.

The following features/functions shall be incorporated in the regulator:

- Cross current compensation
- Slip stabilizer
- Load angle limiter
- Stator current limiter
- Rotor current limiter
- Volt/Hz. Ratio controller
- Rotor temperature transducer/ transmitter with remote mounted indicating recorder
- Field current and voltage measuring equipment
- Under excitation limiter for operation of generator with stability limits and to avoid stator core end heating.

2.4.4.2 400kV/765 Switchyard

400/765 kV Switchyard with one and half breaker bus configuration layout shall be installed. The layout shall be I type with 04 diameters. Tentative configuration of Switchyard is as follows:

- Line Bays to 400/765 kV AC yard – 03 nos.
- Switchable Shunt Bus Reactors - 01 no.
- Station Transformer bays – 02 nos.
- GT bays – 02 nos.

For 400/765 Kv Switchyard control, protection, indication, local/remote operation & monitoring shall be by Substation Automation System (SAS) consisting of star coupler, RTU units, I/P & 0/P cards for digital / analog, air conditioned bay kiosks, hardwares, softwares, LCD screens, video cameras for switchyard area, communications, optic fiber cables etc., The SAS would integrate the SCADA functions and the numerical protection systems provided for various bays.

Control and monitoring of complete switchyard shall be done using suitable number of operating work stations in the switchyard control room. One (1) no. Engineering Station would be provided in the Switchyard control room to make the SAS configuration changes, DR analysis and system settings.

Each line feeder shall be provided with both main and a check meter of ABT type. HV side of Generator transformer, Station Transformer and ICT will have energy auditing meter. Accuracy class of tariff meters / energy auditing meter shall be of 0.2S.

Switchyard shall be provided with redundant 220V DC batteries, redundant Chargers and DC Board to cater the DC loads.

Redundant 48V DC batteries, redundant Chargers and DC Boards shall be provided to cater the Power line carrier communication (PLCC).

Switchyard structures shall be hot dip galvanized and thickness of galvanizing shall be not less than 910 gm/sq.m.

2.4.4.3 Commissioning Power and Construction Power

For commissioning and construction power demand is estimated of the order of 50 MVA. This shall be made availed from Existing Units.

2.4.4.4 Startup/ Commissioning Philosophy

As generated power is being transferred to Madhya Pradesh & neighbouring states power from grid shall be used for commissioning checks and trials only. Power can only be transferred when the AC transmission System is ready for transfer of power.

2.4.4.5 Generator Transformer

The generated voltage of 25~27V will be stepped up and fed to 400/765 kV Switchyard by Generator Transformer (GT) connected directly to the Generator terminals through Isolated Phase Bus-duct (IPBD).

The Transformer will be a bank of three Single Phase Units of 330 MVA, 25~27/ 400/765√3kV, YNdll and 50 Hz suitable for maximum utilization of Generator capacity. The total capacity of Generator

Transformer will thus be 990 MVA. One number Single Phase Unit of 330 MVA, 21~24/400/765 √3KV, 50 Hz Generator Transformer shall be kept as spare.

a) The Transformer would have OFAF or ODAF type of cooling.
b) It will be provided with Off-circuit Tap Change system on HV side having a range of tap of +5% to -5 % of nominal Voltage in 5 steps of 2.5 %.
c) The High Voltage terminals of the Transformer will be connected to the 400/765 kV outdoor Switchyard by overhead conductors.
d) To protect the GT against atmospheric disturbances, Lightning Arrestors will be provided near HV terminals.
e) Maximum Flux Density in any part of the core and yoke at rated MVA, Voltage and Frequency shall be 1.9 tesla.
f) Withstand capability of the GT for 25% above rated Voltage shall be 1 minute and for 40% of above rated Voltage shall be for 5 seconds.
g) The temperature rise at full load shall be limited to 45°C / 50°C over ambient of 50°C for oil / winding.

Total cooling system of transformer shall be so designed that during total failure of power supply to cooling fans & oil pumps, the transformer shall be able to operate at full load for at least ten (10) minutes without the calculated winding hot spot temperature of the transformer under any operating condition shall not exceed 140°C

Online DGA and online PD monitoring shall be considered.

2.4.4.6 Station Transformer

Station Transformers shall be 3 Phase units and will have three winding rated for 80/40/40MVA, 400/765 kV/11/11kV, Vector Group YNyn0 yn0 and Impedance Voltage of 10~15% on 40 MVA base.

a) The ST will have 60%/ 80%/ 100% capacity for ONAN /ONAF / OFAF cooling.
b) The temperature rise at full load shall be limited to 45°C / 50°C over ambient of 50°C for oil / winding.
c) In order to take care of Grid Voltage variation, these Transformers will be provided with On-load Tap Changer to accommodate Voltage variation of plus 10% to minus 10% @1.25 % per tap.
d) HV side of this Transformer shall be connected to 400/765 kV Switchyard through overhead conductor. LV side of these Transformers will be connected to 11kV Indoor Station Switchgear installed in the Main Plant through Phase Segregated Bus-ducts (SPBD).
e) To protect the ST against atmospheric disturbances, Lightning Arrestors will be provided near HV terminals.
f) These transformers shall be provided with Online DGA equipment.

2.4.4.7 Unit Transformer

Two (02) Unit Transformers per unit have been envisaged for feeding the Unit Bus Each of these Unit Transformers will be 3 Ph, 45/ 50MVA, 21~24kV/11kV, ONAN/ ONAF cooling, Dyn1, Impedance Voltage 10~13% on 45 MVA base,

a) The temperature rise at full load shall be limited to 45°C / 50°C over ambient of 50°C for oil / winding.
b) These transformers shall be provided with On-load Tap Changer system on the High Voltage side to take care of voltage variation to the extent of +/-10% @1.25% per tap.
c) The capacity of Unit Transformer shall be chosen on the basis of the Unit Auxiliary load requirements with due consideration to the starting of the largest motor, available CB capacity and voltage regulation requirements.

2.4.4.8 Reactors

Bus Reactors shall be capable of operating continuously at a voltage 5% higher than their rated voltage without exceeding hot spot temperature of 150 deg C at any part of the reactor. The reactor shall be of gapped core type. Five limbed core construction shall be adopted to achieve high zero sequence impedance. In addition to the three gapped core limbs with windings, there shall be two continuous outer return limbs. The core sections between consecutive air gaps shall be molded in epoxy resin to prevent movement between individual laminations. The spacers forming the air gaps shall be blocks of ceramics with a high modules of elasticity and the whole stacking of core modules shall be cemented together during the assembly to form a solid column without possibility of rocking , or rubbing between individual parts. The core segments shall be of radial laminated configuration. The radial laminations shall prevent fringing flux from entering flat surfaces of core steel which would result in eddy current overheating and hot spots.

2.4.4.9 LV Service Transformers

LV Service transformers shall be provided to meet the demand at 415 V levels of auxiliary power systems. Each switch gear shall be fed by two numbers 100 % rated transformers.

a) Each transformer shall be rated to meet the loads connected on both the bus section of Switchboard with 10 % design margin.
b) Maximum rating of the transformer will be limited to 2.5 MVA, so that short circuit rating of 415V systems is not exceeding 50 kA. Further, Transformer voltage impedances shall be so optimized that the auxiliary system voltages under various loading conditions and fault currents are always within permissible limits and equipment are not subjected to unacceptable voltages during operation and starting of motors.
c) HV winding will be delta connected rated for 11 kV or 6.6KV as per distribution and LV winding will be Star connected rated for 415 V. LV neutral shall be solidly grounded. No load voltage ratio shall be at least 5% higher than the nominal voltage to account for voltage drop in the transformer during loaded condition. Accordingly, LV voltage will be 0.433 kV.
d) All Service transformers shall be Dry Type, 3 phase 2 winding type.
e) Dry type transformers shall be designed with Class C insulation with temperature rise limited to Class H. Dry type transformers envisaged shall be of open ventilated dry type transformer with IP 33 enclosure.
f) The transformers shall be provided with off circuit tap changer on HV side.

2.4.4.10 Isolated Phase Busduct (IPB)

For connection between Generator and Generator Transformer/Unit Transformers, Isolated phase Bus duct shall be provided. Bus duct shall be continuous welded type. The Bus duct shall be with aluminum conductor and aluminum enclosure.

The continuous current rating of the main Bus duct shall be arrived at considering continuous MVA capacity of Generator at Turbine Valve wide open condition with a design margin of 10%.

The continuous current rating of the tap-off Bus duct shall be selected to carry Unit Transformer rating with a design margin of 10%.

The short time current rating of the main bus duct shall be arrived at higher the value of the followings: Short circuit current contribution from generator plus contribution of 6.6kV auxiliary system through Unit transformers (OR) Short circuit current contribution from 400 /765 kV systems through generator transformer plus contribution of 6.6kV auxiliary system through Unit transformers.

The short time current rating of tap-off Busducts (to Unit transformer, excitation transformer cubicle and SPVT cubicle) shall be combined contribution of short circuit current from generator and from 400/765 kV system through generator transformer and also the contribution of 11kV auxiliary system through one Unit transformer.

The bus duct design in the outdoor areas shall take into account heating effect due to solar radiation. The bus duct shall be natural air cooled. Degree of protection shall be IP55. Positive air pressurization arrangement shall be provided for the Bus duct to prevent dust ingress.

2.4.4.11 Segregated Phase Busduct (SPB):

Segregated Phase Bus ducts are envisaged for 11 kV system for connection between respective Unit Transformer / Station transformers and 11 kV Switchboards and tie between 11 kV Switchboards.

The Bus duct shall be with aluminium conductor and aluminium enclosure. The Bus duct shall be natural air-cooled. Degree of protection shall be IP: 55.

Current rating shall be selected to carry transformer rating with 10% design margin. Bus duct shall be rated for short circuit withstand rating for 3 sec. Current rating and Short circuit withstand rating of Bus duct shall be not less than respective switchboard rating.

2.4.4.12 LV Busducts

Non-segregated phase Bus ducts are envisaged for connection between LV service Transformer and 415 V PCC for rating of 1000 kVA and above. For lesser ratings, cables shall be provided.

Current rating shall be selected to carry transformer rating with 10% design margin. Size of Neutral Bus duct shall be 50% of Phase Bus duct. Bus duct shall be rated for short circuit withstands rating 50 kA for 1 sec.

The Bus ducts shall be non-segregated type with aluminum alloy conductor. The enclosure shall be steel up to 2000 A rating and with aluminum alloy enclosure for higher rating. The Bus duct shall be natural air-cooled. Bus duct shall be suitable for indoor duty. Conductors shall be treated with mat black paint for efficient heat dissipation.

2.4.4.13 11kV and 6.6 Switchgears

11KV and 6.6 kV Switchgear shall be of Indoor, single front, single tier, metal clad, fully draw out type. Switchgear shall have IP 4X degree of protection.

SF6 breakers and Vacuum circuit breakers (VCB) are popular in medium voltage range. In recent years, for medium voltage application, vacuum technology has become more popular than SF6 alternative and every major manufacturer adopts VCB technology. In Europe and other countries, measures are being considered, to minimize the use of SF6, as SF6 gas leak/release may contribute to 'greenhouse effect'. Hence, vacuum circuit breaker has been proposed only for 6.6 kV systems.

The breakers shall have interrupting current rating to meet system fault level requirement. The switchgear shall be rated to withstand short circuit rating for 3 seconds.

Suitable surge limiters shall be installed on the cable side to limit switching over voltages for VCB.

The continuous current rating of the Switchboard buses and their incomer breaker shall be rated for secondary winding current of their upstream transformer with 10% margin.

Numerical multifunction relays with self-monitoring and diagnostic features shall be provided for protection.

For all incomers multifunction meter shall be provided for energy audit.

2.4.4.14 LV Switch Boards

Power Control Centre (PCC) shall have two bus sections and a bus coupler. Each section shall have 100% rated incomer fed from service transformer. However ESP PCCs shall have two incomers, each 100% rated, without bus coupler. The PCCs shall distribute power to the following

a) To breaker operated LT motors (Rating >110KW)
b) To motor control centers (MCC).
c) To Distribution Boards
d) To Feeders rated > 100 A

The 415 volt Distribution boards shall distribute power to small 415/240 V non motor loads.

The continuous current rating of the PCC buses and their incomer breaker shall be the rated for secondary winding current of their upstream transformer with 10% margin. Redundant mechanical loads shall be fed from separate MCC buses. PCC/MCC/ DB shall be rated for 415 V, 50Hz, 3-phase, 4 wire supply. Normal/Emergency MCC shall have 3- phase, 3 wire supply. PCC & MCC shall be draw out type and distribution boards shall be fixed type.

All the motor starters shall be 'Direct on Line' type. All MCC feeders shall conform to Type 2 co-ordination. Motor feeders shall be of conventional "SFU – Contactor – Relay" combination type. Multifunction numerical relay also can be considered for LT motors, in place of conventional bi-metallic overload relay.

The continuous current rating of the bus bars, incomers, bus couplers of the MCC shall be the maximum load on the bus due to all the running auxiliaries during any operating condition plus 10% margin and the biggest spare feeder rating.

The PCC, MCC and Distribution boards shall be located indoors. Type of outgoing feeders shall be as follows:

- Motors rated > 110KW < 200 kW: Air circuit breaker (ACB) controlled.

- Feeders rated > 400A: Air circuit breaker (ACB) controlled.
- Motors rated < 110kW: Fused Contactor controlled.
- Feeders rated < 400A: Switch fuse units controlled.

2.4.4.15 Motors and Actuators

All AC Motors shall be squirrel cage induction type rated for continuous duty. DC Motors shall be shunting wound type. Power supply for AC motors shall be as follows:

- Single phase motors: 230 V, 1 Phase, 50 Hz.
- Up to < 200 kW: 415 V, 3 Phase, 50 Hz
- 200 KW & above: 6.6 kV, 3 Phase, 50 Hz

Motors shall be capable of delivering the rated output with supply voltage variation of ±

10% and frequency variation of +3% to –5% and absolute sum of 10%. DC Motors shall be rated for 220 V DC with supply voltage variation of – 15 % to + 10%.

Motors shall be considered of energy efficient type. Variable frequency drives can be envisaged for drives like ID fan. All the motors shall be suitable for 'Direct On line' starting. While sizing the motor, deration due to voltage and frequency fluctuation need to be accounted. A design margin of minimum 10% shall be considered in Motor sizing unless otherwise specified in the Mechanical system criteria.

Motors shall be capable of starting and accelerating the load with the direct on line starting without exceeding acceptable winding temperatures when supply voltage is 85% of the rated voltage for LV motors and 80% for HT motors.

Motors shall be suitable for the following starts under the specified conditions of load, torque and inertia in the motor initially at its normal operating temperature.

- No. of consecutive cold starts: 3
- No. of consecutive hot start: 2

Locked rotor current of the AC motors shall be limited to 600% of the full load current of the motors. The BFP motor start up current shall be limited to 450% of full load current of the motor. Type of enclosure/cooling for LT motors shall be TEFC and for HT motors CACA/TETV/TEFC. All insulated winding shall be of copper. All the motors shall have class F insulation. Temperature rise shall be limited to 120 deg C.

Motors rated 1500 kW and above shall be provided with differential protection. Required current transformers, one for each phase shall be mounted in the neutral side terminal box. Actuators shall be integral type. Starter module required for the actuators shall be provided in actuator itself (Integral to actuators.

2.4.4.16 Protection System

Fully graded protection system with requisite speed, sensitivity and selectivity shall be provided for the entire Station. For Generator redundant relays shall be considered for each protection function. For generator transformer, unit transformers (UTs) protections shall be connected to two independent groups/relays, such that one protection system shall always be available for any type of fault.

All the protection relays shall be multifunction numerical type with self-monitoring and diagnostic features and communication link/port.

Current Transformers: Accuracy class of CT core meant for tariff Metering/Energy auditing shall be 0.2S and other power metering core shall be 0.5. However, for current metering it can be 1.0. Instrument security factor shall be < 5. Accuracy class for Protection core shall be 5P20 for protection in general. For differential protection, based on the type of differential relay, CT can be either PS class or 5P20.

Voltage Transformers: Accuracy class of VT core meant for tariff Metering/Energy auditing shall be 0.2 and other power metering core shall be 0.5. However, for voltage metering it can be 1.0. Accuracy class for Protection Core shall be 3P.

2.4.4.17 Plant Communication System

The following communication equipment's are proposed:

- Public address system with page and party line
- Telephone system with 25 external lines and 500 intercoms
- Walky-talkies.

2.4.4.18 Layout Aspects

In the Power house building, BC bay/AB bay shall be utilized to accommodate Electrical and C&I equipment of the Main Plant. Cable spreader room shall be provided for each Switchgear room and Control room / Control equipment room.

Generator Transformers, Unit Transformers, Unit Auxiliary, Station Auxiliary and Station Transformers shall be located in the Transformer Yard. 11kV Unit Switchgear, 11 kV Station Switchgear, 415 V Turbine PCC, 415 V Boiler PCC, Emergency Switchboard, Ventilation MCC, Air condition MCC, 220 V Battery & Charger, 240 V UPS and 415 V dry type Transformers shall be located in rooms of Power house building in A-B Bay.

Minimum clearance of 1000 mm shall be provided on rear of panel for single front boards. For double front boards, clearance from wall/column shall be minimum 1500 mm. For installations with two rows of boards facing each other, minimum clearance of 2500 mm shall be maintained between fronts of boards. Clearance between adjacent panels in a row shall be 800 mm minimum.

Generally all Switchgear/MCC rooms shall have cable spreader rooms. For cable spreader rooms, doors shall be fire rated. Cable trench can be considered for smaller MCC Rooms.

A minimum clearance of 800 mm shall be provided between transformer and wall for LV transformers. For HV transformers the clearance shall be higher based on maintenance requirements. Oil soak pit shall be located at more than 5 meters from the transformer. In transformer yard one common soak pit shall be proposed for each unit sized to accommodate 110% of the volume of oil of the largest transformer

Where oil capacity of the transformer (individual or aggregate) is > 2300 liters, firewall shall be provided unless equipment/ buildings are located at specified distance stipulated in regulations. Fire wall shall be two hour fire rated. 355 mm thick brick or 200 mm thick RCC or suitable hallow block dire wall shall be considered, extended at least 600 mm above the highest point of oil containing part of the transformer.

The batteries shall be located in a separate ventilated room. For batteries, the acid/alkaline resistant protective treatment shall be proposed for the battery room floor and on the wall surfaces. An eye wash basin shall be provided in each battery room.

400/765 control room to have relay panels, SAS system, DC system, PLCC panels, Tariff metering panel etc.

In the transformer yard, rail track shall be provided for transformer movement during installation and maintenance. These rail tracks shall be extended upto nearby road.

Electrical Lab shall be set up and adequate instruments and equipment for the same shall be provided.

2.4.5 Control & Instrumentation Systems

These design criteria will govern all aspects of the design basis and philosophy of the control systems engineering work, systems and equipment. The criterion is intended to provide system level requirements. Proven control technologies and conventional instrumentation will be used for equipment and systems vital to the availability and reliability of the plant.

The intent of this design basis report is to cover the basic design criteria for whole plant I&C package for this project. A brief description and salient feature of the various sub systems are defined here for the basis of design.

2.4.5.1 Plant Description

The scope would involve design, supply & erection, calibration, testing & commissioning of BTG equipment including main plant and its associated control system, DCS, DEH, ETS, SWAS, CPU, LVS, BTG OCAMMMS (Including TSI), other related field instruments, BOP DCS and related instruments, C&I Laboratory Instruments, CEMS, BOP Vibration Monitoring etc. Important operational parameters, alarms and equipment status of the balance of plant packages will be linked to DCS for the centralized supervision and monitoring from central control room.

Main Plant & Balance of Plant (BOP) systems is sub divided into the following Systems:

- DCS
- Cable and Cable Tray
- C&I Erection
- SWAS
- CEMS
- Control & Instrument Lab
- Condition Monitoring System (OCAMMMS)
- CCTV

2.4.5.2 Distributed Control System (DCS)

A Distributed Control System (DCS) will be provided as the main operator for control and monitoring functions of this project. The system offered will be functionally and geographically distributed. All the Control System shall be time synchronized through GPS. The controls and instrumentation for the operation and monitoring of this project will be split in both centralized control and localized mode of control. The BTG (Boiler - Turbine - Generator) control is centralized from the Central Control Room whereas the control, monitoring & operation of the offsite and auxiliary plants will be carried out from control desk of the Combined Common DCS. The packages like fuel oil pressurizing and heating system, CW & ACW pumps, condenser make-up system, compressed air system, Condensate Polishing Unit and Mill Reject system etc will be controlled form CCR through DCS whereas other BOP auxiliaries will not have any control from CCR. However, major operational parameters of such auxiliaries will be monitored in DCS in CCR.

The BOP auxiliaries not controlled from CCR will include coal-handling plant, ash handling plant, DM plant and Fire detection system etc. All such systems will be controlled by Common DCS and will have redundant data communication link to main plant DCS. The fundamental objective of the various control systems provided for this Thermal Power Plant is to facilitate effective plant operations by ensuring the following:-

- Personnel safety.
- Equipment protection.
- Ease of operation (automation).
- Equipment and cycle efficiency.
- Equipment and system reliability. Equipment and system maintainability.
- Minimization of incidence of operator error.
- Maximization of efficiency of operator.

To implement these criteria, normal control and monitoring of the unit will be from a Central Control Room (CCR) provided. The CCR will employ state off the art control system hardware configured for ease of operator interface. The general design philosophy for the control & instrumentation system will meet the following objectives.

- High level of automation
- High degree of overall system reliability, Low downtime & high MTBF
- Enhanced availability of plant, taking into consideration proper
- Redundancies at various levels
- Operational convenience, user friendly
- Consideration of maintainability and accessibility.
- Consideration of long-range economy and better spares management.

The Instrumentation and Control System shall mainly realize the following functions in order to assist the operator to perform safe startup / shutdown and normal / emergency operation of the plant.

a) Closed loop modulating control of parameters for optimized operation of turbine, boiler and balance of the plant.
b) Open loop control for automatic sequential operation, interlock and protection of various drives.
c) Continuous supervision of system parameters and equipment operating conditions

d) State-of-the-art practices prevailing in the field of instrumentation & control for power plant will be considered to ensure safe, efficient and smooth operation of the plant and equipment with minimum interference of the operating personnel during normal working of the plant.

The system design will be such that no single point failure will result in total system paralysis under any operational eventuality. Redundancy will be provided at appropriate levels for critical control system functions. In the event of loss of a major plant item, activities of binary and analog controls will be coordinated to ensure that the plant is automatically brought to a safe holding condition consistent with maintaining maximum generation permissible under reduced plant availability.

Local monitoring and control facilities will be provided for operations, which demand local attention. Local monitoring will be provided in cases where such indications are required for maintenance like pressure gauge for pump, commissioning and tuning of equipment and where recommended by equipment manufacturers for local supervision in case of emergency.

In line with the latest trend of control & monitoring, for centralized control & monitoring of the plant, the I & C system will be built around a Distribution Control System (DCS) with functionally distributed multifunction controllers, suitable Man Machine Interface (MMI) devices and other required peripherals and hardware. However, control of CHP, AHP and WTP etc., auxiliary workshop will be from Common Control rooms by DCS. All auxiliary operating with Common DCS is provided with communication link / hardwired with CCR DCS system so that the CCR shift in-charge can have information of the most plant.

The principal functions of the DCS are as follows: -

a) Provide the control of the steam turbine generator (STG).
b) Provide control of the steam generator, main steam cycle, steam re-heat cycle, steam bypass and water cycle.
c) Provide control of pulverizes, combustion air, burner ignition and flame management.
d) Receive input signals that represent the status of process variables and equipment status; condition the signals; and utilize them for control, protection, monitoring, status display, annunciation and SER.
e) Provide the output signals to modulate and control the final devices, such as control valves, control drives, dampers and pumps.
f) Provide communication for control room monitoring of control and information systems such as (i) DM plant (ii) coal handling (iii) ash handling (v) ESP (hardwired interface for few signals) etc.
g) Provide alarm logging and sequence-of-events recording (SER) capability with 1 mS resolution. The SER will be envisaged to be performed as an inbuilt function of DCS itself.
h) Perform information processing functions including logging and printout of historical data, trend displays, elapsed time monitoring and summation of fuel and energy usage and generation.
i) Provide a means to coordinate the load control of the prime movers in response to remote dispatch load change requests. Status of all drives, pumps, tanks, etc. should also be available in central control room.

j) The automation offered by the system will include boiler master, boiler ignition control, furnace pressure control, Pulverizes load control etc. and turbine master, turning gear control etc.

Coordinated master control will be used to help achieve such automation and to maintain balance between fuel input in boiler and corresponding turbine generator output. The operator will be able to control the equipment via the station operator's consoles in the central control room. Upon synchronization, the unit will be loaded in any one of the following ways:

a) Manual loading by the operator Automatic loading to pre-select load set points initiated manually by the operator through boiler-turbine coordinated control loop.
b) All emergency trip or runback action will be fully automated. No operator action is envisaged for any protection related logics under routine operation and running of the plant.
c) Alarm and data acquisition will be on-line continuous function. Operator’s action will be limited to accepting the alarm and recognizing the malfunction or upset parameters of any equipment or drives.
d) The control system will provide the schemes and logic for startup, shutdown, and control of plant operation within limits, and will provide protection for the equipment.
e) The hierarchy-based control strategy will be implemented to reduce operator intervention during plant start-up, shutdown, and normal operation without compromising on the equipment protection and safety.
f) Interlock and logic systems will be provided in various hardware and software forms.
g) Process switches / Transmitters (i.e., pressure, temperature, level, etc.) used for protective functions will be connected directly to the DCS, FSSS, etc.
h) DEH based control system shall be used for Turbine Governing system as well as TD- BFP supplied by the Turbine Vendor and TD-BFP Vendor respectively.
i) Turbine Protection & TD-BFP Protections shall be PLC/DCS based control system supplied by their respective Vendor
j) The Control System provides the overall coordination between all the elements of the various protection systems. The Control System provides the following safety-related functions.
k) The Control System will provide the automatic start-up and shutdown of standby auxiliary in a safe, fast and coordinated manner thereby limiting major plant disturbances. The Control System also controls auxiliary plant to prevent damage to main plant components.
l) The Control System provides interlocks and protections thereby ensuring that the capability of all plant in service is to maximum and properly matched thus preventing the unit from reaching potentially hazardous conditions.
m) The turbine control system prevents over speed conditions, inadmissible stress, and other functions to limit operation in potentially hazardous conditions. For critical applications like protection of Turbine, triplicate sensors and Triple Modular Redundant (TMR) hardware (I/O units and processors in failsafe configuration shall be used. The system shall be TUV certified safety system to SIL-3 per IEC 61508.
n) The operators have access to all significant process information and all controls that normally require adjustment through the DCS by a single-window concept sitting at one place. Other packaged systems are interfaced with DCS and monitored for major upset conditions. If necessary, a manual communication (Paging / phone or radio set, as per availability) from

Central Control room (CCR) will be done to take all required corrective action. No control is envisaged for remote balance of plant package from CCR console.

o) The DCS will have various details of plant operating conditions and various operating parameters in the form of alarms, reports, trends and other graphical information. And hence it reduces the operator error.

DCS control system shall consist of measurement system, interlock and microprocessor-based annunciation system for control with the process.

a) Application software to suit the project specification requirement.
b) Laptop with license software shall be provided which is used for engineering services like any logic changes.
c) Engineering software's.
d) Licenses software for all the software being used in the DCS. The software licenses shall be provided for the project and shall not be hardware specific. That is, if any hardware/software is upgraded or changed, the same license shall hold good and it shall not be necessary for employer to seek a new license/renew license due to upgradation / change of hardware / machine in the DCS at the site. All licenses shall be valid for the continuous service life of the plant.

2.4.5.3 BOP Controls

The following sub systems listed below will have dedicated control with provision to operate through Common DCS:

- Coal Handling Plant
- Ash Handling System.
- Raw Water Intake
- DM Plant
- CW Treatment System
- H2 generation station
- Sanitary waste water treatment
- Industrial waste water treatment
- Reuse water treatment / coal bearing water treatment
- HVAC
- Chlorination
- Compressed Air System
- Fire Protection & Detection System.

Commonly used for various sub systems will be communicating to DCS through redundant data link.

2.4.5.4 Steam & Water Sampling and Analysing System

System Function

- To detect and measure the quality of steam & water in thermal system.
- To provide control signals to chemical dosing system.
- To monitor the condenser's leakage.

System Description

Each unit has been equipped one set of steam & water sampling and analyzing system which comprise steam & water sampling rack (WET Panel) and instrument panel (Dry panel).

Sample conditioning system shall be designed and constructed to receive and condition all samples as required by the respective analyzers connected to the sample streams. This shall include all conditioning equipment mentioned herein and covers the following:

- Sample filtering
- Primary and final sample cooling and temperature control
- Pressure reduction and control, as required
- Flow rate control
- Pressure and Temperature Protection
- Other treatment as required by individual analysers or mentioned herein.

All the analyzers shall be microprocessors based with drift free, auto compensation and calibration provision. Analyzers shall have the facility to programme from the front keypad and shall have necessary fault diagnostic features. Each analyzer shall have a self-contained readout meter.

The system design should ensure that pH and conductivity transmitters are mounted close to the respective sensors.

Multichannel analyzers are acceptable only for Silica, pH, Conductivity & dissolved oxygen measurements, as these measurements are more to monitor the trend. In all other measurements, such as, Sodium & Hydrazine measurements, Single channel analyzers must be offered.

Cooling water for steam & water sampling and analyzing system will come from the closed circulating cooling water system.

The sampling points and analysis instruments for each unit are as follows:

- Make-up D.M. Water
- Main C.E.P. Discharge
- Condensate Polisher Unit Outlet
- Deareator Inlet Deareator Outlet
- Feed water at Economizer Inlet
- Main Steam (Left side, Right Side)
- Reheat Steam (Left side, Right side)
- Start-up Separator Drainage
- Closed Circulating Cooling Water
- LP Heater Drainage
- HP Heater Drainage

2.4.5.5 Online Computer Aided Microprocessor Based Machinery Maintenance Management System (OCAMMMS)

The vibration monitoring of all plant equipment is split in four groups:

- Group - A: All BTG HT drives
- Group - B: All BOP HT drives
- Group - C: Turbine/Generator supervisory Instruments (TSI)
- Group - D: Turbine driven Feed water Pump supervisory Instruments (MTSI)

For all the above systems, there will be one common online computer aided microprocessor-based machinery maintenance management system (OCAMMMS). The system shall have predictive analytics for operator guidance.

TSI and MTSI will be two separate system hooked up to OCAMMMS through suitable communication link. Also BOP and BTG HT drives vibration monitoring system will be hooked up to main plant OCAMMMS.

Group - A and B drives as well as raw buffer signals from TSI, MTSI are routed to OCAMMMS through communication for analysis besides the 4~20mA signals connected to DCS / DEH. The important signal required for trip or any other protection related logic, hardwired contracts / analog signals are wired from local condition monitor relay output to DCS or PLC directly. Similarly, turbine / MBFP all related protection contacts are hardwired from TSI / MTSI to turbine / MBFP protection system. Communication links to OCAMMMS from TSI, MTSI will be non-redundant.

It will be used for condition monitoring of main STG, Turbine driven BFP and main plant HT drives / motors. OCAMMMS will take care of predictive maintenance of machine / equipment.

It will also have the capability to be accessed remotely through a telephone line and to interface via Modbus serial or Ethernet link to one or more plant process computers or controllers, as well as to interface with network devices to obtain process data.

The monitoring / protection system will be complaint to API670.

2.4.5.6 AAQMS

The analyzers for the Ambient Air Quality Monitoring System (AAQMS) shall be designed to monitor the NOX, SOX, SPM 2.5/10 to meet the requirements laid down by appropriate regulatory authorities. The system to be provided shall include all necessary hardware, firmware and interfaces, all special and field signals cabling required for implementing a fully functional system.

2.4.6 Civil Works

2.4.6.1 Soil Properties and Load Bearing Capabilities

Detailed Soil Investigation studies would be conducted at site and kind of foundation would be decided in the due course based on local soil strata.

Seismic Considerations:

Seismic load to be considered as per IS:1893 (part-l): 2005 Analysis and design of structures to resist the seismic forces will be carried out as per the provisions of IS:1893. The applicable importance factor of 1.75 will be considered during detailed engineering.

Wind Loading:

The applicable design wind pressure will be computed during design of buildings and structures as per IS: 875 for the zone in which the proposed power station is located. Design wind speed to be considered as 55 m/sec. The applicable design wind pressure, appropriate coefficients for variation with heights and shape of structures will be considered.

2.4.6.2 Power House Building Superstructure:

The main power plant building comprising TG bay (A-B bay) and the adjacent electrical & Deareator bay (B-C bay) will be of steel framed construction upto the roof level. The floor slabs at intermediate levels will be of RCC and supported on steel beams & columns. The TG Bay roof (A-B bay) and side cladding will be provided with 0.5mm pre-colour coated PVF-2. The Deareator bay (B-C bay) will have side cladding of brickwork (cement plastered with architectural finishes); B-row and C-row duly painted. Floor slabs and roof covering of B-C bay will be of cast in situ RCC construction. A-B bay will be equipped with EOT cranes. B, C, D raw wall will be of bricks.

Roof will be provided with suitable drainage arrangement through rainwater down comers, doors, windows and rolling shutters will be provided.

All structural components will be shop welded while the field connections will be made with high-tensile bolts or welding as determined in design stage. The transverse frames will be of framed type. In the longitudinal direction, these transverse frames will be braced to resist horizontal forces.

2.4.6.3 Special Foundation Requirements for Rotating Equipment:

The foundation systems for rotating equipment will be sized and proportioned not to exceed the bearing and settlement criteria and to assure satisfactory performance of the equipment. In addition to a static analysis, a dynamic analysis will be performed to determine the fundamental frequencies of the foundation system. To preclude resonance, the fundamental frequency of the foundation will be 25 percent removed from the operational frequency of the equipment. The dynamic behaviour of the foundation will meet the requirements of IS: 2974 (Part I to IV) - Code of Practice for Design and Construction of Machine Foundations.

All rotating equipment will be provided with vibration isolation spring system mounted foundations. The vibration isolation system supplied will be of proven make, consisting of steel helical spring units and viscous dampers (providing damping resistance in all three planes). The vibration isolation foundation system will be provided for Turbo-generator, Boiler feed pumps, ID/FD/PA fans, Coal mills and Coal crushers.

The vibration isolation system will be capable of vibration isolation not less than 95%. If minor equipment is to be supported on building structures, floors etc. suitable vibration isolation will be provided.

Civil foundations will be designed to take into consideration soil bearing capacity and ground water table. Generally, raft/spread foundations will be considered.

The minimum grades of concrete will be in accordance with the appropriate class of exposure as per IS - 456- 2000. Concrete grade for various works will be –

For decks of spring supported machine foundations and substructure.

- M30 - Foundation chimney shell and substructure of spring supported machine foundation.
- M25 - Structural RCC work in foundations and superstructures, water retaining structures and chimney raft foundation.
- M20 - Grade slab & other miscellaneous items
- M15 - Sub-grade filling, mud-mat etc. (depending upon the aggressiveness of foundation soil)

Brickwork in cement mortar 1:4/1:6 will be used for plant buildings as applicable. Ductile detailing of RCC structures will be as per IS: 13920.

Foundations of all major equipment with vibrating load such as fans (ID, FD, PA), coal mills and coal crusher etc. will be spring supported deck type with supporting framed structure of RCC. Equipment foundation will be separated from the adjoining part of building and other foundations joints at floor/slab will be suitably sealed.

All building will be provided with 1500mm wide and 150mm thick plain cement concrete paving around on the outside. The plinth protection will be laid over prepared sub-base and base.

Steel doors, windows, rolling shutters will be provided with glazing as required. The roads in the plant area will be of adequate thickness and width as per requirement of different areas. It is proposed to have water-bound macadam roads during construction stage and the same will be finished with asphalt surfacing during completion stage. Adequate plant roads/culverts, grading and drainage will be provided. All roads will be designed & provided as per applicable IRC standards.

2.4.6.4 Structural Steel Works:

Structural works will be designed for dead-load plus adequate live-load plus worse of wind load and earthquake load with importance factor of 1.75 and seismic load as per IS 1893:2005 as applicable for zone-III.

Bunker bay will comprise of structural steel framework supporting the coal bunkers, feeder floor and tripper floor. The structural frame will be designed as a fixed joint frame in the transverse direction and braced frame in the longitudinal direction. Coal bunkers will be of structural steel plates and will be lined with stainless steel liner plates in the entire conical portion. The floors will be of reinforced concrete with hardened top and supported on steel beams. The column foundation and mill foundations will be supported on raft/spread foundations. Tripper bay and conveyor galleries will be provided with colour coated sheet cladding.

Stairs, platforms and galleries will be of minimum 900mm width complete with hand rails, toe plate and curbing as required. Stair treads will be of 250mm with 150/190mm height between successive treads.

RCC foundations for Turbo-generators, Boiler feed pumps, (as required) ID/FD/PA fans, coal mills and coal crushers will be provided with vibration isolation systems supporting the top RCC deck to support the machine/equipment.

2.4.6.5 Civil Works for Cooling Tower:

Induced draft cooling tower for each unit to handle approx. 100000 cum/hr water with leak proof underground basin and separation of whole basin in two parts by means of partition wall, internal platform arrangement, hot water duct system and CW channel etc. Suitable draining and pumping arrangement from the drain box outside is provided for sludge disposal. Cooling Tower will be RCC framed structure as per the requirement of BS: 4485-1996 Part I to IV.

2.4.6.6 Civil Works for Coal Handling Area:

Crusher house and Stacker Reclaimer will be constructed. Conveyors galleries, supporting trestles and transfer houses will be of fabricated structural steel work. All components will be of welded fabrication with bolted/welded joints for erection and assembly in the field. Intermediate floors and roof in transfer houses will be of reinforced concrete supported on structural steel framing. Crusher foundation with vibration isolation spring system for isolating the crusher house building will be of RCC frame. Conveyor tunnels will be of concrete box section with provision of appropriate water proofing arrangement.

2.4.6.7 Civil Works for Ash Handling Plant:

The Ash collector & store system will be of RCC construction with RCC columns and beams. The ash hopper will be compartmentalized lined with abrasion resistant liners. Provision for suitable steel inserts will be made for the installation of the pipes, valves etc. The facilities will have the provision for travelling crane of adequate capacity and lift. The blower/compressor room will be separate RCC construction in flat roof construction located close to ESPs to accommodate the blowers/ compressors with its auxiliaries.

Pipe rack for conveying the ash and water pipes to silos will be of structural steel framed construction having its columns mounted on the RCC foundations Foundation for collection tank, pipe rust structures and foundation for conveying system to silos and provision of installing composed air system will be provided.

2.4.6.8 Civil works for Chimney:

One (1) single flue RCC wet chimney for each unit will be provided. The height of the chimney as per MOEF Guideline. The chimney will be fitted with 500 kg capacity elevator, outside staircase. Chimney will be fitted with pollution measuring apparatus & warning lights at top.

Chimney will be provided with lightning arrestor, aviation warning lights as per statutory requirement. The outside of the chimney shell will be painted with acid resistant cement paint. The top of the chimney shell will be painted with alternate red and white bands conforming to Aviation safety Standard requirement.

2.5 Sustainable Development

The Kyoto Protocol, part of the United Nations Framework Convention on Climate Change (UNFCCC), took effect in February 2005. The Clean Development Mechanism (CDM) within Article 12 of the protocol allowed industrialized countries to implement or purchase emission reductions from projects in developing nations and receive Certified Emission Reductions (CERs) as credit. However, the Kyoto Protocol's validity ended with the completion of its second commitment period on 31.12.2020.

Subsequently, the Paris Agreement, a legally binding international treaty on climate change, was adopted at COP 21 in December 2015 and came into force on November 4, 2016. This agreement united nations in combating climate change and adapting to its impacts by striving for global peaking of greenhouse gas emissions as soon as possible to achieve a climate-neutral world by mid-century. The Paris Agreement operates on a 5-year cycle of increasingly ambitious climate actions declared by countries through their nationally determined contributions (NDCs), outlining their commitments to reducing greenhouse gas emissions to align with the agreement's goals.

Article 6 of the Paris Agreement introduces mechanisms to promote efficiency gains based on countries' varying marginal costs of abatement. Article 6.4 envisages a new international carbon mechanism, like the Sustainable Development Mechanism (SDM), under the guidance of bodies such as the UNFCCC, for trading emissions reductions worldwide. This mechanism aims to replace the CDM. Meanwhile, Article 6.2 allows countries to engage in joint market cooperation, facilitating the trading of emission reductions or other climate-related achievements to meet their respective climate targets.

As of now, Article 6 of the Paris Agreement is undergoing finalization and negotiation, anticipated to be operational by 2023. The SDM under Article 6.4 or Bilateral/Multilateral crediting mechanisms under Article 6.2 offer opportunities to earn revenue through greenhouse gas emission reductions. This revenue is crucial in enhancing the Internal Rate of Return (IRR) of climate projects. Therefore, this project intends to leverage the benefits of the SDM or crediting mechanisms under Article 6.2 to improve its IRR once these mechanisms are operationalized.

MBPMPL is operating Anuppur TPP Stage-I (2x630MW) in Anuppur District of Madhya Pradesh. Various activities of the existing station are already having a significant positive impact on the surrounding area. Proposed Anuppur TPP Stage-II (2x800 MW) and allied activities shall further enhance the positive impacts on the achievement of Sustainable Development Goals. Brief on alignment of proposed project activities with Sustainable Development Goals is given as under:

Table 2-6: Sustainable Development Goals

Sr. No.	Proposed Activities under Anuppur TPP, Stage-II (2x800MW)	SDG Coverage
1	Adoption of Ultra Super Critical Technology generating higher energy efficiency resulting in lesser coal & water consumption and lower GHG emissions.	7,8,9, 12, 13
2	Utilization of existing land for main plant components. Land acquisition is proposed for ash ponds only preventing the land use change.	15
3	Provision of state-of-the-art technologies for air pollution control (ESP, FGD, Low NOx Burner, Over Fire Air, Dust Extraction and Dust Suppression etc.)	9, 13
4	Provision of Closed Cycle Cooling System with higher COC of 7.0.	12, 13, 14

Sr. No.	Proposed Activities under Anuppur TPP, Stage-II (2x800MW)	SDG Coverage
5	Provision of Effluent & Sewage Treatment Plant, Reuse/Recycling and compliance to Zero Liquid Discharge norms.	6,7
6	Provisions for Sustainable Waste Management Practices (Reuse/Recycling, Re-processing, Co-processing etc.)	7, 9, 12, 13,14, 15
7	Plantation inside Plant premises and Afforestation in outside Areas.	3, 13, 15, 17
8	Corporate Social Responsibility (CSR) and Community Development (CD) works for the surrounding areas.	3, 4,5, 6, 10, 17
9	Employment Generation and Economic Activities (Direct & Indirect) in the region.	5, 8,10, 17

SDG Goal no.1, 2, 11 & 16 are directly not influenced by the activities of the proposed Anuppur TPP, Stage-II (2x800MW). However, there will be a positive impact on these goals indirectly due to overall development of the area.

3. Baseline Environment

3.1 Introduction

Baseline environment data forms a part of the Environmental Impact Assessment study and helps to evaluate the predicted impacts on the various environmental attributes in the study area by using scientifically developed and widely accepted environmental impact assessment methodologies. Baseline data is also required in preparing an Environmental Social Management Plan (ESMP) outlining the measures for improving the environment quality and scope of future expansions for environmentally sustainable development.

3.2 Study Area and Period

An area of 10km radius (aerial distance) from the boundary of the project area is the study area for the EIA Study. The project site is located at Villages Laharpur, Murra, Guwari, Belia & Jethari, Jethari Tehsil, District Anuppur in Madhya Pradesh District. Features of the project site as seen on toposheet are shown in **Figure 3-1**.

The data collected are used to understand the existing environment scenario around the proposed power project against which the potential impacts of the project can be assessed. The study area is divided into two zones viz core zone and buffer zone where core zone is the Project site and buffer zone is of 10km radius around the project boundary. The study period for baseline data collection for post-monsoon period was **October to December, 2024**.

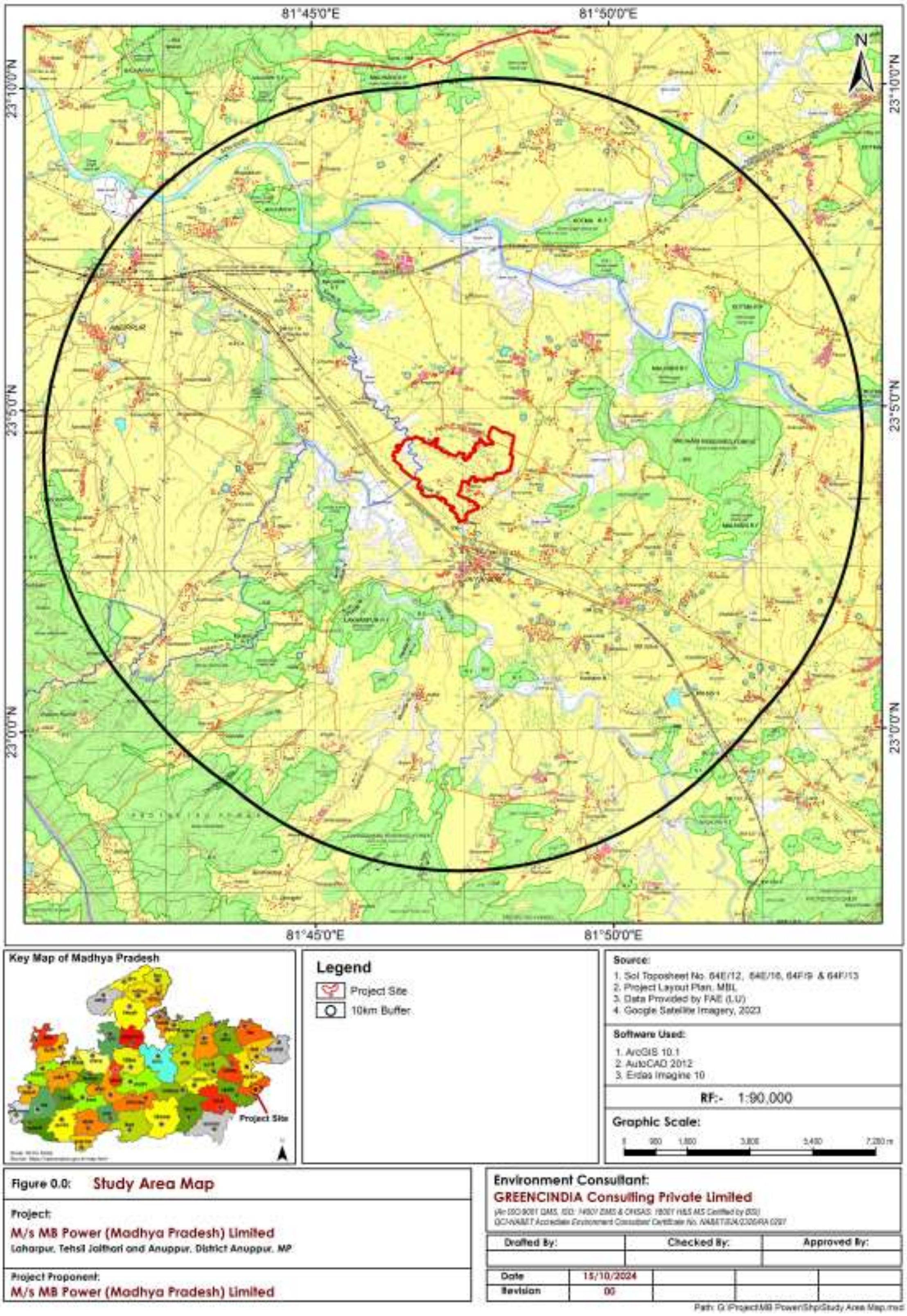


Figure 3-1: Site on Toposheet.

3.3 Methodology Adopted

The baseline study was conducted during the post-monsoon season, 2024 i.e. October, November and December, 2024. A detailed field monitoring study of the project study area was carried out for baseline environment assessment of the project area.

Baseline data was generated for various environmental parameters including air, water (surface and groundwater), land and soil, ecology and socio-economic status to determine quality of the prevailing environmental settings. Sampling of soil and water, monitoring of air quality and noise level and other field data collection were carried out by the team operating from this field station. The field team consisted of technical personnel viz. environmental scientists and social experts along with the field staff. The noteworthy activities completed during the field visit were as follows:

- A meteorological station was setup at project site. Wind speed, wind direction, solar radiation, atmospheric pressure, storm, dry and wet bulb temperature, relative humidity and general weather conditions were recorded throughout the study period in an automated data logger.
- In order to assess the Ambient Air Quality (AAQ), samples of ambient air were collected by installation of Respirable Dust Sampler and Fine Particulate Sampler with gas samplers at different locations from the study area during study period and analysed for primary air pollutants to work out the existing status of air quality.
- Groundwater samples were collected during the study period from the existing hand-pumps, while surface water was collected from rivers. The samples were analysed for parameters necessary to determine water quality (based on IS: 10500 criteria for groundwater and CPCB classification for surface water) and those which are relevant from the point of view of environmental impact of the proposed site.
- Soil samples were collected and analysed for relevant physical and chemical characteristics in order to assess the impact of the proposed plant on soil.
- The noise level measurements were also made at eight locations in different intervals of time with the help of sound level meter to establish the baseline noise levels in the impact zone.
- Ecological data was procured from both primary and secondary sources. A primary data was collected through survey and walkover by ecological experts.
- Socio-economic data was collected from field studies and secondary sources like Census of India 2011, BPL Lists, Revenue Department data, etc.

3.4 Regional And Locational Setting

3.4.1 Project Location

MBPMPL's Anuppur - Thermal Power Project is located on the left bank of Sone River near village Laharpur, Murra, Guwari, Belia & Jethari in Anuppur district of Madhya Pradesh. The site is at a distance of about 10 km from Anuppur dist Head Quarter and is approachable from -NH 43 (Gulganj to Chaibasa) (~10.6 km in N direction). Shahdol town is about 47.6 km from the project. The 10 km radius buffer zone falls in Anuppur District of Madhya Pradesh state the location of study area is presented in **Figure 3-1**. The co-ordinates of the study area are given in the **Table 3-1** and shown in **Figure 3-2**.

Table 3-1: Co-ordinates of the Study Area

Point	Latitude	Longitude
A	23°4'26.01"N	81°46'24.16"E
B	23°4'33.83"N	81°46'43.33"E
C	23°4'31.71"N	81°47'5.72"E
D	23°4'18.91"N	81°47'26.59"E
E	23°4'31.21"N	81°47'47.48"E
F	23°4'42.33"N	81°48'0.23"E
G	23°4'34.40"N	81°48'21.17"E
H	23°4'15.43"N	81°48'20.61"E
I	23°04'1.40"N	81°48'17.87"E
J	23°3'53.38"N	81°48'0.61"E
K	23°3'48.83"N	81°47'36.15"E
L	23°3'39.39"N	81°47'24.95"E
M	23°3'29.16"N	81°47'45.76"E
N	23°3'15.58"N	81°47'33.29"E
O	23°3'14.09"N	81°47'26.06"E
P	23°3'25.63"N	81°47'17.5"E
Q	23°3'34.11"N	81°47'8.316"E
R	23°3'41.08"N	81°46'48.34"E
S	23°3'54.51"N	81°46'41.47"E
T	23°04'4.27"N	81°46'27.95"E
U	23°4'11.78"N	81°46'20.91"E
V	23°4'20.39"N	81°46'21.72"E
Point	**Latitude**	**Longitude**
I	23°3'47.38"N	81°48'52.42"E
II	23°3'48.71"N	81°49'09.96"E
III	23°3'39.16"N	81°49'13.33"E
IV	23°3'38.05"N	81°48'59.32"E
V	23°3'40.99"N	81°48'51.94"E

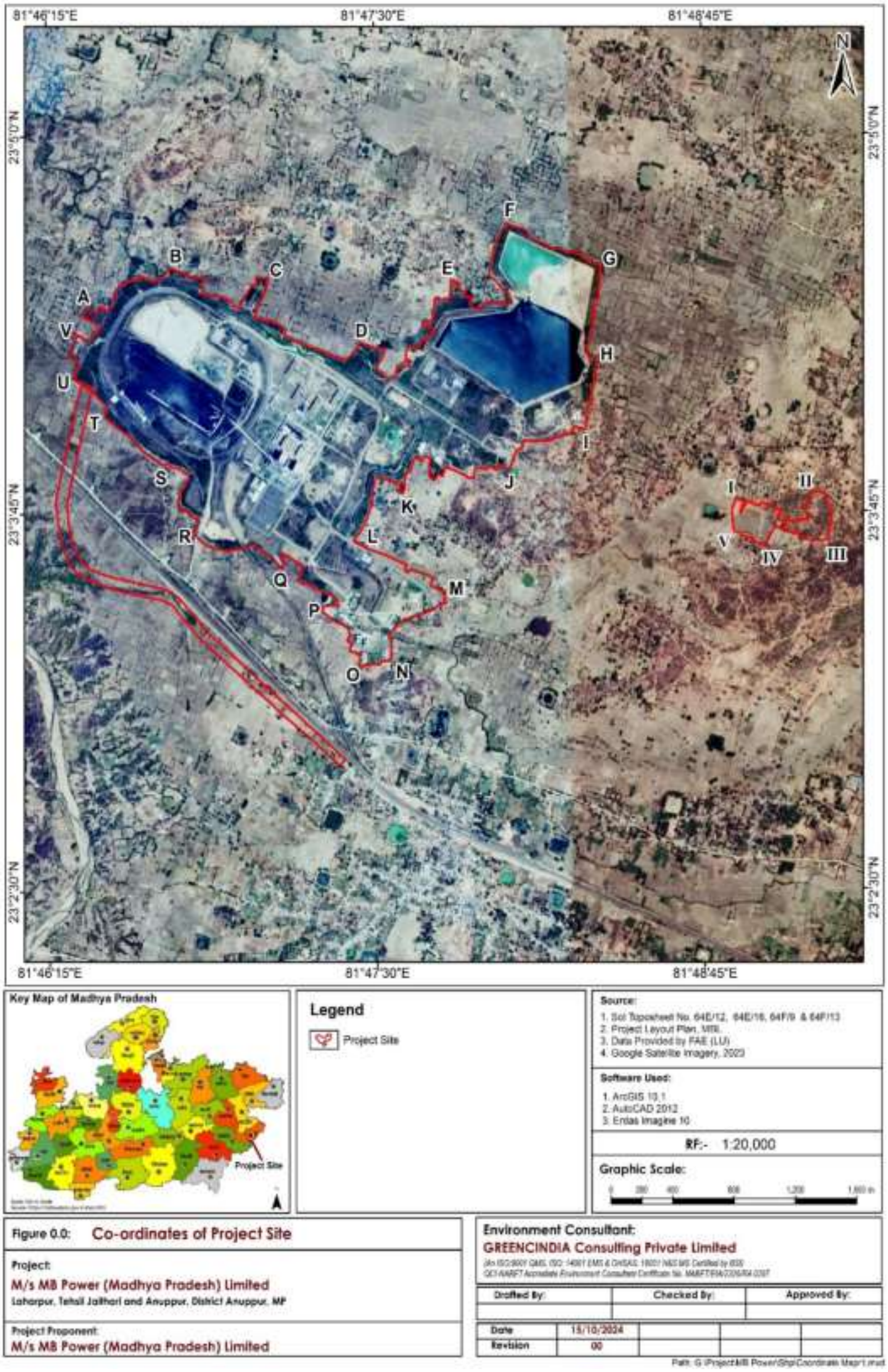


Figure 3-2: Coordinates of Project Site

3.4.2 Site Connectivity

The nearest Railway Station is Jaithari Railway station which is at an approx. distance of 2.6 km SE from the project site. The approximate distances from the nearest commercial airports to the site are 237 km from Jabalpur and 281 km from Raipur. (**Figure 3-3**)

Figure 3-3: Location Connectivity of Project Site.

3.4.3 Environment Sensitivity

There is no National Park, Wildlife Sanctuary or Ecologically sensitive area within 10km of the project site and **Table 3-2 & Figure 3-4** is showing the locations of environment sensitivity.

Table 3-2: Environmental Sensitivity Locations

SL No	Name	Distance in Km	Direction
Rivers and Waterbodies			
1	Kirnar N	Adjacent	
2	Tipan Nadi	1	WSW
3	Gobrar N	1.6	WSW
4	Hansia N	2.9	SSW
5	Son River	4.7	NE
6	Koylar N	5	S
7	Gohirari N	5.6	NNE
8	Taradand Reservoir	9.3	W
9	Gujar N	10.6	ESE

SL No	Name	Distance in Km	Direction
10	Kewai River	11	ENE
11	Bakan Nadi	13.2	WNW
12	Mauhari Dam	13.6	WNW
13	Chachai Lake	14.8	WNW
Forests			
14	Lakhanpur RF	0.127	SE
15	RF	1.8	SE
16	Lakhanpur RF	2	SSW
17	Mauhari RF	2	NE
18	2 RF	3.5	S
19	Mauhari RF near Mahuari	3.6	NW
20	2 RF	5	NE
21	Kotma RF near Kukurgora	5.5	NNE
22	Maikala RF	5.8	SW
23	2 Kotma RF Rahilakachhar	5.9	ENE
25	Dahnadawra RF	6.9	S
26	5 PF, 1 RF	8.1	SE
27	2 PF	8.2	SSE
28	Kotma RF near Kukurgora	8.7	ENE
29	Lakhanpur RF	8.7	WSW
30	Mauhari RF near Bholgar	9.7	NW
31	Nigaura RF	10.4	SE
32	Rampur RF	10.7	N
33	Sulkhari RF	12.2	SSE
34	Munda RF	12.5	SE
35	Maikala RF	12.8	WSW
36	Bamni PF	13.1	NNE
37	Jareli RF	13.3	SE
38	RF, PF	13.6	SE

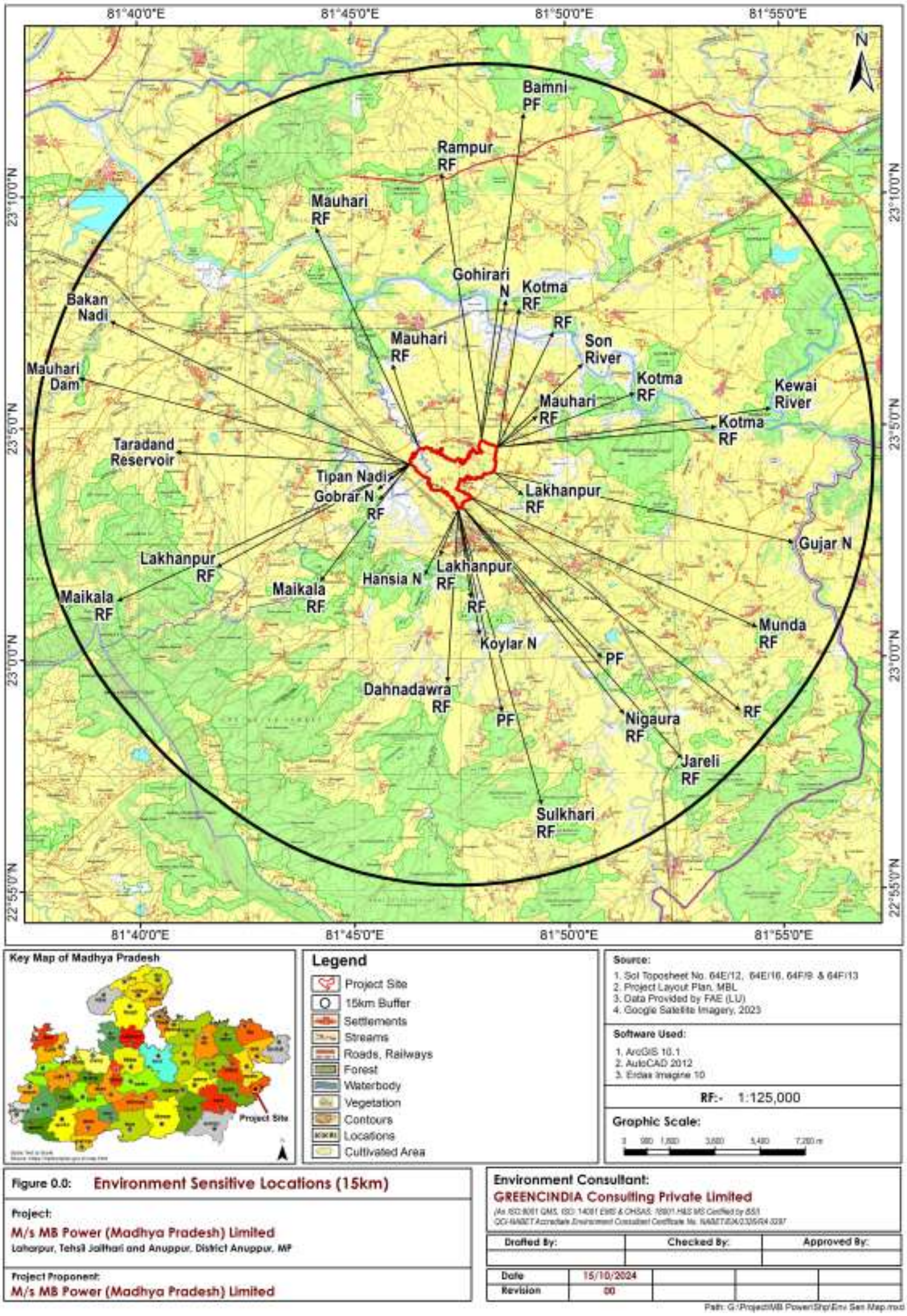


Figure 3-4: Environmental-sensitivity Map of 15 km radius of project site

3.5 Land Use and Land Ownership

3.5.1 Land Use/ Land Cover Details of The Study Area

The land-use mapping of the study area is carried out on the basis of False Colour Composite of ResourceSat II satellite data for Post monsoon Season for the respective years, Survey of India Toposheet, recent Google satellite imagery (2023) and site visit by FAE (LU) which is given in **Table 3-3**. The pie-diagram depicting land use pattern of the study area is shown in **Figure 3-5** while the land-use map is given in **Figure 3-6**.

Table 3-3: Land Use of Study Area for the year 2023

S. No.	Land Use	Area in ha	Area in %
1	Built up	1803.04	3.96
2	Project Site	451.20	0.99
3	Forest	6197.95	13.63
4	Vegetation/ Scrub Land	6641.78	14.60
5	Sandy Area	353.35	0.78
6	Waterbody	929.23	2.04
7	Barren Land	803.19	1.77
8	Agriculture Land	28299.62	62.23
Total Area		**51328.40**	**100.00**

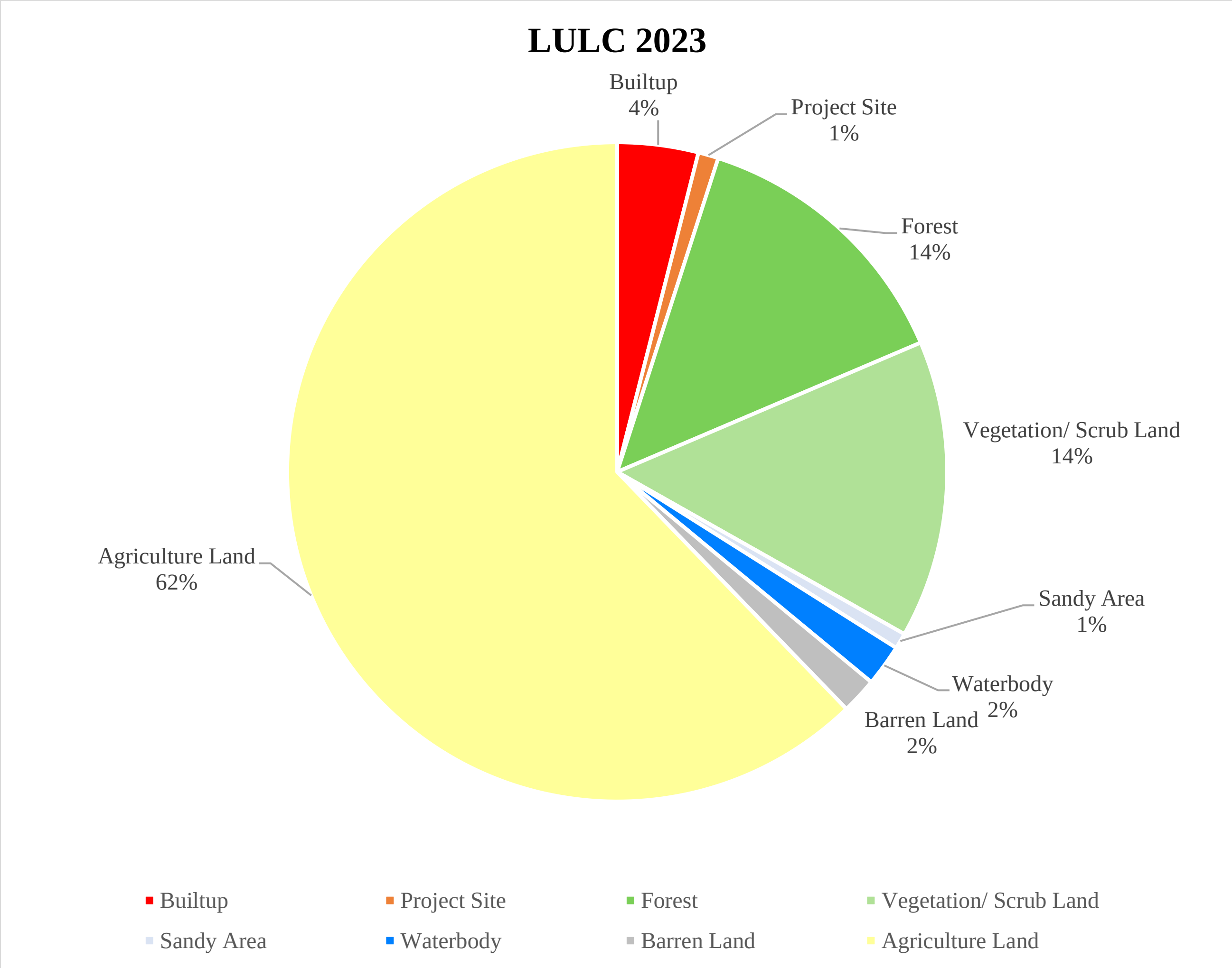


Figure 3-5: Statistical Representation of Land use of study area for 2023

Study Area: A site visit was carried out for the entire project site and the land features were compared with the satellite images and SOI Toposheet for data verification.

From **Table-3.3** showing the Land Use pattern of the study Area has been analysed based on FCC, SOI Toposheet and the graphical projection. The buffer zone of the project site area is of total 45,479.37 ha among which agricultural area is 28299.62 Ha. (62.23%) total study area. The forest land 6197.95 Ha. (13.63%), Scrub land and vegetation is 6,641.78 (13.63%), barren land is 803.19 (1.77%), and plant area is 451.20 Ha. (0.99%) are also crucial land use characters of the study area. About 2.04% of the study area is covered by the water body which covers primarily rivers, channels, ponds and reservoirs. Built up area (1,803.04 Ha) of the study area is which is 3.96% of the total study area.

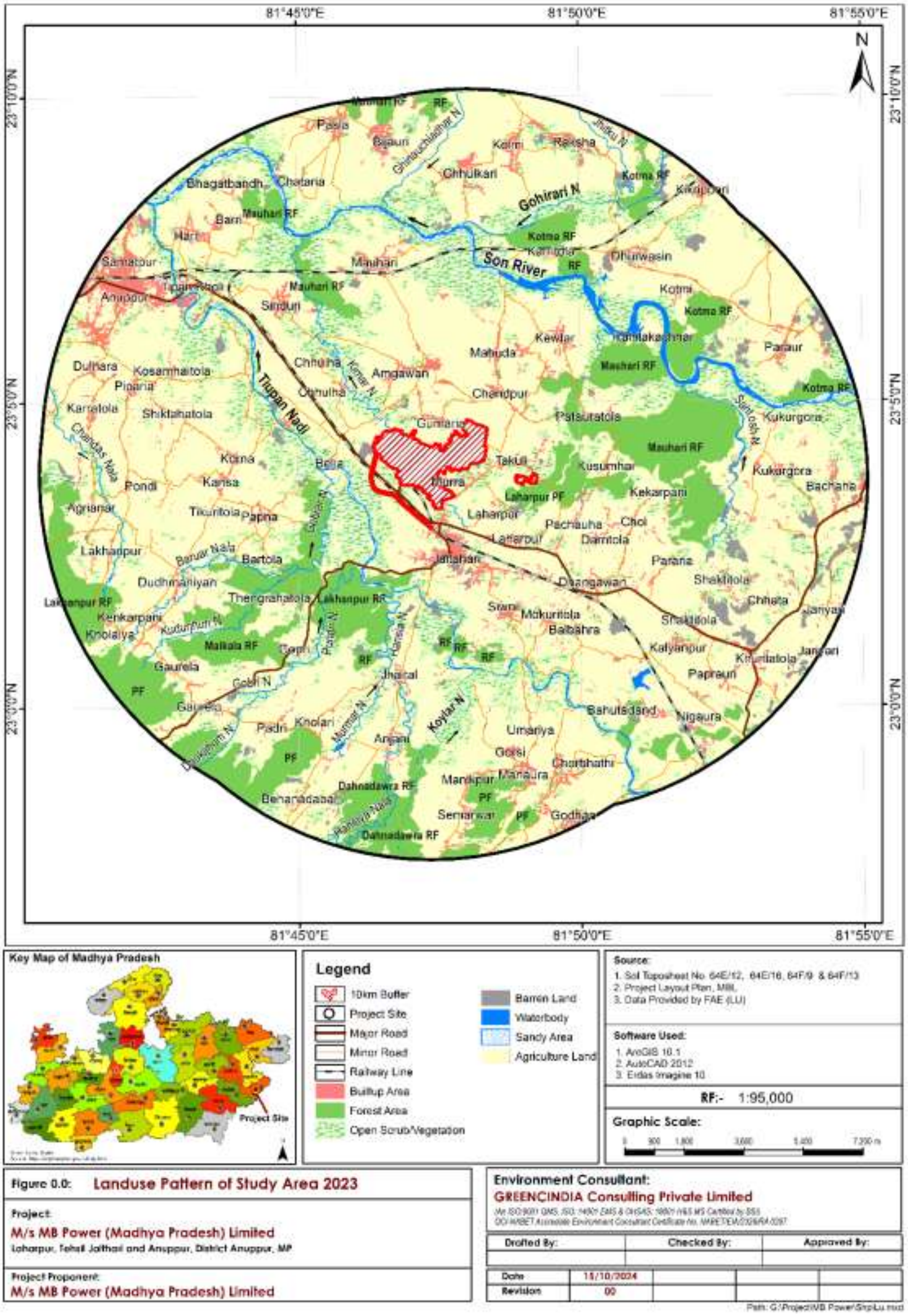


Figure 3-6: LULC Map of the Study area for 2023.

False Colour Composite Map: Ground truth has been carried out to validate the interpretation accuracy and reliability of remotely sensed data, by enabling verification of the interpreted details and by supplementing with the information, which cannot be obtained directly on satellite imagery. Digital image processing techniques like classification of False Colour Composite (FCC) image, were applied for the mapping of the land use land cover classes of the provided area from the satellite data.

Band 2: 0.52 - 0.59 µm (green): This band corresponds to the green reflectance of healthy vegetation and is spanning the region between the blue and red chlorophyll absorption bands.

Band 3: 0.62 - 0.68 µm (red): This red chlorophyll absorption band of healthy green vegetation is one of the most important bands for vegetation discrimination. In addition, it is useful for soil-boundary and geological boundary mapping.

Band 4: 0.77 - 0.86 µm (near infrared): This band is especially responsive to the amount of vegetation biomass present in ascene. It is useful for identification of vegetation types, and emphasizes soil-crop and land-water contrasts.

Discussion: The FCC map highlights various land features within a 10 km buffer zone around the project site, using colour to differentiate between vegetation, water bodies, and urban areas. Vegetation typically appears in shades of red, while water bodies and other features are shown in different colours, to analyse land use and environmental conditions in the region. This map is a valuable tool for environmental assessment, offering a clear visual representation of the area.

3.5.2 Comparative Analysis of Land use

Land Use Land Cover Study for 2016

The same methodology was followed for identification of land use patter for the study area during the post monsoon season of 2016. The result for the land use pattern for the year 2016 is shown in **Figure 3-7 and 3-8.**

Table 3-4: LULC data for 2016.

Land use	Area in ha	Area in %
Built up	958.09	2.11
Project Site	417.00	0.92
Forest	6279.57	13.81
Vegetation/ Scrub Land	8879.86	19.53
Sandy Area	412.99	0.91
Waterbody	975.53	2.14

Land use	Area in ha	Area in %
Barren Land	1290.30	2.84
Agriculture Land	26266.03	57.75
Total Area	**45479.37**	**100.00**

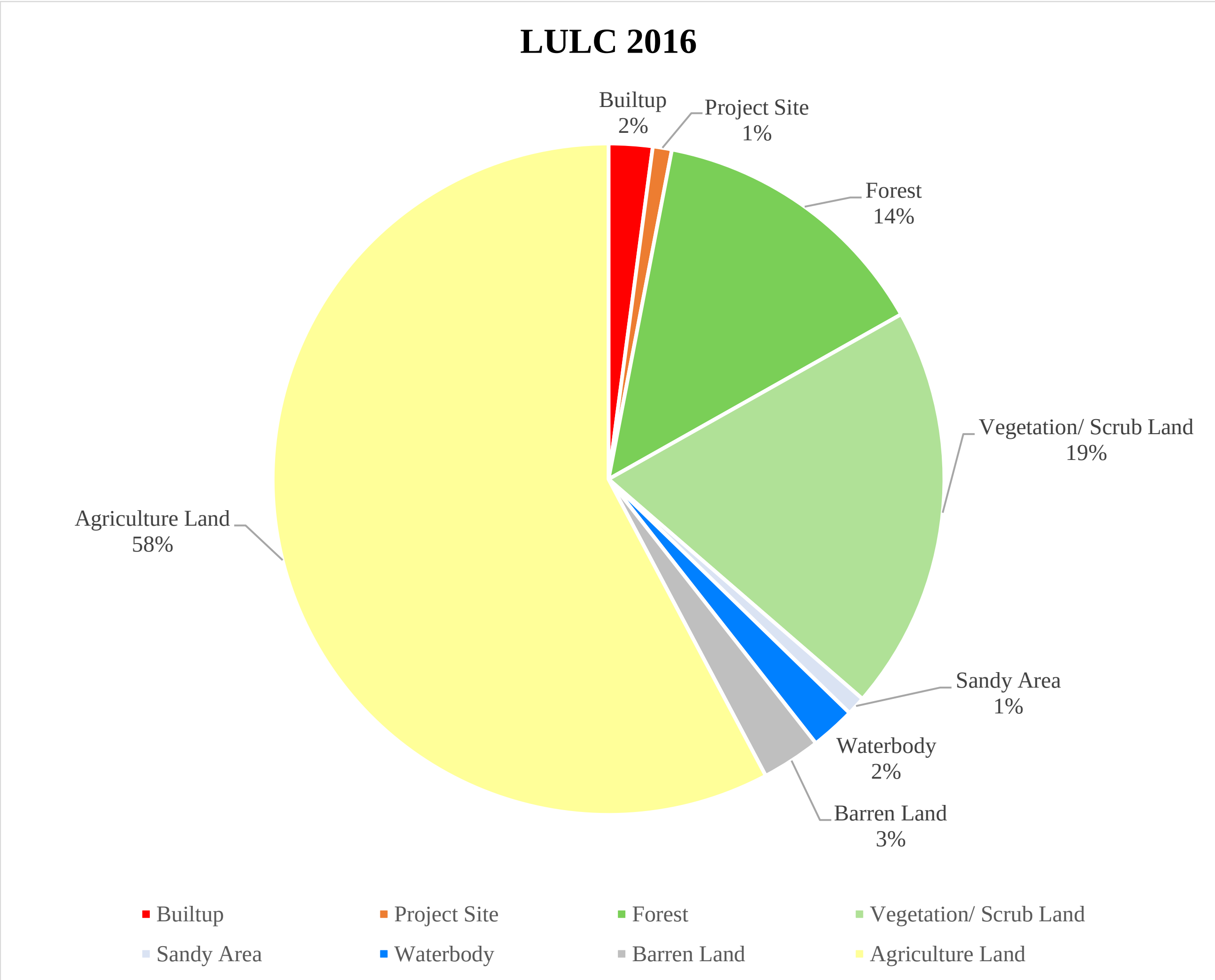


Figure 3-7: Statistical Representation of Land use of study area for 2016

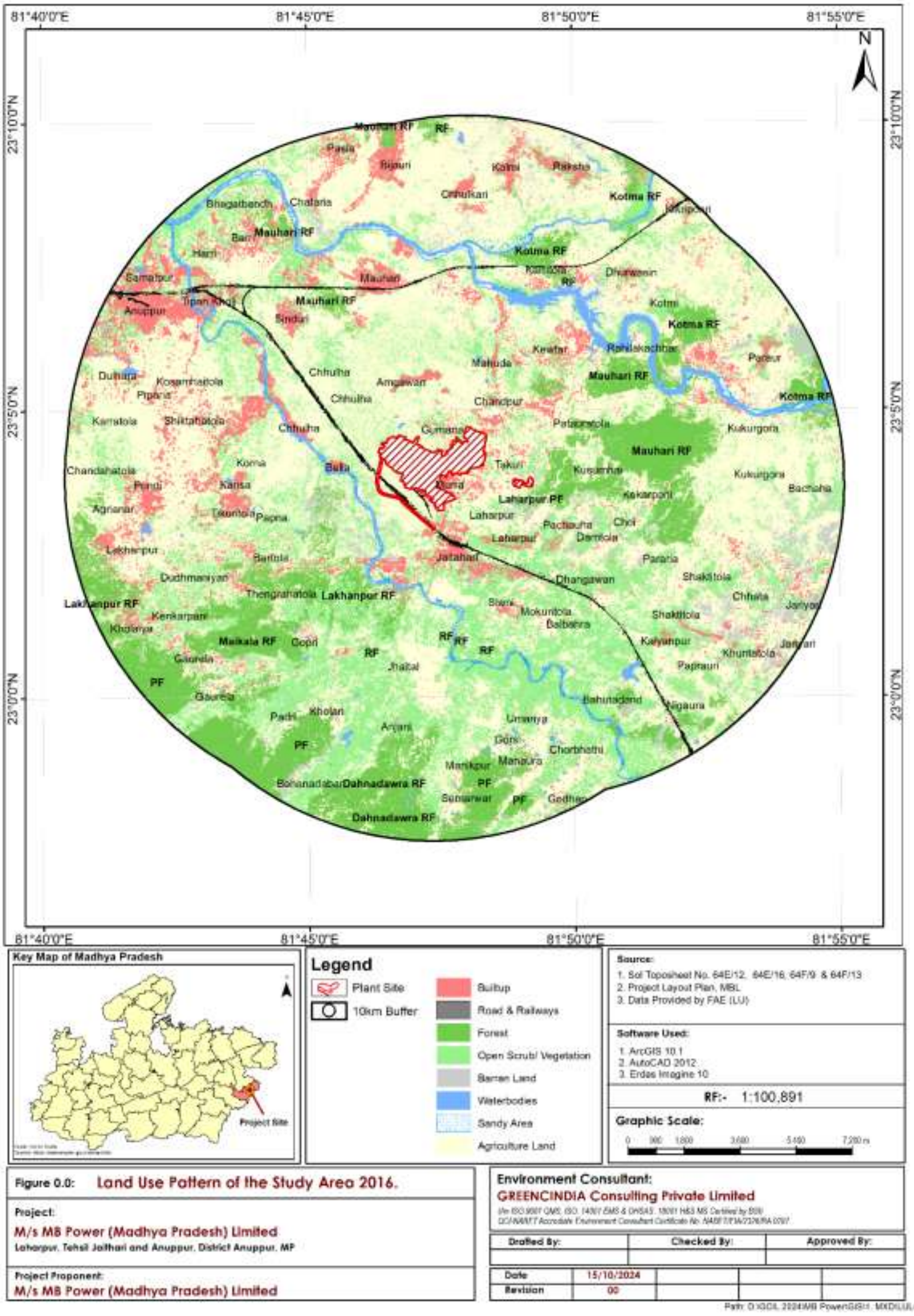


Figure 3-8: LULC for the study area for 2016.

Land Use Land Cover Study for 2010

The same methodology was followed for identification of land use patter for the study area during the post monsoon season of 2016. The result for the land use pattern for the year 2016 is shown in **Figure 3-9 and 3-10.**

Table 3-5: LULC data for 2010.

Land use	Area in ha	Area in %
Built up	836.84	1.84
Project Site	0.00	0
Forest	6333.65	13.93
Vegetation/ Scrub Land	10905.70	23.98
Sandy Area	458.87	1.01
Waterbody	973.97	2.14
Barren Land	1371.91	3.02
Agriculture Land	24598.80	54.09
Total Area	**45479.37**	**100**

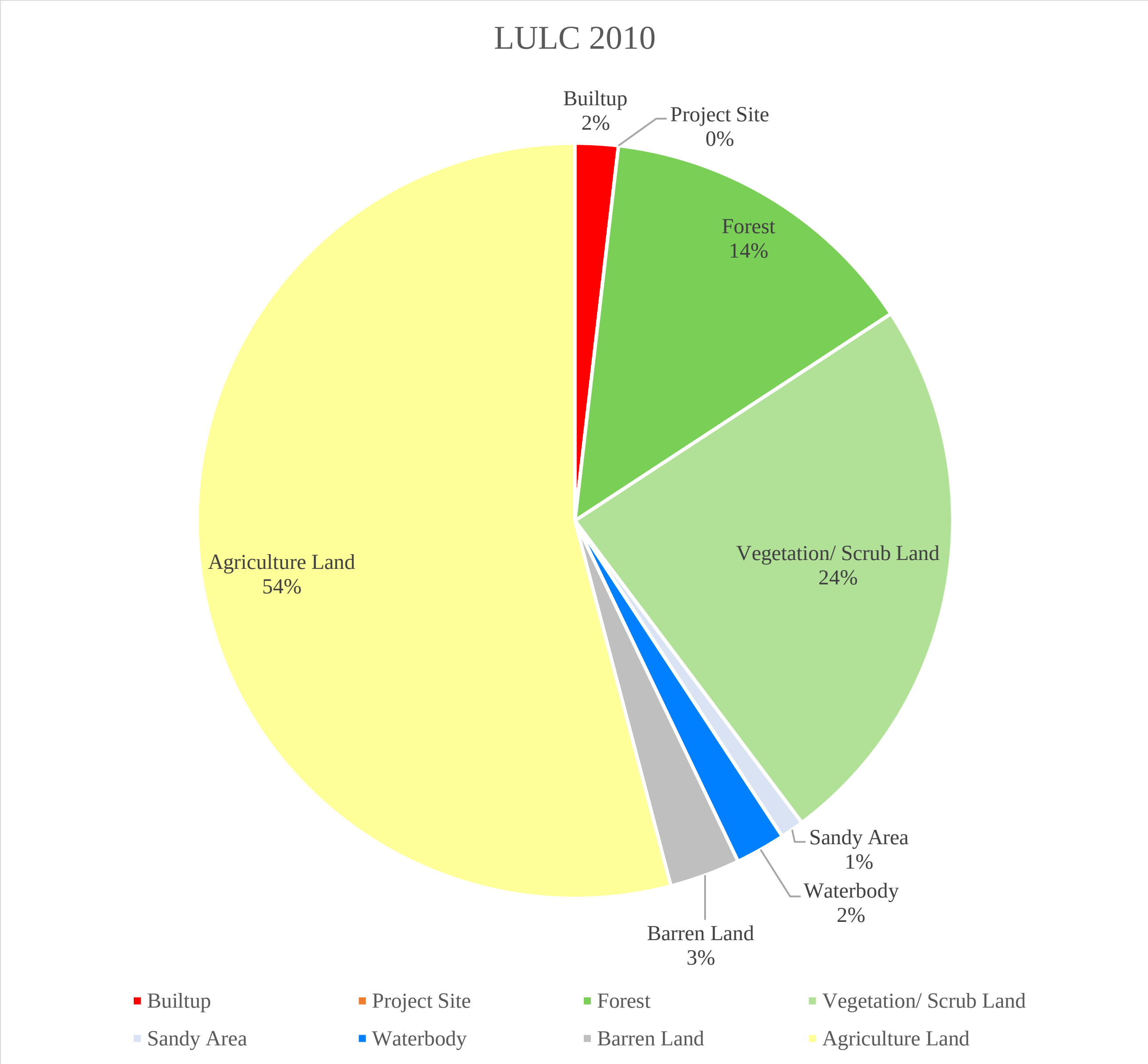


Figure 3-9: LULC Statistics for 2010.

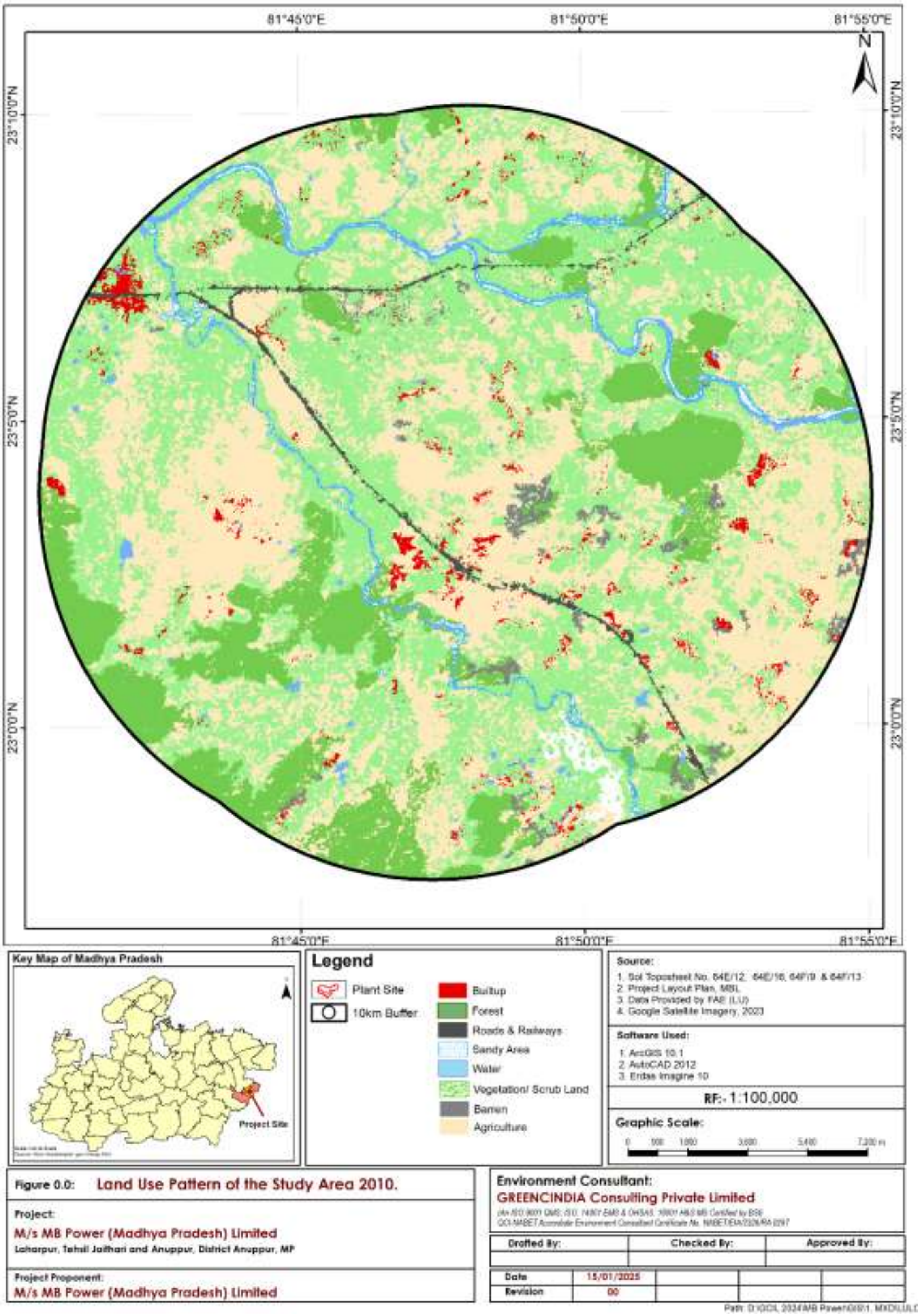


Figure 3-10: LULC Map for the study area for 2010.

3.5.2.1 Comparison of LULC throughout the period of 2010-2023

The observed results for the change in land use in 2023 from 2016 is as follows-

Table 3-6: Comparison of LULC data for 2016 & 2023.

Land use	2010		2016		2023	
	Area in ha	Area in %	Area in ha	Area in %	Area in ha	Area in %
Built up	836.84	1.84	958.0919	2.11	1803.04	3.96
Project Site	-	0	417	0.92	451.202	0.99
Forest	6333.65	13.93	6279.5726	13.81	6197.95	13.63
Vegetation/ Scrub Land	10905.70	23.98	8879.861	19.53	6641.78	14.6
Sandy Area	458.87	1.01	412.9894	0.91	353.35	0.78
Waterbody	973.97	2.14	975.5256	2.14	929.23	2.04
Barren Land	1371.91	3.02	1290.3019	2.84	803.19	1.77
Agriculture Land	24598.80	54.09	26266.0276	57.75	28299.62	62.23
Total Area	**45479.37**	**100**	**45479.37**	**100**	**45479.37**	**100**

The major changes in terms of land use could be observed in Built up, which increased from 1.84% (836.84 Ha) in 2010 to 2.11% (958.09 Ha) in 2016 to 3.96% (1803,04 Ha) in 2023, decrease in Vegetation and Scrub land from 23.89% (10,905.7 Ha) in 2010 to 19.53% (8879.86 Ha) in 2016 to 14.60% (6641.78 Ha) in 2023, decrease in Barren land could also be observed from 3.02% (1,371.91 Ha) in 2010 to 2.84% (1290.30 Ha) in 2016 to 1.77% (803.19 Ha) in 2023. Significant increase in Agricultural land could also be observed from 54.09% (24,598.8 Ha) in 2010 to 57.75% (26,266.03 Ha) in 2016 to 62.23% (28,299.62 Ha) in 2023. Forest land does not have any significant change in land use though slight decline in land area from 13.93% (6,333.65 Ha) in 2010 to 13.81% (6279.57 Ha) in 2016 to 13.63% (6197.95 Ha) in 2024.

3.6 Physical Environment

3.6.1 Physiography

Anuppur is predominantly hilly and forested district. It is picturesque with certain pockets and belt of Sal and mixed forest. The district consists of series of mountain ranges and rivers. It can be divided into three geographical divisions.

1. High land of mountain ranges
2. The central plateau and
3. Low land of valley areas

In general, Anuppur district is characterized by hilly to undulating terrain with altitude ranging between 470m and 1170m, above mean sea level. The main high relief features of the area are the Maikal Range and Maikal Plateau (Amarkantak Plateau) in South-east part of the district covered with deccan Trap Basalts. Some denudational hills/ hillocks are at foot hills of Rajendragram plateau. Linear ridges of intrusive (Dolerites) at north-eastern part, and Plateaus in remaining part of the district. The river Son forms valley in the district.

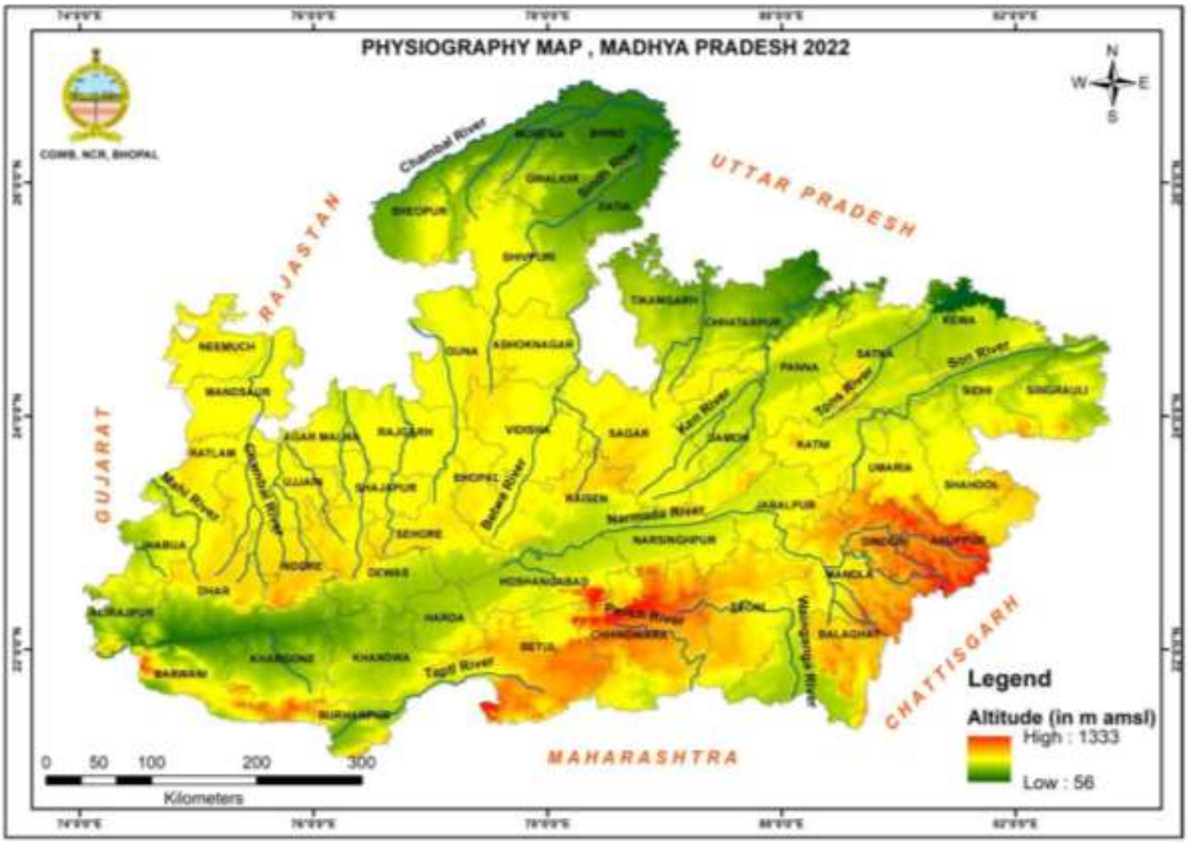


Figure 3-11: Physiography Map

Digital Elevation Model: The map provided in **Figure 3-12** is a Digital Elevation Model (DEM) representing the buffer zone surrounding the Anuppur Super Thermal Power Project, Stage-II (2x800MW), located in Anuppur, Madhya Pradesh. The DEM illustrates the varying elevations within a 10 km buffer zone around the project site, with elevation levels color-coded for easy interpretation. The whole study area ranges from 604m to 396m, with a relative relief of 208m. In the south-west direction, the highest elevation within the 10 km boundary is found at 581- 604 meters. The elevation of the project site ranges from 421m to 460m. The slope of the project site is from the east site to west side.

Slope: The slope within the study area is majorly gentle to very gentle (0-8 percentage). Slope of the study area is very gentle and highly suitable for development. The slope map is given in **Figure 3-14.**

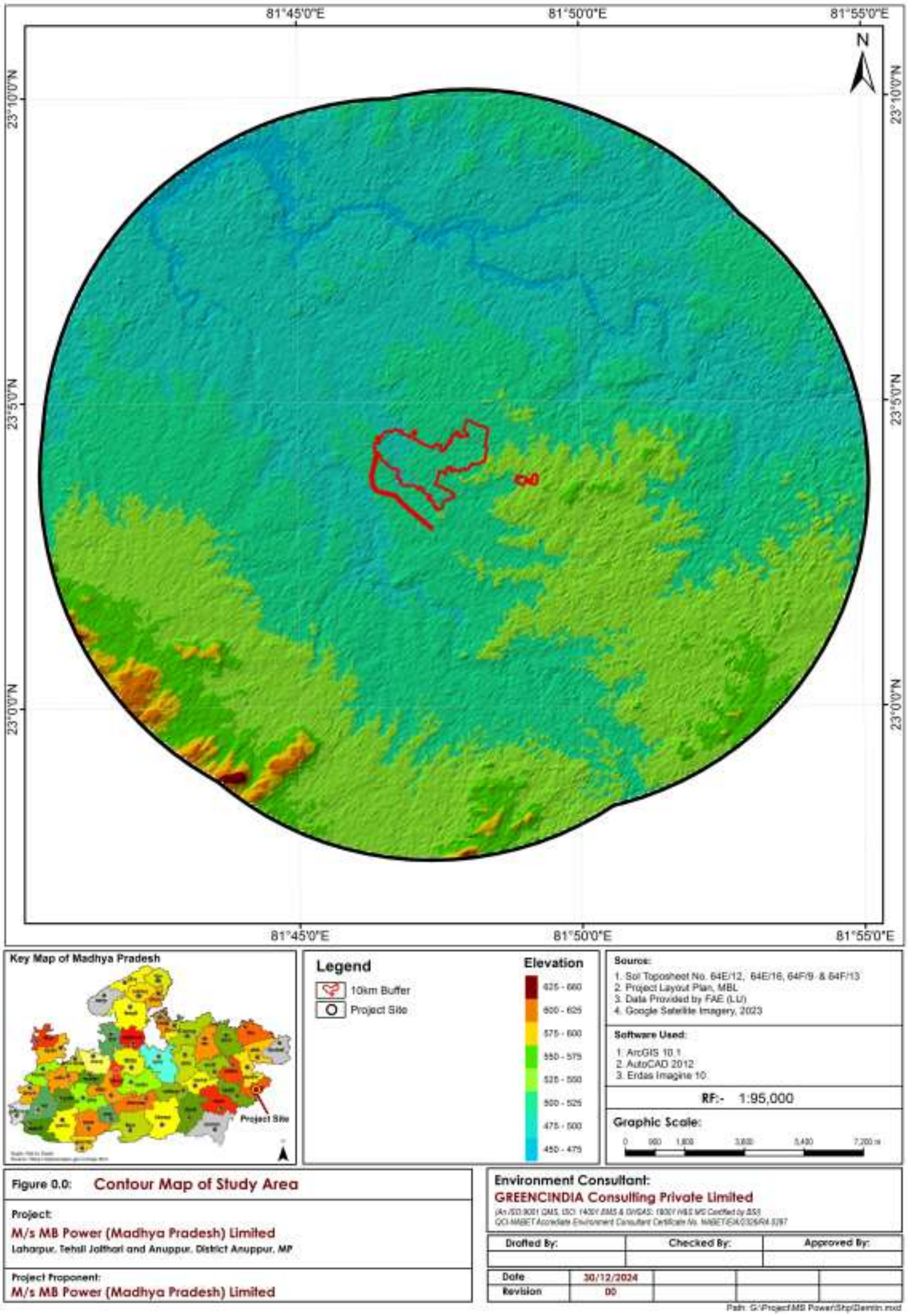


Figure 3-12: Digital Elevation Model map of Study Area

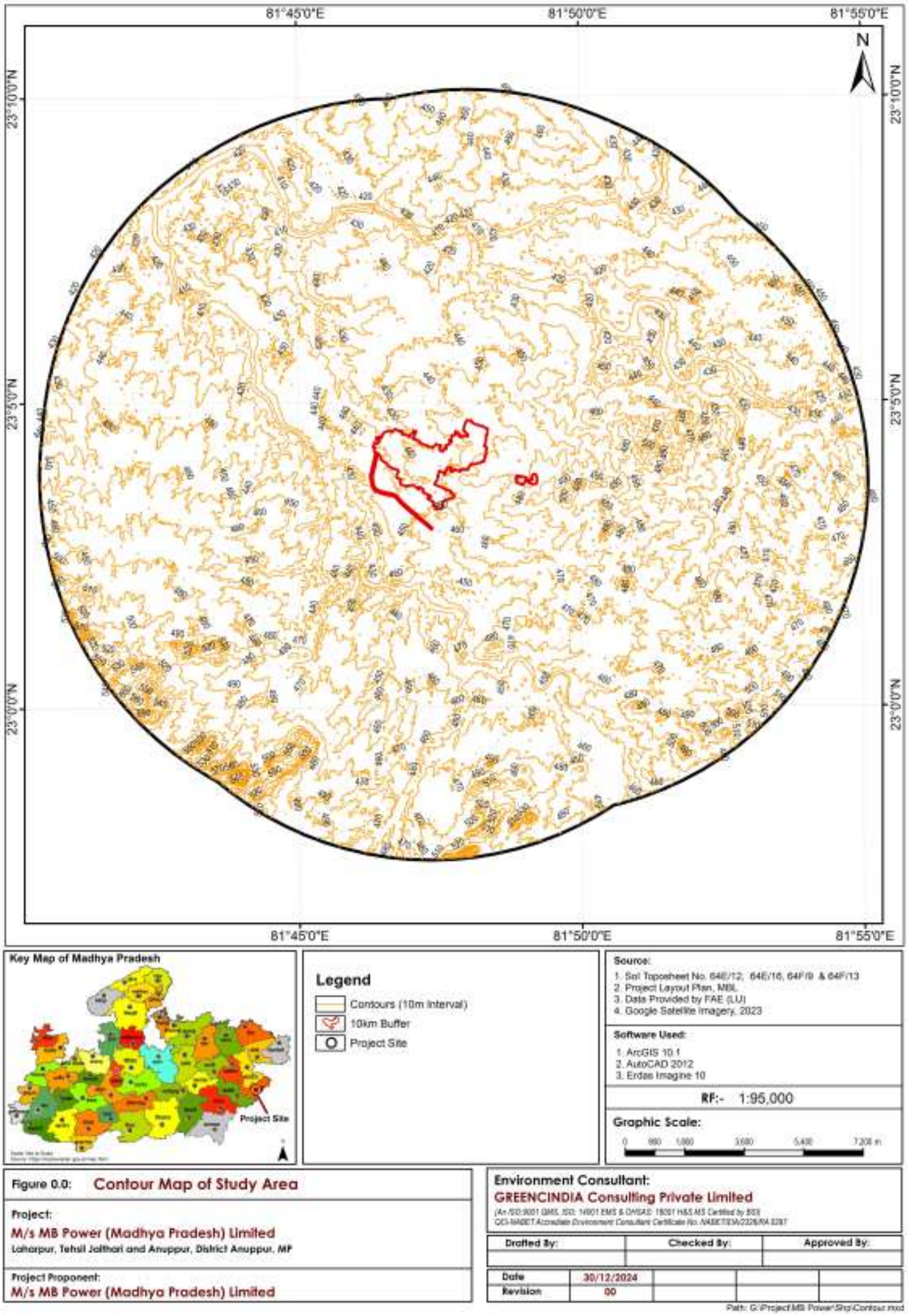


Figure 3-13: Contour Map of the Study Area.

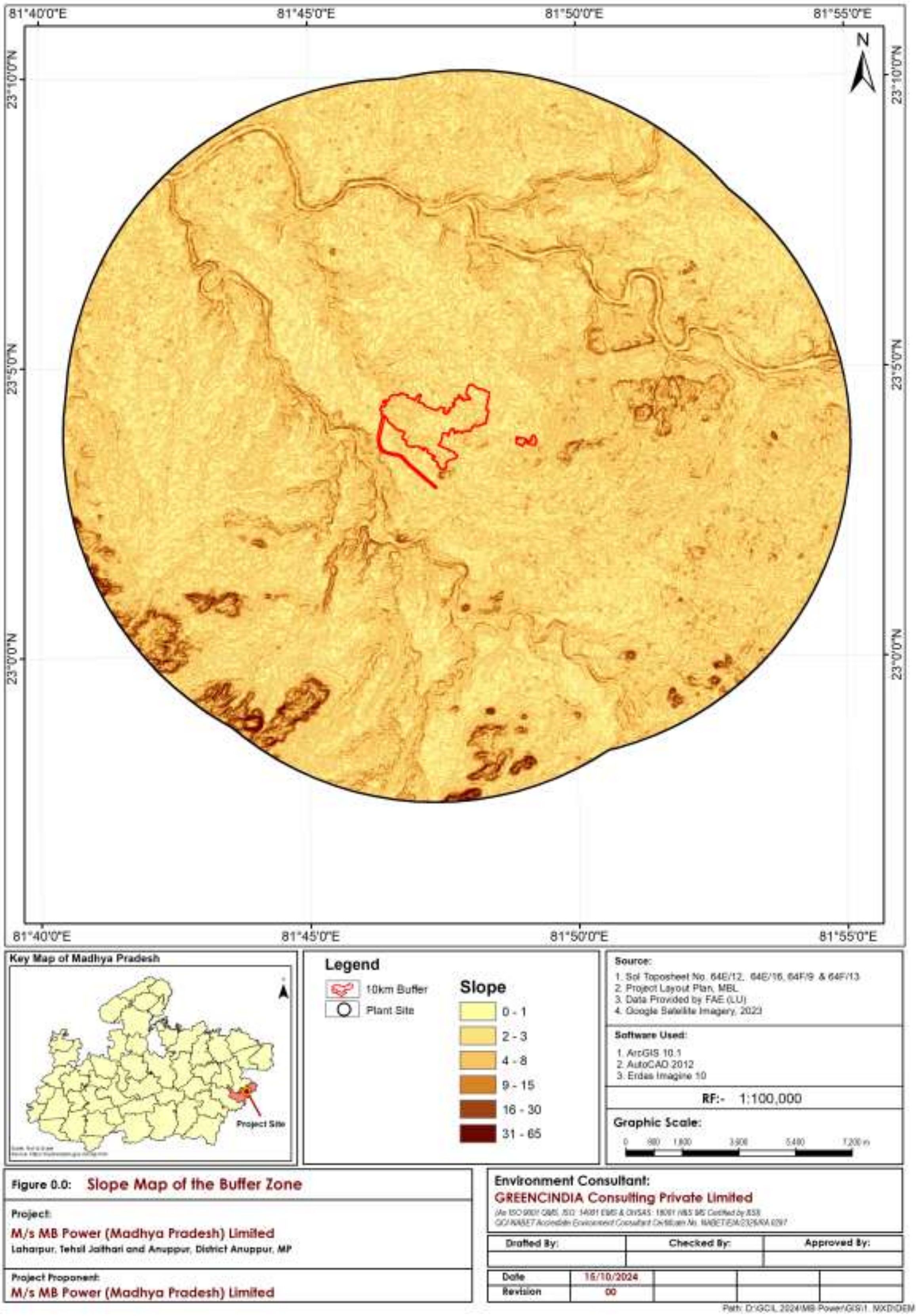


Figure 3-14: Slope Map of the Buffer Area.

3.6.2 DRAINAGE

Drainage of Study area: Two perennial rivers- Son River and Tipan Nadi are flowing from the study area. Son River is flowing from the East to North-West direction and is located at 4.7 km in the North East direction from the project site. Another River Tipan Nadi is flowing from South- East to North West direction and is located at 1 km distance from the project site. One of the tributaries of Son River, Kirnar Nala is flowing through the project site. Other than this major drainage channels other Nala and nadi that are flowing through the 10km study area are Chandas Nala, Baruar Nala, Kudurjhuri N, Gobri N, Pundri N, Hansia N, Koylar N and Hansiya Nala flowing into Tipan Nadi which is further joining into Son River in the North-Western side of the Project Site. The drainages in the study area are arranged in dendritic pattern. The study area has 1st to 5th order streams shown in the **Figure 3.15.**

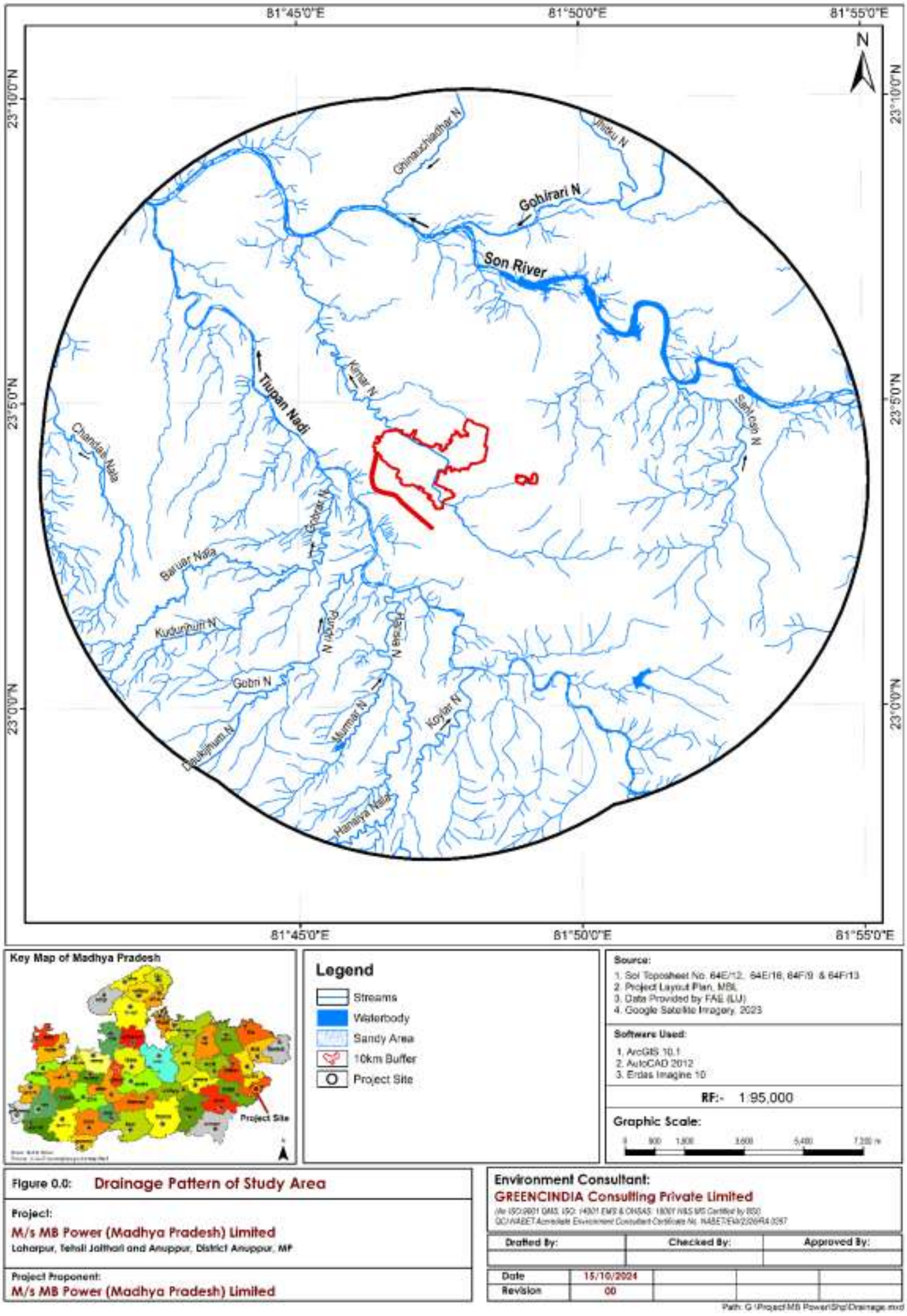


Figure 3-15: Drainage Map of the Study Area.

3.6.2 Geology

The rock formation occurring in the regional geology belongs to Barkar formation of lower Gondwana but many basaltic/dolerite dykes and skills (equivalent to Deccan Traps) cut across Gondwana and Lameta Formations. These Dykes and sills are spread near the surface or spread over the Paleo-topography surface in limited area as basaltic flow and form hills wherever exposed. These are weathered, vesicular, jointed and fractured similar to Deccan Trap basalt without the layering features of basaltic flows. These exhibit scope of groundwater development because of the development of secondary porosity. The yield is limited and varies according to the degree of weathering, weathered mantle, presence of fractures and joints etc. however on drilling a borehole piercing the thin dolerite/ basalt near the base of the hills (dykes/ sill), where the dolerite/ basalt flow pinches, and good yields are obtained from the underlying Gondwana and Lameta formations.

The lithology of the 10 km study area consists mostly of Shale, Sandstone, Clay, Conglomerate, Siltsone, Diamictite and Shale Conglomerate of Lower Gondwana Group of Late Carboniferous to Permian Age. Limestone, Sandstone Conglomerate of Meso-Proterozoic and Neo-Proterozoic age and Chhotanagpur Gneissic Complex of Proterozoic Age could also be found within the study area. The project site consists Majorly of Lower Gondwana Group and Chhotanagpur Gneissic complexes. The Geological map of the study area is given in **Figure: 3-16.**

Table 3-7: Geological successions of Anuppur district

Lithology	Stratigraphy	Age	
Gravel, Unconsolidated sand, Clay	Alluvium	Quaternary	Holocene
Laterite	Laterite		Cainozoic
Dolerite Dykes	Deccan Trap		Creatceous to Paleogene.
Basalt Flows			
Limestone Green/ Felspathic Sandstone	Lameta Group		Cretaceous
Shale, Sandstone, Clay, Conglomerate	Unclassified Gondwana	Gondwana Super Group	Carboniferous to Cretaceous
Sandstone, Siltstone, Shale	Barakar Formation		Permian
Diamictite Sandstone, Shale Conglomerate	Talchi Formation		Carboniferous to Peremian
Bhander Shale	Bhander Group	Vindhyan Supergroup	Neo-Proterozoic
Olive Shale, Gluconie Bed, Limestone, Shale, Porcellanite, Quartzite, Conglomerate	Semri Group		Meso Proterozoic
Sandstone, Conglomerate	Jungel Group		
Ping Granite with Pegmatites, Quartz Vein, Basin Intrusive	Intrusive		
Unclassified metasediments comprising of phyllite, Limestone, Quartzite, Conglomerate, BHQ, Marble, Dolomite, Metabasics, Tuffs and Ash beds.	Mahakaushal Group		Paleo-Proterozoic
Granite Gneisses, Granite			Archaean

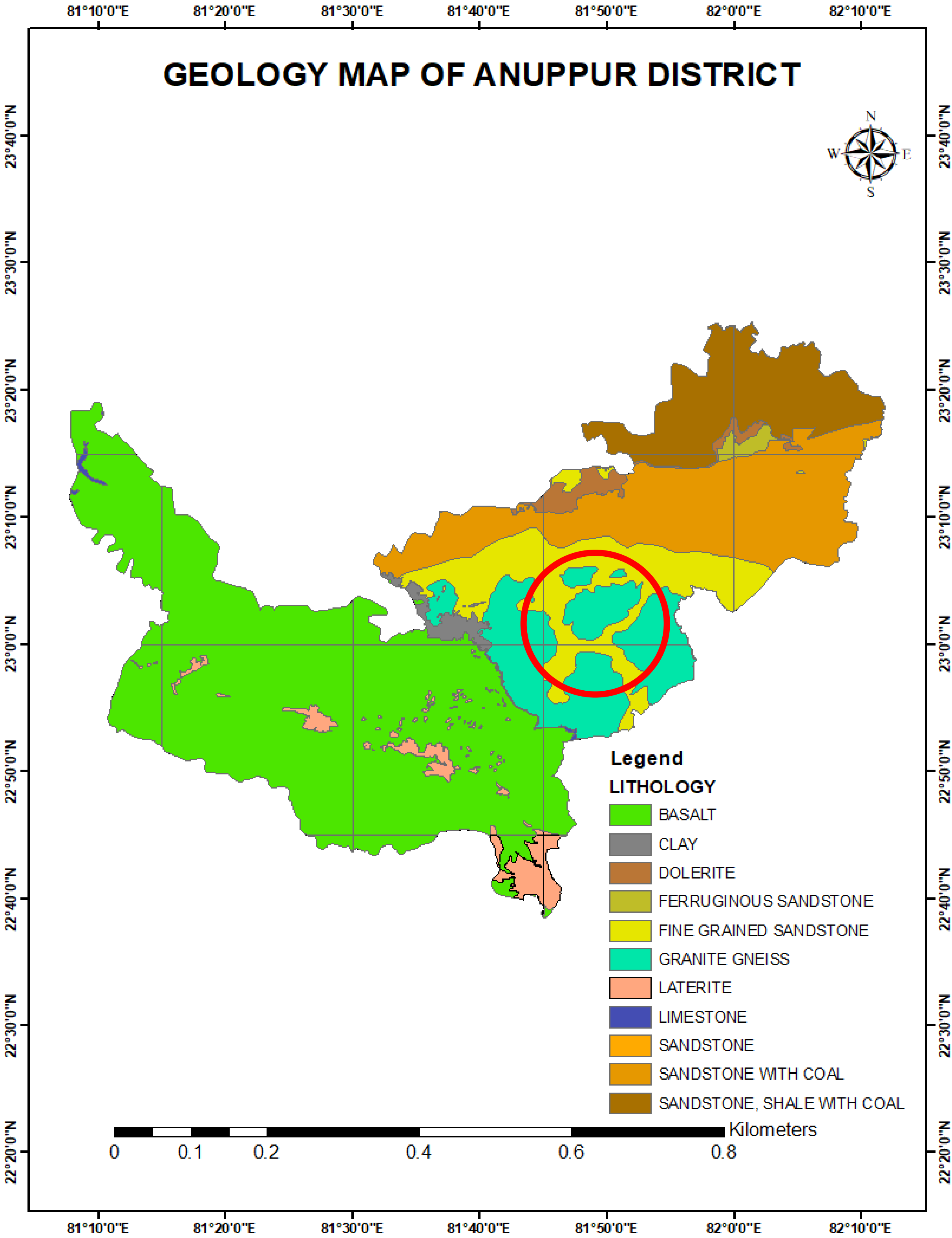


Figure 3-16: Geological Map of Anuppur District.

Source: Central Ground Water Board Report Anuppur district, MP

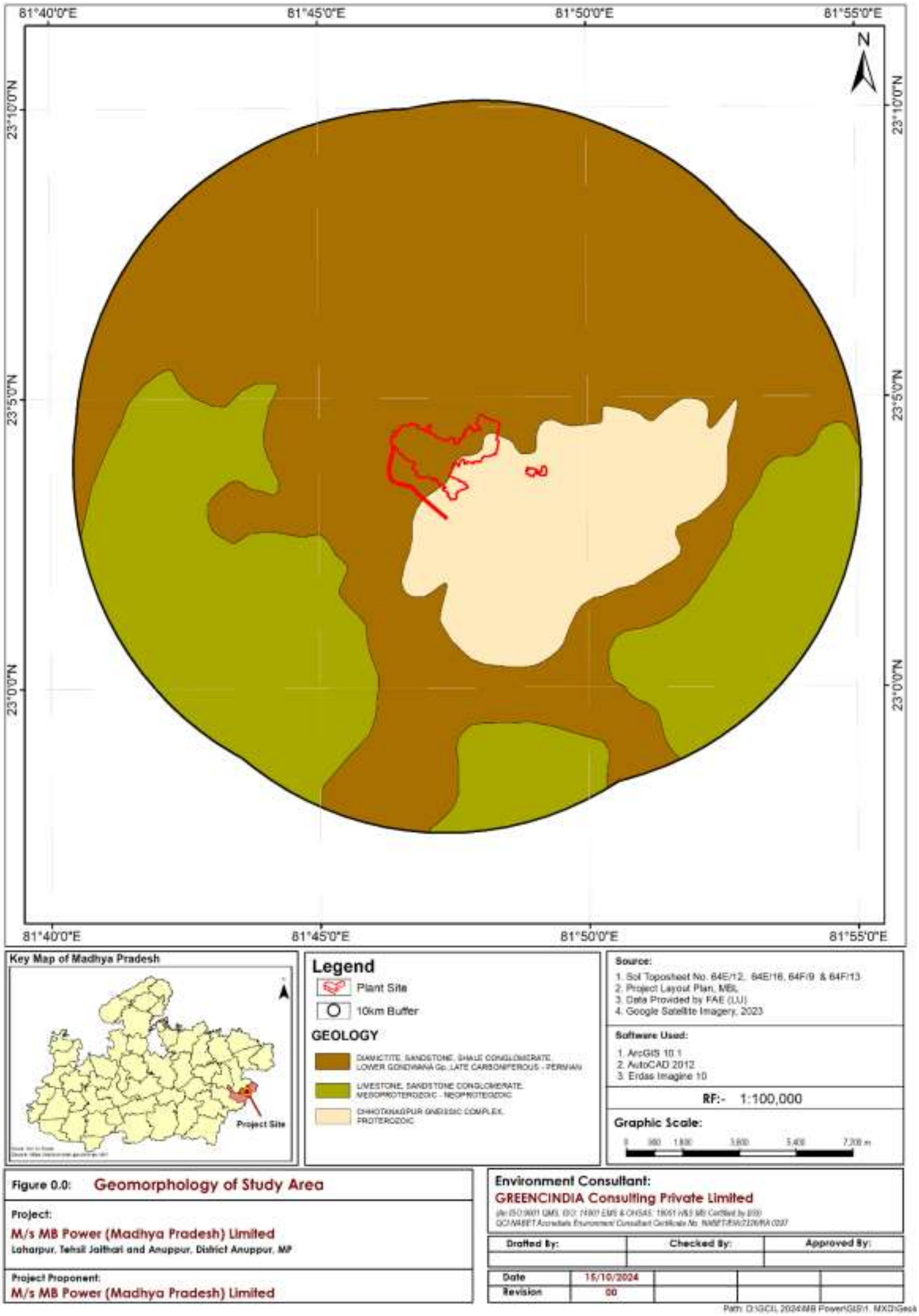


Figure 3-17: Geology of the Study Area.

3.6.3 Geomorphology

Anuppur district is underlain by various geological formations, forming different types of aquifers in the area. Main lithological units of the area are, Archaeans, Gondwanas, Lametas and Basalts. Occurrence and movement of ground water in hard rocks is essentially by development and nature of secondary porosity through joints and fractures. Primary porosity in Gondwana rocks and vesicularity in basalts play and important role. Lametas are also potential aquifers made up of relatively loose and friable material. Ground water in general occurs under unconfined to semi confined conditions. Buffer zone of 10 km radius from the project site comprises of Fine-Grained Sandstone, Granite Gneiss, and Sandstone with Coal. The geomorphology within the study area are majorly Pediment and Pediment-Pediplain complexes with scattered Gullied lands and lateral bars along the Son River, Tiupan River and Fohirari Nadi.

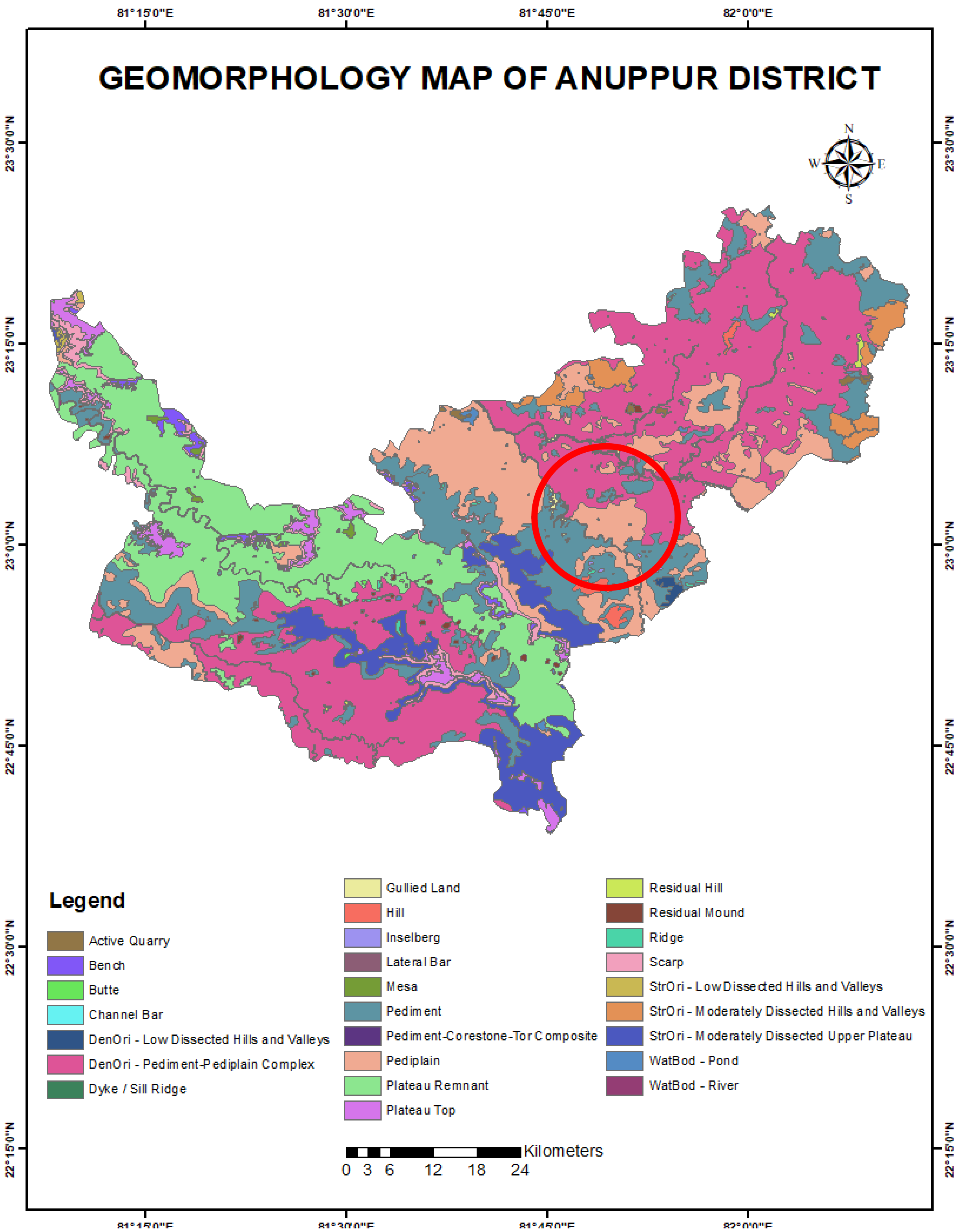


Figure 3-18: Geomorphology Map of Anuppur District.

Source: Central Ground Water Board Report Anuppur district, MP

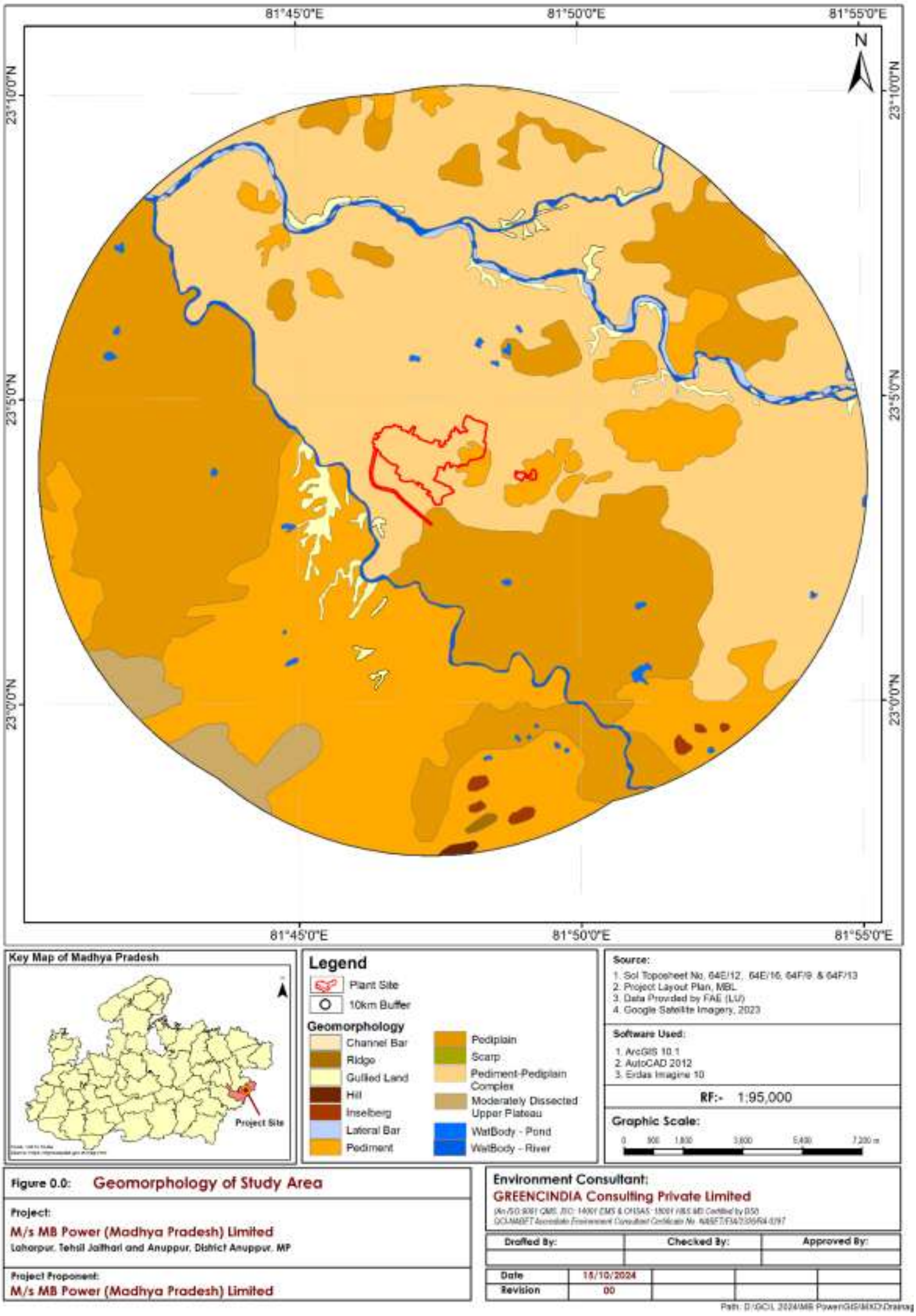


Figure 3-19: Geomorphology of the Study Area.

3.6.4 Soil Cover

The district is mainly covered by three types of rocks, namely basalts, Lameta and Gondwana. Soil is also depending upon lithology of the area. Hence soils of the area have been classified into three groups.

i. Soils of Basaltic rocks
ii. Soil of Lameta rocks
iii. Soils of Gondwana rocks

Soils of Basaltic rocks are occupying major south west part of the area. Soils of Lameta rocks is reported in isolated patch in south west corner of the district surrounded by basaltic soils, Soils of Gondwana rocks are covering north-east part of the district. Soils of three categories are further classified as per the classification of National Bureau of Soil Survey and Land Planning; Nagpur and they are described in the given map. As per the CGWB report on Anuppur district, the study area consist majorly of Loamy soil with clayey soils in the southern part of the study area.

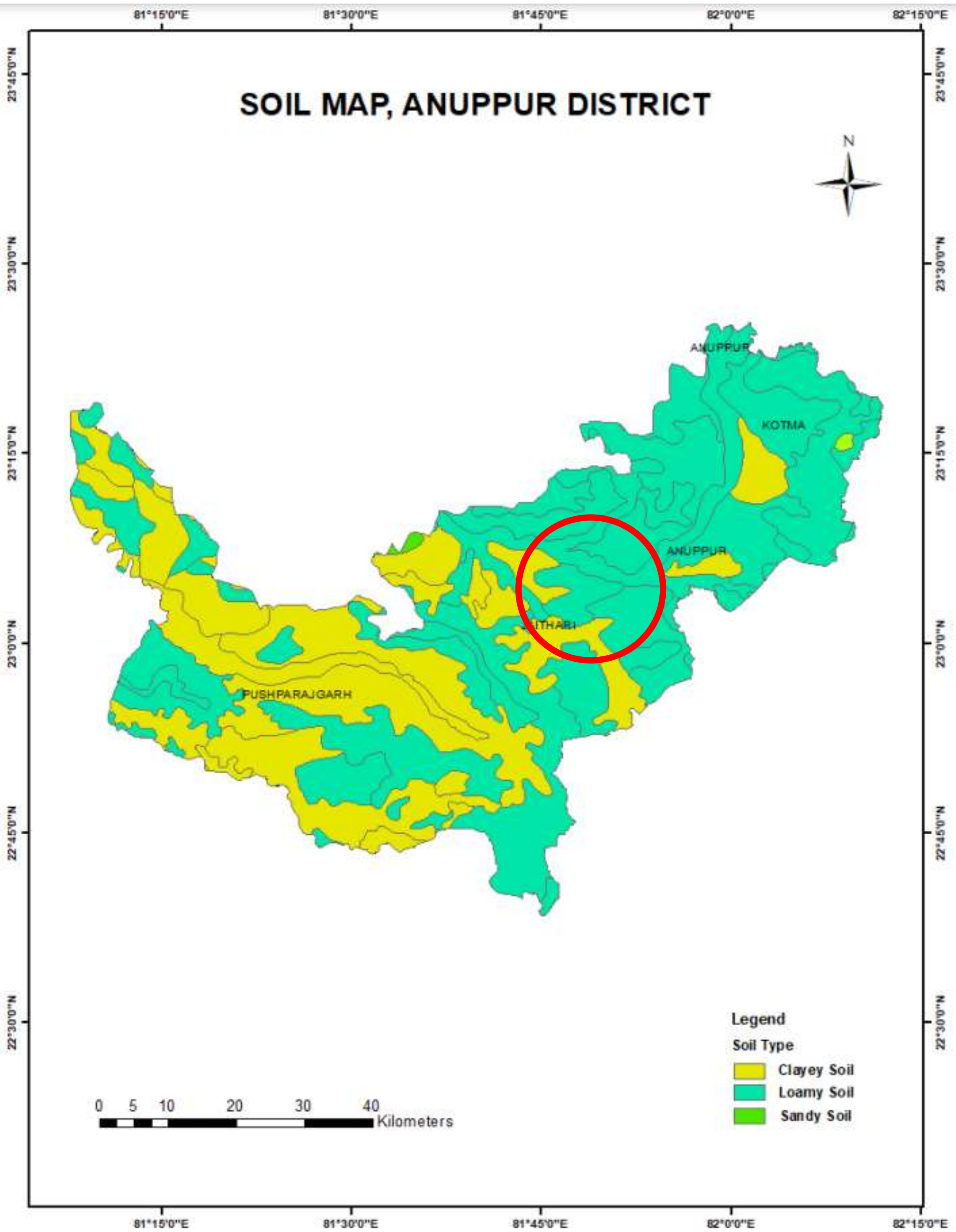


Figure 3-20: Soil Map of Anuppur.

Source: Central Ground Water Board Report Anuppur district, MP

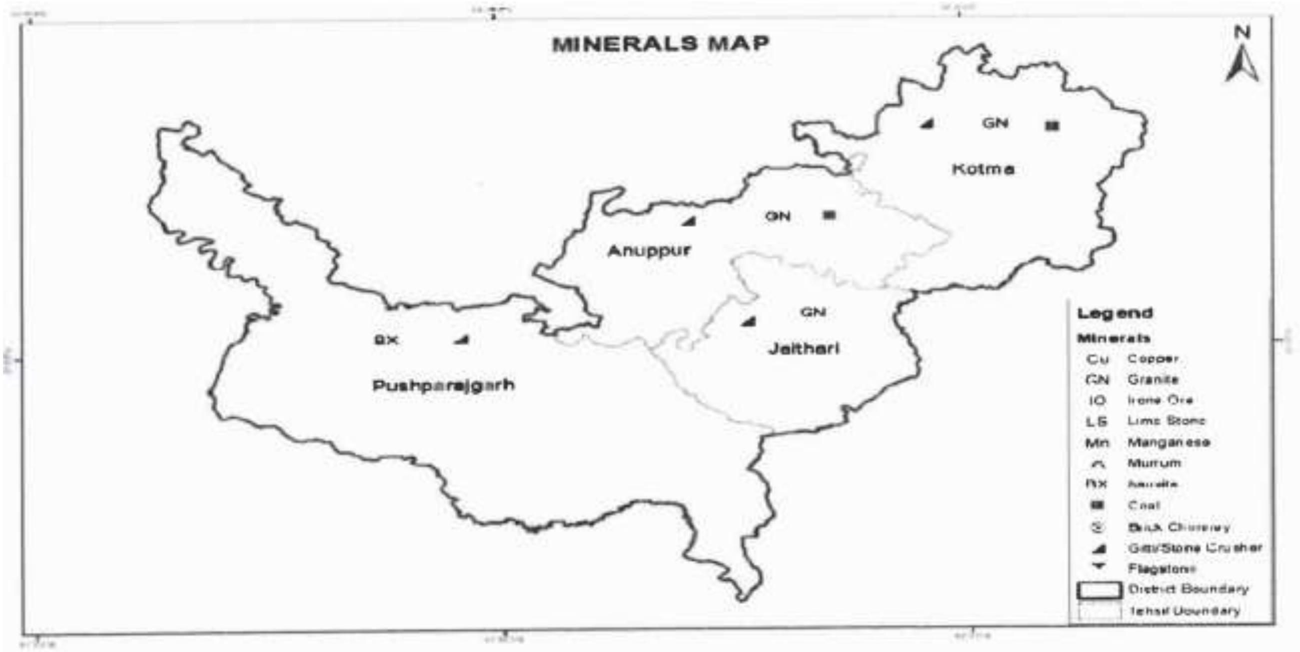


Figure 3-21: Mineralogy Map of Anuppur

Source: District Survey Report of Minor Mineral for Anuppur District, MP 2022

3.6.5 Hydrogeology

Ground water levels form a very important parameter of the Hydrogeology of the system, as these are its physical reflection. Water level data, including historical data area essential for not only to know the present ground water conditions but also for forecasting future trends in response to ground water reservoir operations.

Pre-Monsoon Depth (May 2021)

Pre-Monsoon depth to water level in the year 2021 range from 1.55 mbgl at Nagara Bandh site, Kotma block (minimum) to 15.86 mbgl Venkat Nagar at site, Jaithari block (maximum). In the district 80% area is having the water level ranges from 2-5 mbgl and only in small patch water level is below 10 mbgl.

Post Monsoon (November 2021)

During post monsoon period, water level ranges from 1.25 mbgl at Nagara Bandh site, Kotma Block to 15.86 mbgl at Venkat Nagar site, Jaithari block. In the district about 75%-80% area water level ranges from 1-2 mbgl specially in the block Kotma, Anuppur and Pushprajgarh.

Pre-Monsoon Water Level Fluctuation Map (May 2012-May 2021)

In the district water level fluctuation of 10 years (2012-2021) for the block Pushprajgarh and Jaithari block is below 2m where as for the block Anupppur and Kotma block water level fluctuation is 2-5 m. Only in small patch water level fluctuation is greater than 10 m.

Post Monsoon Water Level Fluctuation (November 2012 – November 2021)

In the district water level fluctuation of 10 years (2012 -2021) for the block Pushprajgarh, in small part of Jaithari block and Kotma block ranges from 5-10m whereas in the Jaithari block and some part of

Anuppur block water level fluctuation is 2-5m. Only in small patch water level fluctuation is greater that 10m and below 2m.

Table 3-8: Ground Water Categorisation (CGWB, 2022)

Tehsil	Ground Water Extraction for			Annual GW Allocation for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categoriza-tion
	Irrigation Use (Ham)	Domestic Use (Ham)	Total Extraction				
Jaithari	3450.6	467.6482	3918.25	501.91	7920.09	33.0	Safe
Anuppur	1228.608	364.1401	1592.75	390.82	6832.23	18.85	Safe

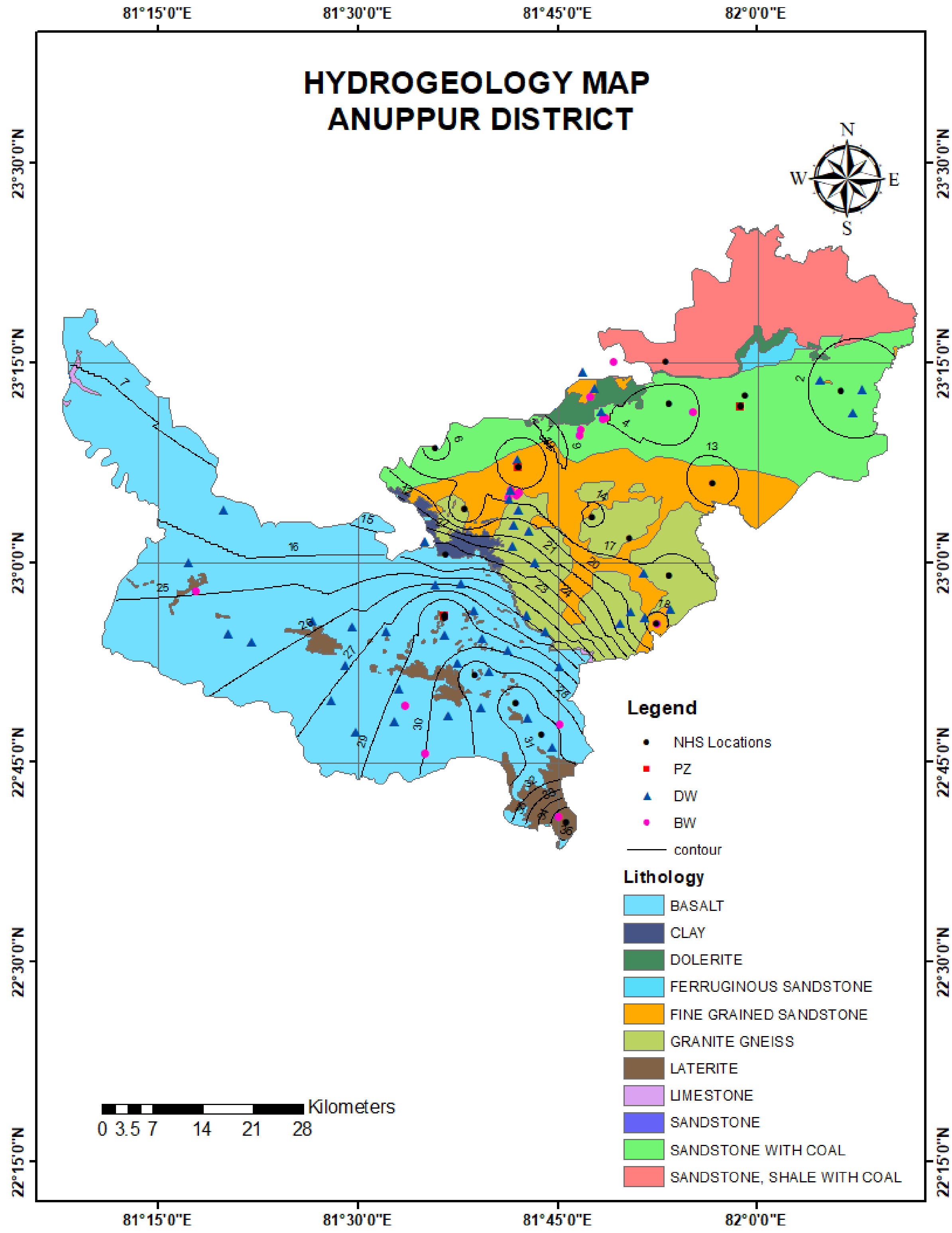


Figure 3-22: Hydrogeology Map of Anuppur.

Source: Aquifer Mapping and Management of Ground Water Resources, Anuppur District 2021-22

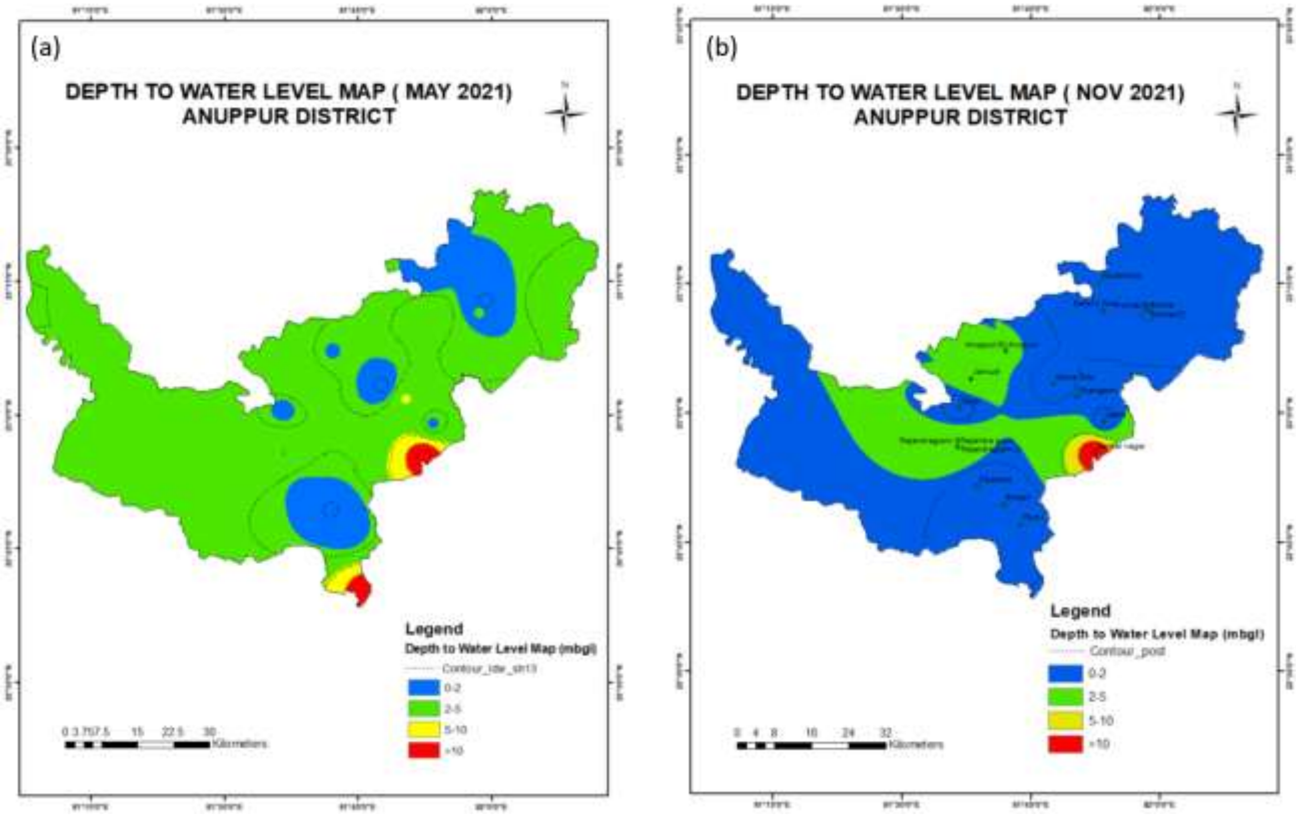


Figure 3-23: Depth to Water level during (a)Pre-monsoon Season and (b) Post Monsoon Season in Anuppur District.

3.6.5 VULNERABILITY OF STUDY AREA

The earthquake vulnerability atlas and wind vulnerability atlas of Madhya Pradesh are provided in **Figures 3-24** and **Figure 3-25** respectively. The entire state of Madhya Pradesh falls in seismic zones according to the vulnerability atlas of India[1] viz., Zone II: Low Damage Risk Zone (MSK VI or less) to Zone III: Moderate Damage Risk Zone (MSK VII). The district Anuppur has fall under Zone III: Moderate Damage Risk Zone. The project site falls in moderate damage risk zone.

According to the wind vulnerability atlas, Madhya Pradesh falls in High Damage Risk Zone - A (Vb=47 m/s) to Moderate Damage Risk Zone B, where Vb is the basic wind speed. Anuppur district as well as the project site fall in Moderate Damage Risk Zone B (Vb= 39 m/s).

[1] https://vai.bmtpc.org/th.html

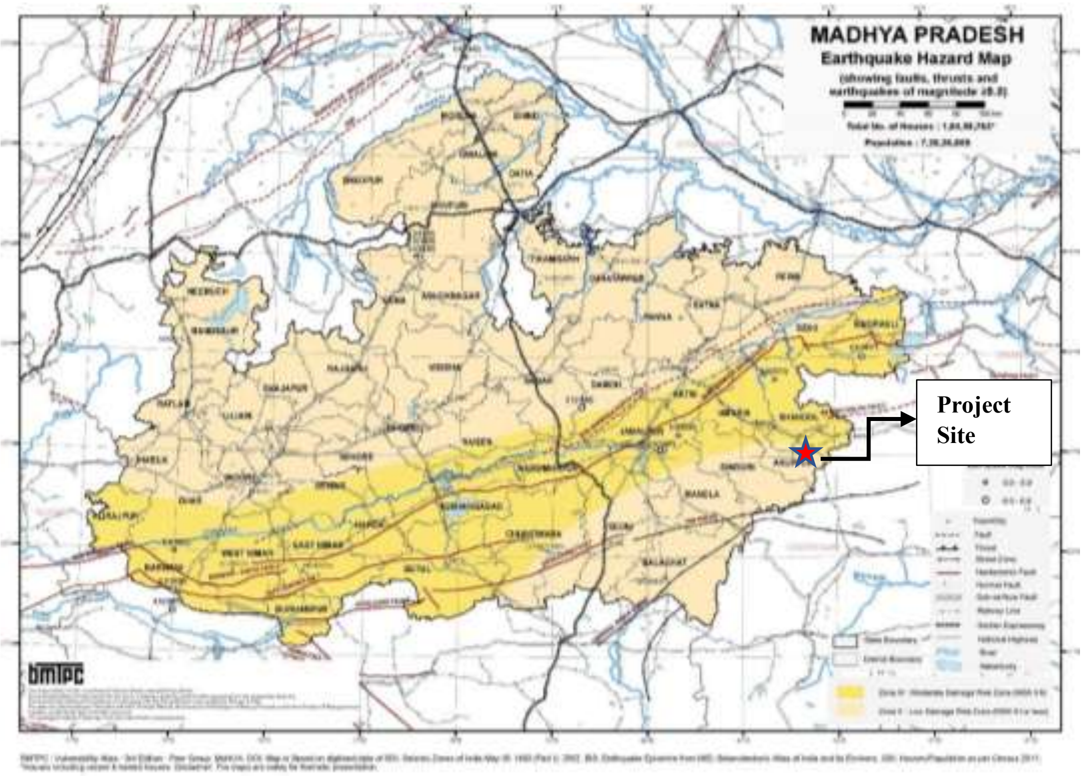


Figure 3-24: Earthquake Hazard Map of Madhya Pradesh.

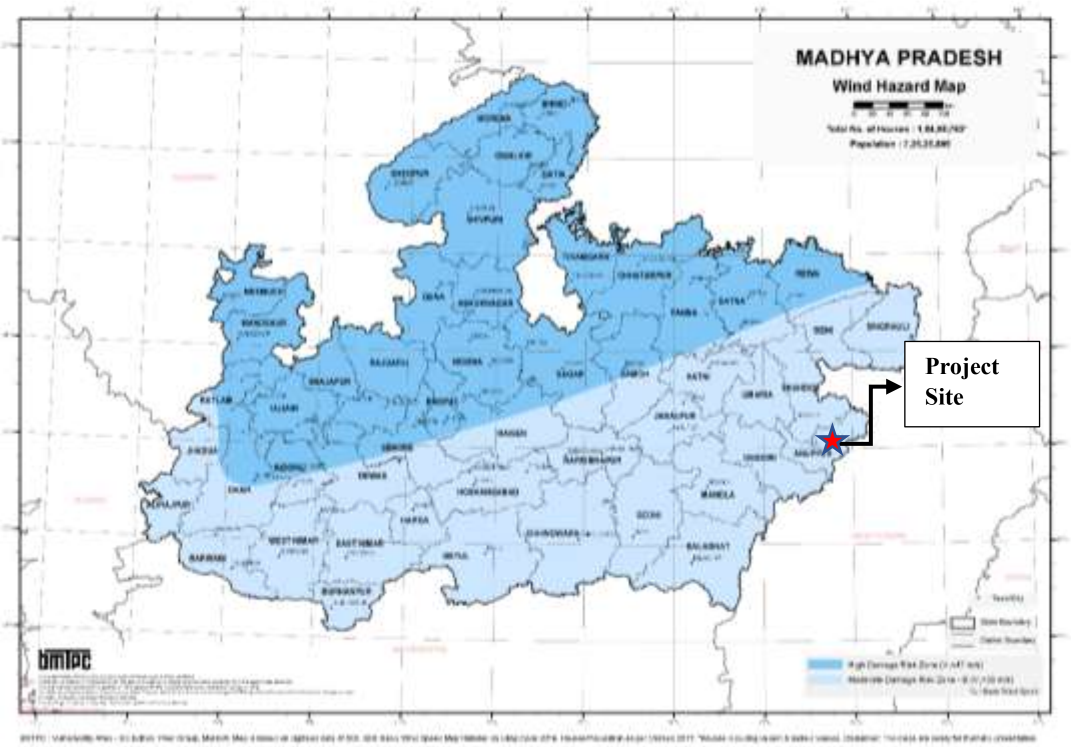


Figure 3-25: Wind Hazard map of Madhya Pradesh.

Flooding frequency is quite frequent in many talukas of the Anuppur district. Flood Hazard Zonation Map of Anuppur district showing the plant site is given in **Figure 3-24.**

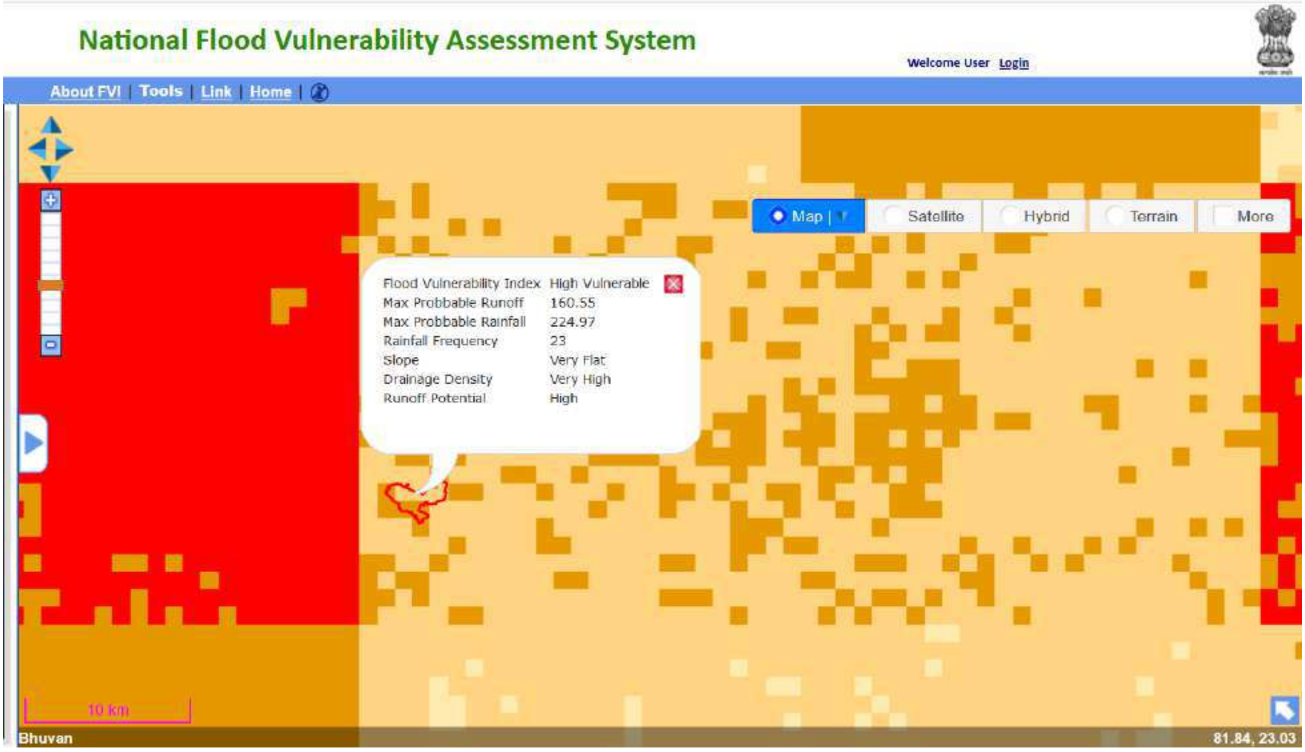


Figure 3-26: Flood Vulnerability Index of the Plant site.

Anuppur is one of the newly made district out of Shahdol in 2003. The district of Anuppur as well as the plant site fall in flood prone area as per the Disaster management department, Anuppur. *(Source: https://bhuvan-app1.nrsc.gov.in/nfvas/#)*

The Project site is located at a 1km distance from the HFL line of the Tipan River. The Relative relief from project site to Tipan Nadi is 39m with a gradual slope of 0.97% (1:102) towards the river. The certified copy of the distance from HFL of Tipan River is attached in **Annexure 3.3.**

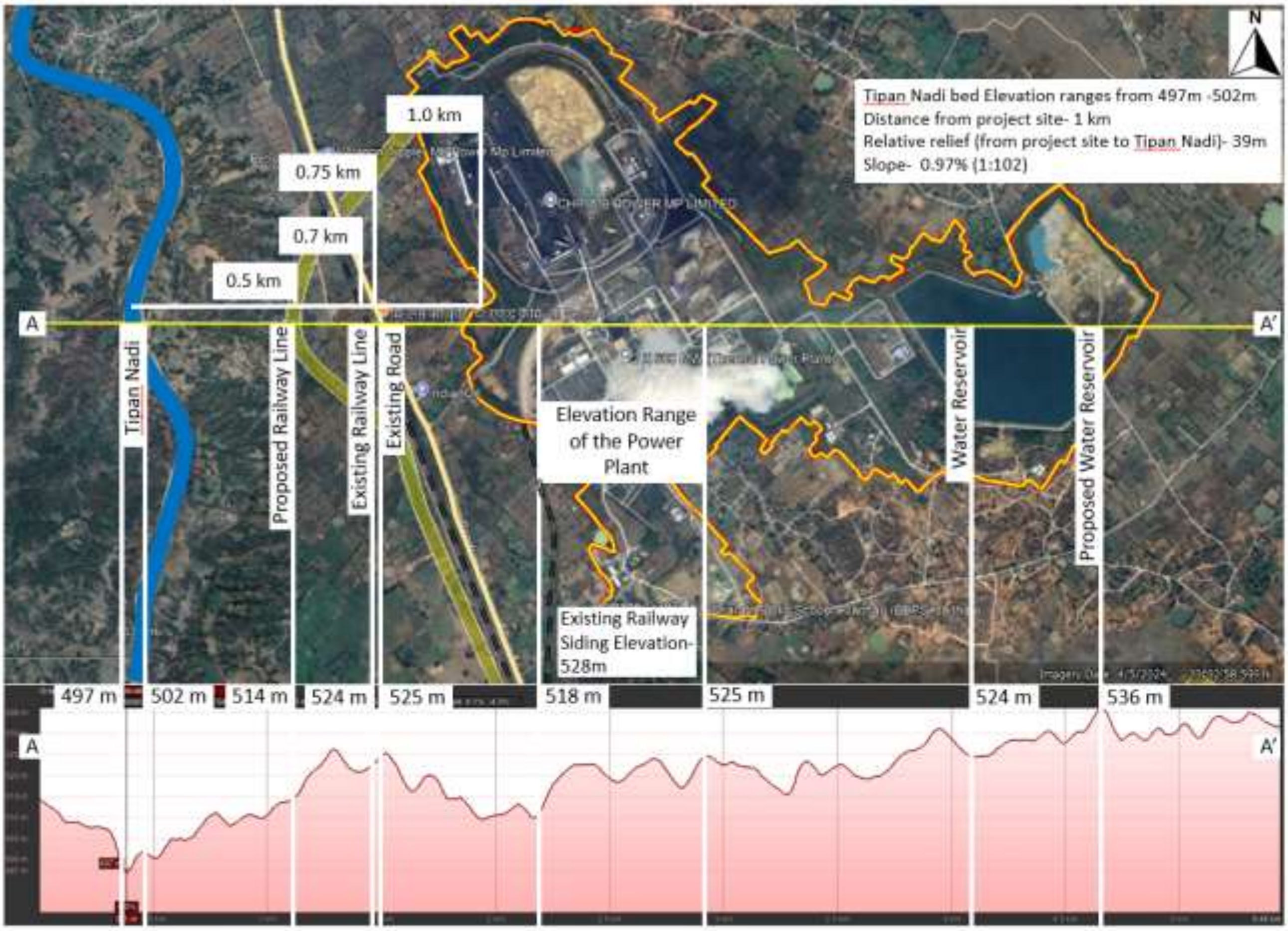


Figure 3-27: Distance and Topographical height of the Project site from Tipan River.

3.6.6 SOIL QUALITY

Soil is a thin layer of earth's crust and is a living media, which is one of the important factors of crop production and serves as a natural nutrient source for the growth of plants. The components of the soils are mineral material, organic matter, water and air, the proportions of which vary and which together form a system for plant growth.

Soil quality of the study area is one of the important components for Environment Impact Assessment (EIA). The composite soil samples were collected from the study area and analysed for different parameters. **Table 3-9** depicts the location of soil sampling in the study area. **Figure 3-29** shows the soil sampling locations.

Table 3-9: Soil Sampling Locations

ID	Monitoring Locations	Lat	Long.	Direction
S1	Project Site	23° 4'14.20"N	81°47'24.35"E	-
S2	Jaithari	23° 3'15.25"N	81°47'34.86"E	SE

ID	Monitoring Locations	Lat	Long.	Direction
S3	Amgawan	23° 5'32.14"N	81°46'49.15"E	NNW
S4	Gumaria village	23° 4'22.26"N	81°47'30.13"E	N
S5	Belia	23° 4'0.76"N	81°45'31.63"E	W
S6	Murra	23° 3'41.57"N	81°47'43.21"E	E
S7	Laharpur	23° 2'49.20"N	81°48'24.82"E	SE
S8	Near Ash Dyke	23° 4'40.64"N	81°48'1.27"E	NE

Figure 3-28: Soil sampling for Post Monsoon Season.

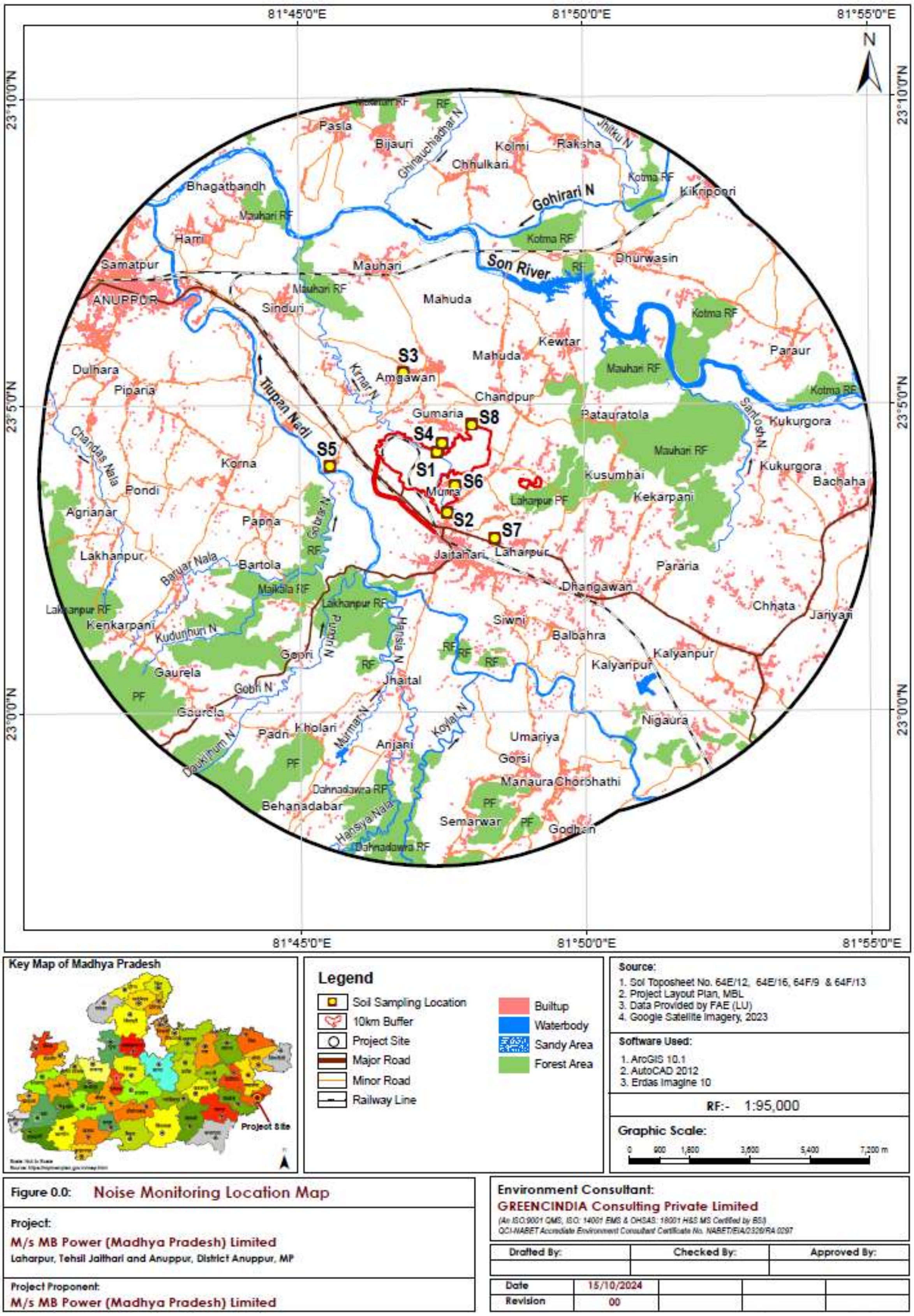


Figure 3-29: Soil Sampling Locations

3.6.6.1 Sampling Frequency & Analysis Method

The sealed samples were sent to laboratory for analysis. Soil samples were analyzed as per the standard methods prescribed in "Soil Chemical Analysis" (M.L. Jackson, 1967). The samples of soil were collected in study period. The physical and chemical characteristics of the soil of the study area have been assessed by analyzing various parameters as per the methods described in "Soil Chemical Analysis" (M.L Jackson, 1967) and Department of Agriculture and Cooperation. Standard classification of Soil as per Indian Council of Agriculture Research, New Delhi.

Table 3-10: Analytical Technique for Soil Sample

Sl. No.	Parameters	Analytical Method	Reference
1	Texture	Sieve analysis &Hygro meter	------
2	pH	pH meter	IS2720- Part 26, 1987 by pH meter
3	Conductivity (1:2)	Conductivity meter	Department of Agriculture & Cooperation, Govt of India Page No. 81-82:2011
4	Potassium	Flame Photometric	TM-S/13
5	Phosphorus	Spectrophotometric	TM-S/11
6	Nitrogen	Distillation & Titration	TM-S/17
7	Infiltration Rate		TM-S/40
8	Cation Exchange Capacity (CEC)		Department of Agriculture & Cooperation, Govt of India
9	Organic Matter	Black method	IS2720-(Part 22),1972, Reaffirmed 2001
10	Organic Carbon	Calculation	IS2720-(Part 22),1972, Reaffirmed 2001 (By Calculation)
11	Bulk Density	Sand replacement, core cutter	TM-S/34
12	Porosity		TM-S/33
13	Copper	Spectrophotometer	Department of Agriculture & Cooperation, Govt of India
14	Iron	Spectrophotometer	Department of Agriculture & Cooperation, Govt of India
15	Manganese	Spectrophotometer	Department of Agriculture & Cooperation, Govt of India
16	Zinc	Spectrophotometer	Department of Agriculture & Cooperation, Govt of India

3.6.6.2 ANALYSIS OF SOIL QUALITY

It is essential to determine the potentials of soil in the area to identify the current status of soil quality and also to predict the impacts that may arise due to the project. Accordingly, a study for assessment of the baseline soil quality has been carried out in the region. The physico-chemical characteristics of soil samples collected is provided in **Table 3-11**.

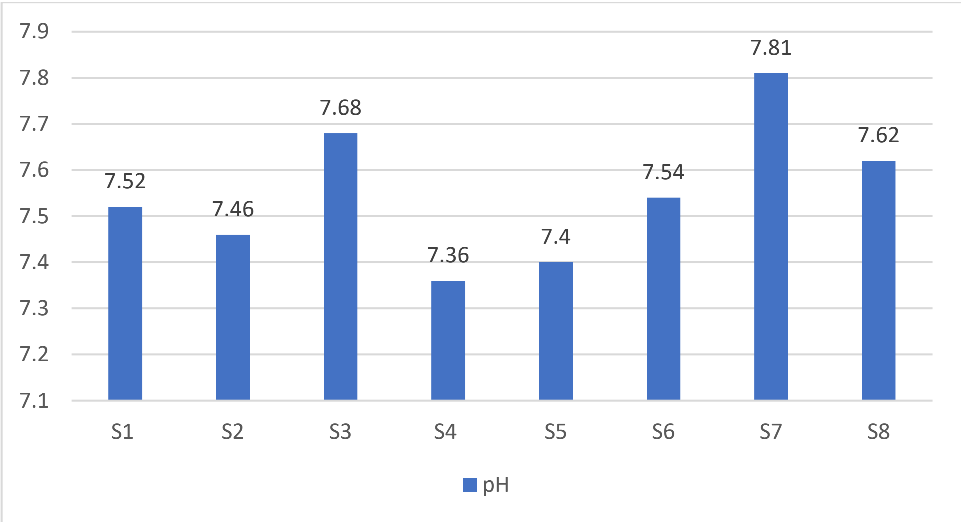
Table 3-11: Physico-chemical parameters of soil samples

S No	Parameter	UoM	S1 - Project site	S2– Jaithari	S3- Amgawan	S4- Gumaria	S5 - Belia	S6 - Murra	S7- Laharpur	S8- Near Ash Dyke
1	pH	-	7.52	7.46	7.68	7.36	7.4	7.54	7.81	7.62
2	Electrical Conductivity	µmhos /cm	121	128	210	157	144	171	138	112
3	Cation Exchange Capacity (CEC)	meq/100g	11.2	14.2	13.4	11.7	15.4	12.2	13.6	11.8
4	Available Nitrogen	Kg/ha	184.26	210.56	226.4	210.2	244.8	194.8	206.4	124.26
5	Available Phosphorus	Kg/ha	30.26	38.2	41.74	32.84	47.26	35.48	46.14	26.48
6	Available Potassium	Kg/ha	96.4	110.6	145.7	164.2	205.4	157.2	186.4	92.1
7	Organic Carbon	%	0.72	1.02	0.84	0.71	0.67	0.86	0.74	0.51
8	Organic Matter	%	1.24128	1.75848	1.44816	1.22404	1.15508	1.48264	1.27576	0.87924
9	Bulk Density	g/cc	1.26	1.32	1.33	1.26	1.29	1.38	1.41	1.22
10	Available Moisture	%	6.26	7.12	5.44	5.82	6.86	5.82	6.24	4.24
11	Water Holding Capacity	%	32.46	37.42	36.28	38.61	36.15	38.44	41.26	30.24
12	Ex. Calcium	meq/100g	50.46	57.46	62.254	48.71	55.28	55.48	67.26	52.81
13	Ex. Magnesium	meq/100g	18.26	24.58	24.82	19.25	32.27	34.81	24.72	18.48
14	Copper (as Cu)	mg/kg	2.41	1.52	4.11	2.58	4.26	3.14	6.22	1.18
15	Iron (as Fe)	mg/kg	4.26	5.14	6.86	4.78	6.24	4.51	7.22	1.84

S No	Parameter	UoM	S1 - Project site	S2– Jaithari	S3- Amgawan	S4- Gumaria	S5 - Belia	S6 - Murra	S7- Laharpur	S8- Near Ash Dyke
16	Zinc (as Zn)	mg/kg	0.82	0.85	0.91	0.78	1.12	1.26	1.41	0.75
17	Lead (as Pb)	mg/kg	0.14	0.26	0.16	0.11	0.18	0.24	0.32	1.26
18	Texture		Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam
19	Sand	% by mass	61.4	63.8	58.1	55.2	62.4	58.4	65.8	54.6
20	Silt	% by mass	12.6	14.2	18.6	15.8	11.5	14.8	10.4	32.4
21	Clay	% by mass	26	22	23.3	29	26.1	26.8	23.8	13

3.6.6.3 OBSERVATION:

pH: The pH value recorded in the study area varies from "Slightly Alkaline" as per ICAR report. pH has been found to be lowest in S4: Gumaria (Agriculture land). Alkaline soils have a high saturation of base cations (K^+, Ca^{2+}, Mg^{2+} and Na^+). This is due to an accumulation of soluble salts which are classified as either saline soil or alkaline soil. In the study area all the monitoring points show slightly alkaline pH in soil. In other classification changes of soil nutrients mainly NPK with pH has been represented in **Figure 3.30.** Soil pH classification has been represented in **Table 3.12**.



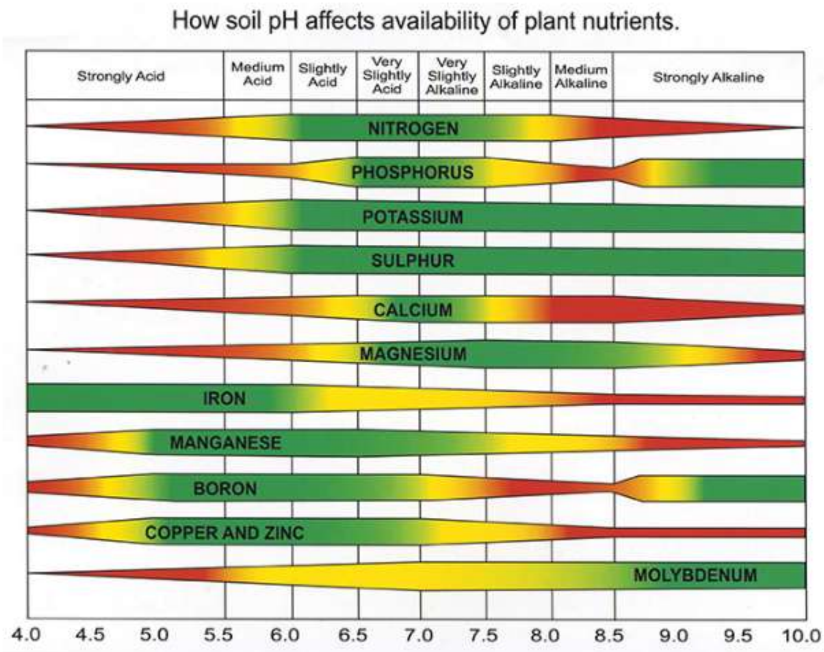


Figure 3-30: Change of Soil Nutrients (NPK) status with pH class

Green: available; yellow: low availability; red: not availability

Table 3-12: Soil classification for pH

Standard Classification of Soil pH as per ICAR, New Delhi	
<4.5	Extremely acidic
4.51- 5.50	Very strongly acidic
5.51-6.0	Moderately acidic
6.01-6.50	Slightly acidic
6.51-7.30	Neutral
7.31-7.80	Slightly alkaline
7.81-8.50	Moderately alkaline
8.51-9.0	Strongly alkaline
9.01	Very strongly alkaline

Electrical Conductivity (EC): The electrical conductivity of soil is actually a measure of salinity. Excessively high salinity can affect plants in the following ways: Specific toxicity of a particular ion (such as Sodium), higher osmotic pressure around the roots prevents an efficient water absorption by the plant. Some plants are more susceptible to electrical conductivity than others and each species has an electrical conductivity threshold, beyond which yield decreases. In the study area soil conductivity varies between 112 µmhos/cm at S8 to 210 µmhos/cm at S3. ICAR classification has been represented in **Table 3.13**.

Table 3-13: Conductivity of the Soil Sample collected from the project site and study area

Parameter	Classification
Salinity Electrical Conductivity (ppm) (1 ppm = 640 µmhos/cm)	• Up to 1.00 Average • 1.01-2.00 harmful to germination • 2.01-3.00 harmful to crops (sensitive to salts)

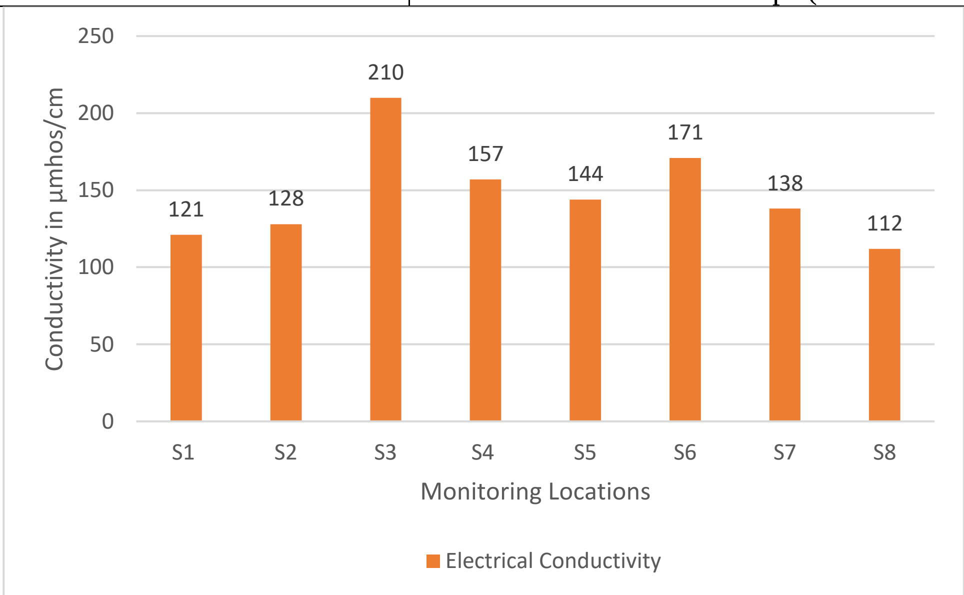


Figure 3-31: Conductivity of the Soil sample

Soil Texture: According to the study of soil texture, the soil of the study area varies from 20% Clay, 20% silt and 60% Sand. The soil texture of the study area varies between sandy clay loam (S1, S2, S3, S4, S5, S6 & S7) to Sandy loamy(S8). Loam soil is ideal for growing crops because it retains nutrients well and retains water while still allowing the water to flow freely. These soils allow for better water penetration than clays, better water holding capacity and better nutrient retention than sands and silts, and more of the soil moisture and nutrients available to the plants than in clays. In **Figure- 3.32** the textural triangle showing the 12 classes and points of different sample in it has been shown which represents the textural classification of the sample in the study area.

Figure 3-32: Figure 3 27: Textural triangle showing 12 classes with black dots pointing to the classified soil sample. (Reprinted from USDA-NRCS, 1999)

Bulk Density: Bulk density of a soil is a dynamic property that varies with the soil structural conditions. In general, it increases with profile depth, due to changes in organic matter content, porosity and compaction. It is required for gaseous exchange, such as high bulk density would pose restriction to the growth of deeper-rooted plants and may be one of the reasons of cessation of plant growth (Ghose *et al.,* 2004).

Bulk density of the study area ranges between 1.22 gm/cm3 at S8 to 1.41 gm/cm3 at S7. A normal range of bulk densities for clay is 1.0 to 1.6 mg/m3 and a normal range for sand is 1.2 to 1.8 mg/m3 with potential root restriction occurring at ≥ 1.4 mg/m3 for clay and ≥1.6 mg/m3 for sand. Bulk density of a soil is a dynamic property that varies with the soil structural conditions. In general, it increases with profile depth, due to changes in organic matter content, porosity and compaction.

Moisture: Soil moisture is important for hydrological, biological and biogeochemical processes. The field moisture of all the samples range between 4.24% at S8 to 7.12% at S2. The moisture content of the study area, however, remains lower than the wilting point.

Table 3-14: Average available water content for various soil textural classes

Textural class	Wilting point	Field capacity	Available water
	(% moisture)		
Sand	5	12	7
Sandy loam	9	21	12
Loam	16	36	20
Silt loam	18	39	21
Clay loam	24	39	15
Silty clay	24	39	13
Clay	27	39	12

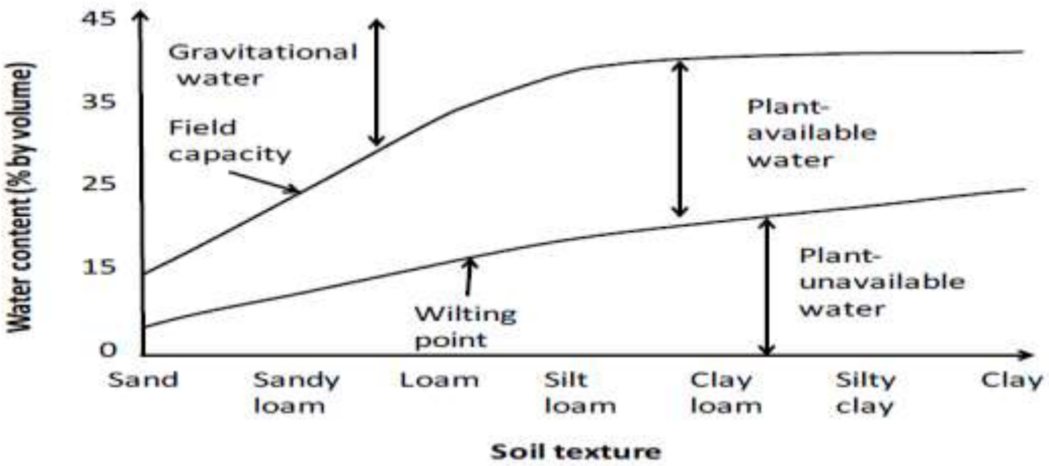


Figure 3-33: Gravitational, plant-available and plant-unavailable water content for various soil texture

- ***Wilting Point: Moisture level at which plants will begin to suffer***
- ***Field Capacity: Highest moisture level at which do not exceed to avoid runoff***

The water available to support plant growth is called plant available water and is the difference between field capacity and the wilting point. Field capacity is the amount of water remaining in the soil profile after 48-72 hours of free drainage following saturated conditions. Water moving downward in the soil following a saturating event can be effectively used by growing plant. The relation between moisture content and infiltration rate has been represented in **Figure 3.33**.

Soil nutrients refer to the inherent capacity of the soil to supply nutrients in adequate amounts and in suitable proportions for crop growth and crop yield. The trend in increasing the yield by adopting high yielding varieties has resulted in deficiency of nutrients in soils and has reflected as deficiency symptoms in plants. Hence, it is required to know the fertility (NPK) status of the soils of the State for applying the required dosage of fertilisers and planning the regional distribution of fertilisers.

a) **Phosphorus:** Phosphorus is the key content which plays an important role in the photosynthesis, respiration, energy storage and transfer, cell division, cell enlargement and several other properties in the living plant. Available Phosphorus ranges between 26.48 kg/ha at S8 site to 47.26 kg/ha at S5. As per ICAR classification the phosphorus in the study area present is classified as "less" to "medium".

b) **Potassium:** Potassium is an essential plant nutrient and is required in large amounts for proper growth and reproduction of plants. Potassium is considered second important after nitrogen, when it comes to nutrients needed by plants, and is commonly considered as the "quality nutrient. It affects the plant shape, size, color, taste and other measurements attributed to healthy produce. Potassium content in the study area ranges between 92.1 kg/ha at S8 to 205.4 kg/ha at S5. As per ICAR classification the potassium in the study area present is classified as "very less" to "medium".

c) **Nitrogen:** Nitrogen is important because it is a major component of chlorophyll, the compound by which plants use sunlight energy to produce sugars from water and carbon dioxide during photosynthesis. It is also a major component of amino acids. Soil nitrogen exists in three general forms: organic nitrogen compounds, ammonium (NH_4^+) ions and nitrate (NO_3^-) ions. The majority of plant-available nitrogen is in the inorganic forms NH_4^+ and NO_3^- (called mineral nitrogen). Nitrogen content in the surface soil of the study area varies between 124.26 kg/ha at S8 to 244.8 kg/ha at S5. As per ICAR classification the nitrogen in the study area presents as "good" to "better" in the study area. The Classification of NPK as per ICAR in soil are given in **Table 3.15**.

Table 3-15: Classification of NPK as per ICAR

Sl. No.	Parameter	Classification
1	Phosphorus (kg/ha.)	• Up to 15 very less • 16-30 less • 31-50 medium, • 51-65 on an average sufficient • 66-80 sufficient • >80 more than sufficient
2	Potassium (kg/ha.)	• 0 -120 very less • 120-180 less • 181-240 medium • 241-300 average • 301-360 better • >360 more than sufficient
3	Nitrogen (kg/ha.)	• Up to 50 very less • 51-100 less • 101-150 good • 151-300 Better • >300 sufficient

Organic Matter: The organic matter of the soil has its origin in the decay of dead plants and animals Research on soil and plants have received considerable impetus in connection with the role of organic matter in regulating the growth of plants. But, it must be remembered that all organic matters are not beneficial to higher plants. In the coastal region soil organic matter also rise by soil salt. The soil organic matter plays an important role as the store house of plants nutrients. In the study area organic matter varies between 0.88% to 1.8%. As per ICAR classification as given in **Table 3.16**, the organic matter found in the study area is "sufficient" to "more than sufficient". The quality of soil is rather dynamic and can affect the sustainability and productivity of land use.

Table 3-16: Classification of Organic Matter as per ICAR

Parameter	Classification
Organic Matter (%)	• Up to 0.2: very less • 0.21-0.4: less • 0.41-0.5 medium, • 0.51-0.8: on an average sufficient • 0.81-1.00: sufficient • >1.0 more than sufficient

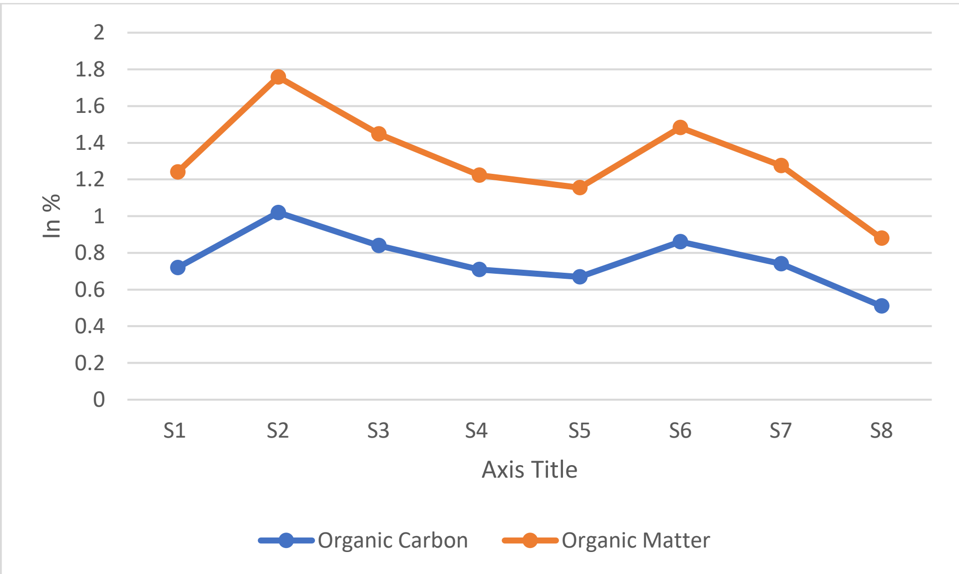


Figure 3-34: Organic Carbon & Organic Matter status of soil samples

Micronutrients

Copper: Copper has an essential function for plant growth. Its essential status for plant nutrition. Cu content in study area varied between 0.18 mg/kg (S8) to 6.22mg/kg (S7)

Zinc: It is an essential micronutrient that has significant role in basic plant metabolic processes and enhances the growth, yield and quality by stimulating chlorophyll production, photosynthetic activity, nutrient uptake and protein biosynthesis. Zn varied from 0.75 mg/kg (S8) to 1.41 mg/kg (S7).

Iron: Iron (Fe) plays a significant role in physiological and biochemical pathways in plants. It involved in the synthesis of chlorophyll and is essential for the maintenance of chloroplast structure and function. Fe varied from 1.84 mg/kg (S8) to 7.22 mg/kg (S7).

Inferences: The NPK content was found to be satisfactory for growth of plants. Therefore, it can be concluded that the soil quality in terms of fertility is good for growth of vegetation in study area.

3.7 CLIMATOLOGY AND METEOROLOGY

3.7.1 IMD METEOROLOGICAL DATA

Meteorology is the key to understand the air quality. The essential relationship between meteorological condition and atmospheric dispersion involves the wind in the broadest sense. Other factors such as variation in temperature, humidity etc. also plays a direct role in dispersion and dilution of pollutants. Wind fluctuations over a very wide range of time, accomplish dispersion and strongly influence other processes associated with them. This section makes a comparative analysis of the meteorological data of the study area collected by project team in 2024. The data used for the purpose are the 30 years average IMD data from 1993 to 2023 taken from Meteorological Station, Umaria. The area has irregular and erratic rainfall. The winter starts in December when day and night temperatures fall rapidly. December is the coldest month. The highest rainfall occurs in the month of September. The summary of the 30 years meteorological data of Umaria IMD Station from 1993-2023 is shown in **Table 3-17**.

Table 3-17: Meteorological Data of Anuppur IMD from 1993-2023

Sl. No.	Parameters	Season	Months	Monthly Total		
1	Rainfall in mm	Winter (Dec to Feb)	December	10		
			January	21.2		
			February	16.5		
			Total	**47.7**		
		Summer (Mar to May)	March	24.4		
			April	18.4		
			May	24.0		
			Total	**66.8**		
		Monsoon (Jun to Sep)	June	174.2		
			July	327.4		
			August	349.62		
			September	228.20		
			Total	**1079.42**		
		Post-Monsoon (Oct to Dec)	October	61.9		
			November	10.4		
			December	10		
			Total	**82.3**		
2	Temperature		**Month**	**Max**	**Min**	**Average**

Sl. No.	Parameters	Season	Months	Monthly Total		
		Winter (Dec to Feb)	December	25.02	9.0	17.01
			January	23.80	8.57	16.18
			February	27.54	11.55	19.54
			Average	**25.45**	**9.7**	**17.58**
		Summer (Mar to May)	March	32.56	15.95	24.26
			April	37.85	20.99	29.42
			May	40.31	24.96	32.64
			Average	**36.91**	**20.63**	**28.77**
		Monsoon (Jun to Sep)	June	37.09	25.49	31.29
			July	31.66	23.98	27.82
			August	30.45	23.48	26.97
			September	31.27	22.65	26.96
			Average	**32.61**	**23.9**	**27.25**
		Post-Monsoon (Oct to Dec)	October	31.36	18.60	24.98
			November	28.50	12.97	20.73
			December	25.02	9.0	17.01
			Average	**28.29**	**13.52**	**20.9**
3	Relative Humidity in (RH) %		**Month**	**8.30**	**17.30**	
		Winter (Dec to Feb)	December	77	51	
			January	78	52	
			February	70	46	
			Average	**75**	**49.7**	
		Summer (Mar to May)	March	57	34	
			April	44	30	
			May	41	27	
			Average	**47.3**	**30.3**	
		Monsoon (Jun to Sep)	June	61	51	
			July	83	75	
			August	87	80	
			September	82	75	
			Average	**78.3**	**70.3**	
		Post-Monsoon (Oct to Dec)	October	76	61	
			November	75	56	
			December	77	51	
			Average	**76**	**56**	
4	Wind pattern		**Months**	**Wind Speed (Kmph)**		
		Winter (Dec to Feb)	December	4.4		
			January	6.2		

Sl. No.	Parameters	Season	Months	Monthly Total
			February	8.5
			Average	**6.4**
		Summer (Mar to May)	March	8.3
			April	9.5
			May	9.8
			Average	**9.2**
		Monsoon (Jun to Sep)	June	11.9
			July	9.6
			August	12
			September	8
			Average	**10.4**
		Post-Monsoon (Oct to Dec)	October	6.9
			November	5.3
			December	4.4
			Average	**5.5**

Temperature: Temperature of the study area is generally high during April to June. As per the IMD Climatological table (1993–2023) the maximum temperature was recorded in the month of May & the minimum temperature is recorded in the month of December. (Refer **Figure 3-35**). Comparison between long term temperature data (30 years, 1993-2023) and the average temperature of last decade shows slight increase in temperature in post monsoon months. Maximum deviation in temperature is seen in the month of September of 0.5 Degree C.

Table 3-18: Long term Temperature Data Analysis. (1993-2023)

Month	Long-term Average over 30 Years (1993 to 2023)			Average Temp of last decade (2013 to 2023)			Percentage Deviation		
	Tmin	Tmax	Average	Tmin	Tmax	Average	Tmin	Tmax	Average
January	8.57	23.80	16.19	8.76	23.56	16.16	2.1%	-1.0%	-0.2%
February	11.55	27.54	19.54	11.59	27.67	19.63	0.4%	0.5%	0.4%
March	15.95	32.56	24.25	15.93	32.27	24.10	-0.1%	-0.9%	-0.6%
April	20.99	37.85	29.42	20.97	37.93	29.45	-0.1%	0.2%	0.1%
May	24.96	40.31	32.64	24.55	39.97	32.26	-1.6%	-0.8%	-1.1%
June	25.49	37.09	31.29	25.49	37.02	31.26	0.0%	-0.2%	-0.1%
July	23.98	31.66	27.82	24.19	31.86	28.02	0.9%	0.6%	0.7%
August	23.48	30.45	26.96	23.71	30.63	27.17	1.0%	0.6%	0.8%
September	22.65	31.27	26.96	23.12	31.70	27.41	2.1%	1.4%	1.7%
October	18.60	31.36	24.98	19.07	31.51	25.29	2.5%	0.5%	1.2%
November	12.97	28.50	20.74	12.85	28.82	20.84	-0.9%	1.1%	0.5%
December	9.00	25.02	17.01	9.17	24.80	16.98	1.8%	-0.9%	-0.2%

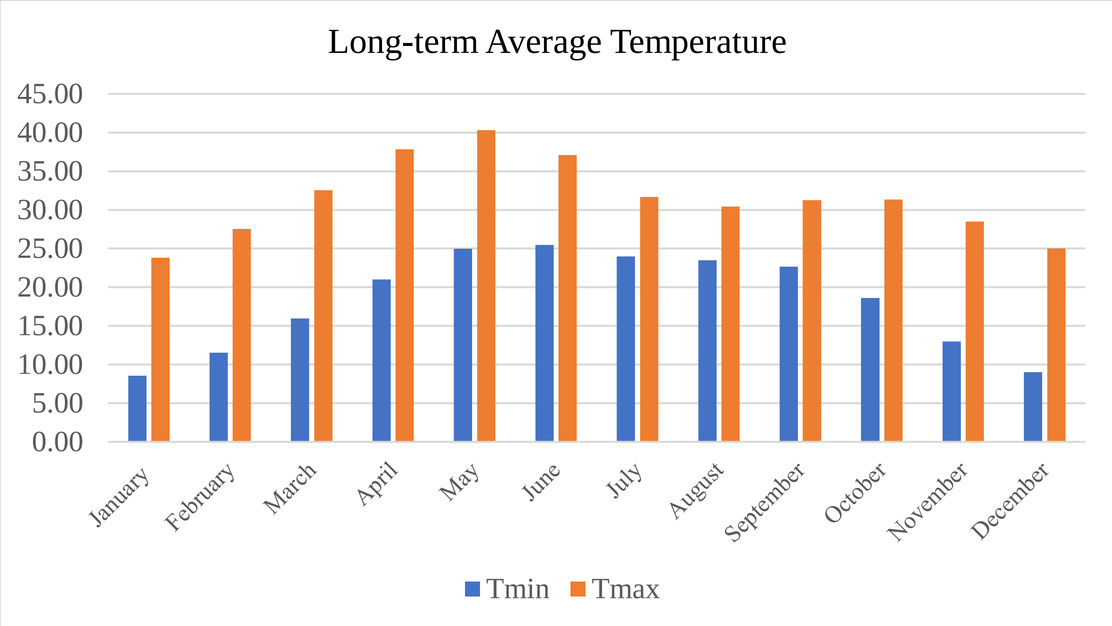


Figure 3-35: Temperature as per IMD

Rainfall: The long-term average annual rainfall of 30 years is 1268.68 mm. Whereas the average annual rainfall for the last decade is 1,245.29 mm. The comparison between the long term (30 years) and last decade's Average Annual Rainfall shows slight decrease in rainfall (23 mm). Maximum Rainfall was recorded in the months of July (327.4 mm) and August (349 mm). Average Rainy days in a year is 87 days. The 30-years average monthly rainfall data is furnished in **Figure 3-36**.

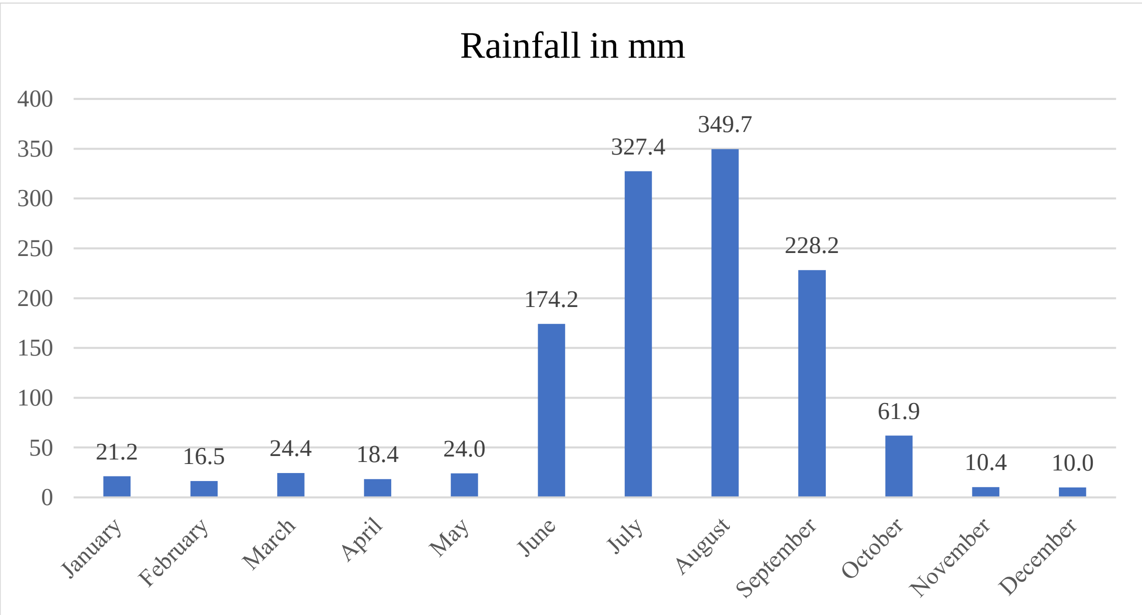


Figure 3-36: Rainfall as per IMD

Relative Humidity: The humidity is highest in July to October with average relative humidity of 80.3%. The annual mean relative humidity of 30 years is furnished in **Figure 3-37**.

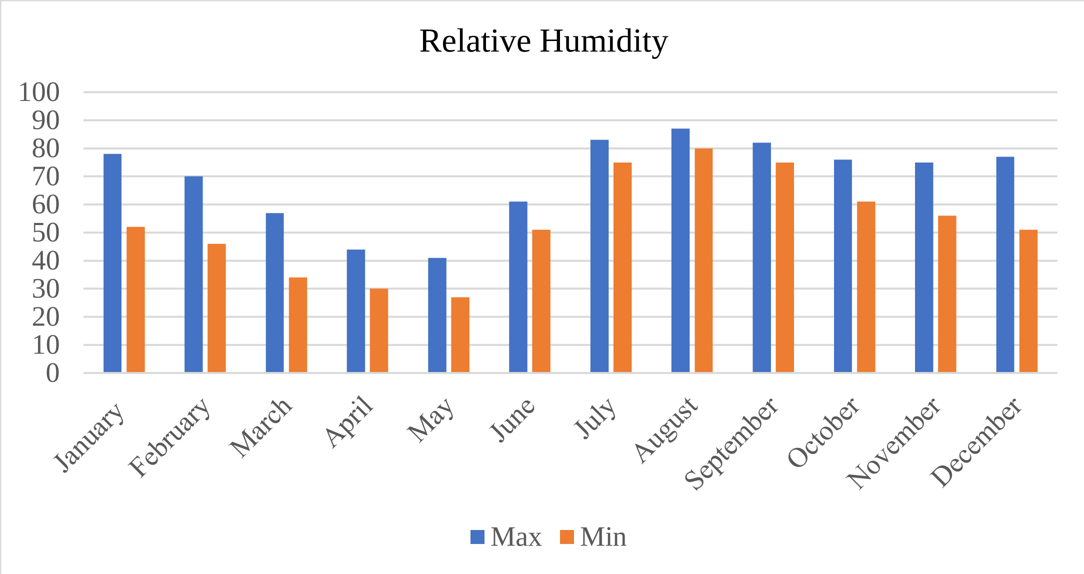
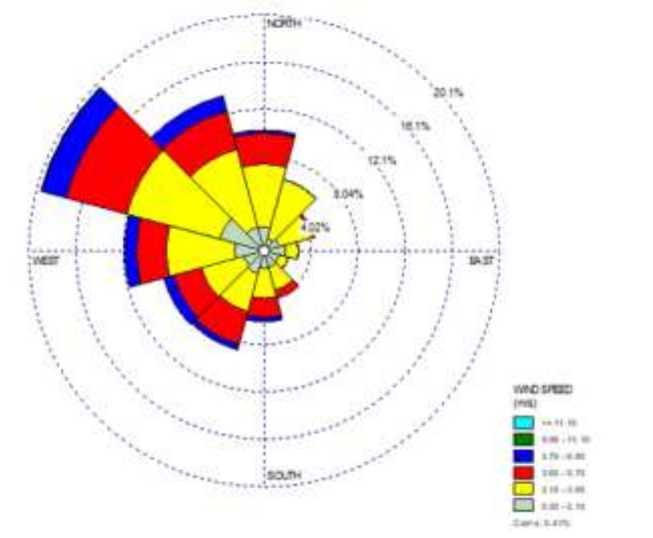
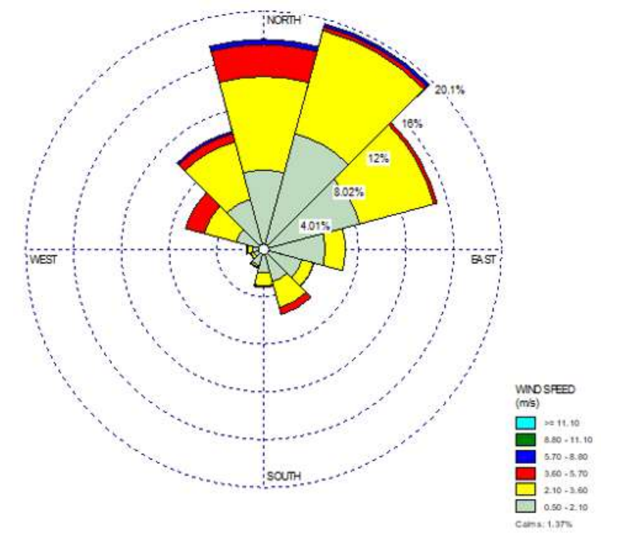


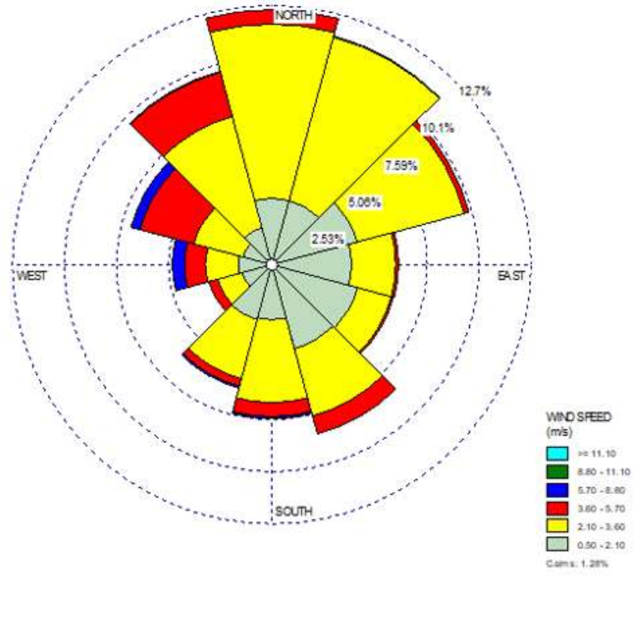
Figure 3-37: Relative Humidity as per IMD

As per IMD station at Umaria, the dominant wind direction throughout the year is from WNW and during the Post Monsoon season the dominant wind direction is from NNE and During Winter it is from N direction. The wind-speed was found to be highest during the monsoon month of October to December with the average wind speed of 11.02 kmph (3.06 m/s). The IMD wind rose diagrams are shown in **Figure 3-38**.

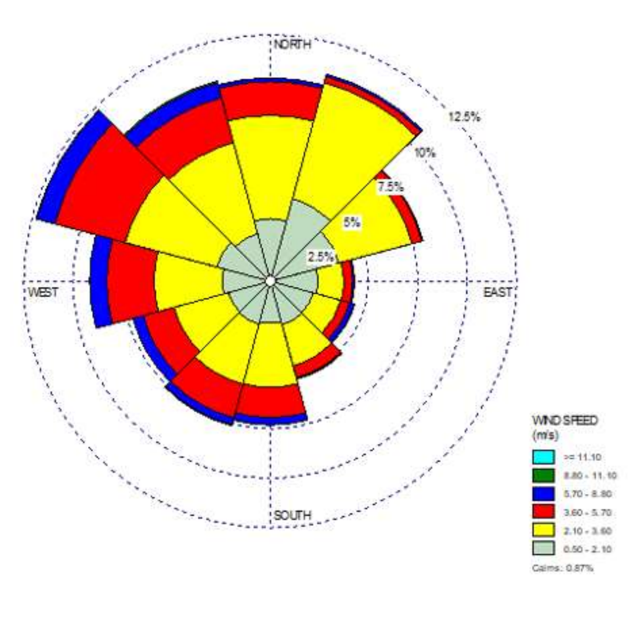




Pre-Monsoon	**Post-Monsoon**



Winter



Annual

Figure 3-38: Wind Rose Diagram

3.7.2 Methodology of Data Generation

During the study a continuous automatic weather monitoring station was established at site to record Wind speed, Wind Direction, Solar radiation, Relative Humidity and Temperature at 2 m and 10 m above ground. Atmospheric pressure was recorded twice a day at 08:30 and 17:30 hrs. Cumulative Rainfall was monitored by rain gauge on daily basis. This station is in operation since October, 2024 and the present report incorporates the data from October, 2024 to December, 2024. The methodology adopted for monitoring meteorological observations is as per the standard norms laid down by Bureau of Indian Standards (BIS) and the India Meteorological Department (IMD). Hourly maximum, minimum and average values of wind speed, direction and temperature are recorded continuously at site.

Meteorological Observation at Site

A fully instrumented continuous recording meteorological observatory is established and operating at Anuppur from March,2024 and this report presents the data from March,2024 to May,2024. The following parameters are being measured: -

- Temperature at 2 m and 10 m level
- Relative humidity
- Wind speed and direction
- Rainfall

The brief details of instruments, parameter and frequency are presented in **Table-3.19.**

Table 3-19: Instruments, Parameters and Frequency of Meteorological Monitoring at Site

S. No.	Parameters	Instruments	Frequency
1.	Wind Speed	Automatic Weather station (Envirotech AWS10B)	Continuous (averaging time of 1 hour)
2.	Wind Direction		
3.	Ambient Temperature at Two Heights 2m & 10m		
4.	Max. & Min Temperature	Wet & Dry Bulb Thermometer	Daily at 08:30 & 17:30 IST
5.	Humidity	RH senser	Daily at 08:30 & 17:30 IST
6.	Atmospheric Pressure	Barometer senser	Daily at 08:30 & 17:30 IST
7.	Storm	Visual observation	Daily
8.	Rainfall	Rain Gauge	Daily
9.	Solar radiation	Solar radiation senser	Continuous (averaging time of 1 hour)

The aforesaid meteorological parameters were monitored over a period of 3 months starting from October, 2024. The meteorological data for three months i.e. from October, 2024 to December, 2024, recorded at site is given in **Table- 3.20**.

Table 3-20: Onsite Meteorology Data

Month	Temperature, °C			Relative Humidity, %		Rainfall (mm)	Wind Speed, km/hr
	Min	Max	Monthly average	Min	Max	Monthly Total	Mean
October	11.2	30.3	20.75	53.2	77.9	52.9	4.01
November	10.9	27.7	19.3	55.7	78.3	8.2	2.78
December	6.8	28.1	17.45	55.4	82.5	11.5	2.35

The analysis of the field observation is given below

3.7.2.1 Ambient Temperature

The observed seasonal minimum and maximum temperatures were 9ºC and 31.36ºC where the minimum temperature was observed 6.8ºC and 30.3ºC. Whereas the average temperature ranges between 17.45ºC to 20.75ºC respectively.

3.7.2.2 Relative Humidity

The seasonal average relative humidity varies from minimum 53.2% to 55.7% and maximum 77.9% to 82.5%

3.7.2.3 Rainfall & Storm

During the monitoring period the highest rainfall was observed in the month of October (52.mm).

3.7.2.4 3.7.2.5 Wind Speed

Analysis of hourly wind speed shows that the winds are generally moderate in this area. The monthly mean wind speed varies from 8.46 to 14.44 km/hr.

3.7.2.5 3.7.2.6 Wind Pattern

The wind-rose diagram for pre monsoon season has been drawn on the basis of hourly wind speed and direction data. The wind rose shows that the dominant directions of the wind flow are west north west for the months of March to May. The seasonal wind rose diagram at site are presented in **Figure 3.39.**

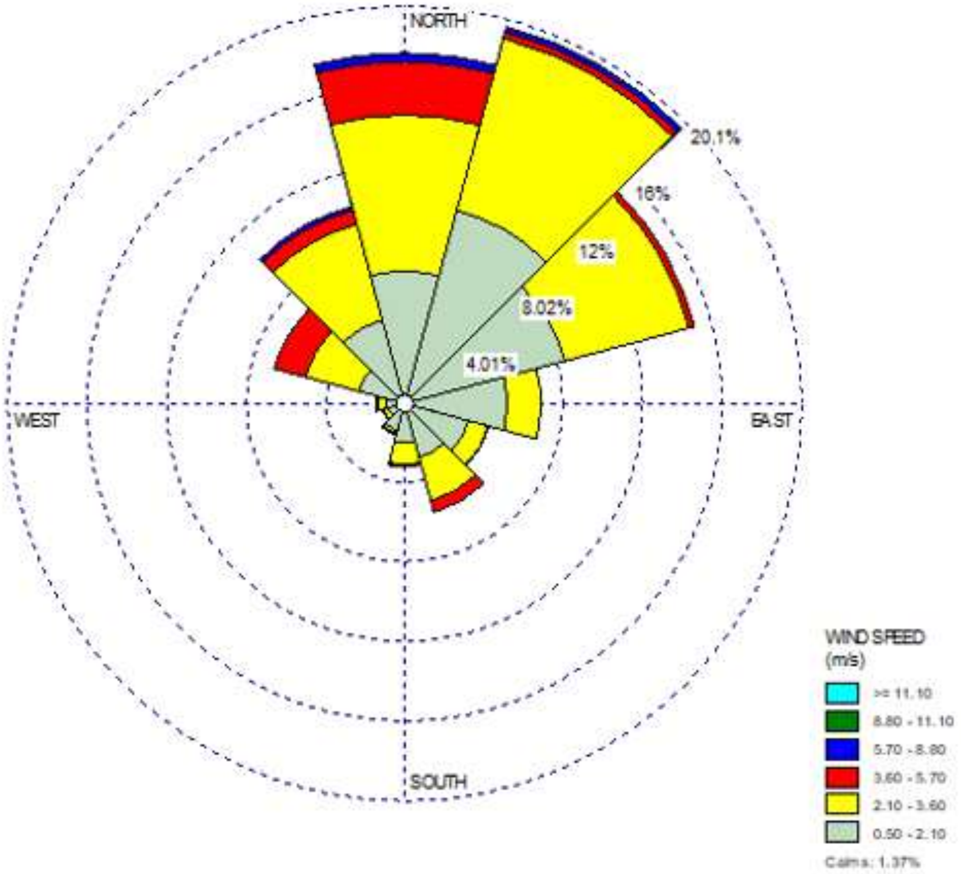


Figure 3-39: Wind Rose Diagram (Post-Monsoon)

3.8 AIR ENVIRONMENT

3.8.1 FREQUENCY AND PARAMETERS OF MONITORING

The area is predominantly clean with no predominant industrial activities. Transport and domestic activities are main generation sources of pollution. Ambient air quality monitoring has been carried out with a frequency of two samples per week at Eight locations for three months (October- November 2024). The monitoring of ambient air has been carried out for the following parameters as mentioned below:

- Particulate Matter10 (PM_{10})
- Fine Particulate Matter2.5 ($PM_{2.5}$)
- Sulphur dioxide (SO_2)
- Nitrogen Oxide (NO_x)
- Carbon monoxide (CO)

3.8.2 INSTRUMENT USED FOR SAMPLING

In order to assess the Ambient Air Quality (AAQ), samples of ambient air were collected by installation of Respirable Dust Sampler and Fine Particulate Sampler at different locations within the study area and analysed to find out the existing status of air quality. The samples for CO were collected in bladder.

3.8.3 SAMPLING AND ANALYTICAL TECHNIQUE

With a view to collecting the samples, Envirotech/SSCE made Fine Particulate Sampler and Respirable Dust Samplers along with Gaseous attachment have been used. Filter papers were used for the collection of PM10 & PM2.5. SO_2 was collected by drawing air at a flow-rate of 0.5 litres per minute (lpm) through an absorbing solution (TCM). The NO_X and Ozone were collected by drawing air at a flow rate of 0.5 liters per minute (lpm) through the mixture of absorbing solutions. Carbon monoxide was collected 8 hourly and analyzed by Non-Dispersive Infra-Red Spectroscopy (NDIR). The particulate matter for analysis of Mercury was collected on EPM2000 filter paper.

3.8.4 SELECTION OF SAMPLING LOCATIONS

Ten monitoring locations have been selected on the basis of predominant wind direction. All probable directions, which may be affected due to expansion of the project, have been considered. Also, the effort was made to collect the representative baseline conditions of all the project affecting villages.

The monitoring stations have been setup in order to locate the locations as close as feasible to the anticipated maximum pollutant concentration areas. Logistic considerations such as accessibility, security, and availability of reliable power supply etc. were also examined while finalizing the stations. The monitoring locations are depicted in **Table 3-17** and **Figure 3-35**.

A Coverage Factor concept was used for determining the location of AAQ monitoring stations (R E Munn). A large number of stations were identified as potential monitoring stations all around the project. A Coverage Factor (C) was calculated by the following equation:

$C_{ij}=F_j/(1+D_i)$

Where, C_{ij}=Coverage Factor of i^{th}. station in j^{th}. direction

Fj = Frequency of wind in j^{th} direction
Di = Distance of i^{th} station

The stations having high values of Cij were selected as final monitoring stations. The monitoring locations are depicted in **Table 3-21** and **Figure 3-40.**

Table 3-21: Air Monitoring Locations

Code	Monitoring Locations	Lat	Long	Direction	
AAQ1	Project Site	23° 3'42.20" N	81°47'10.56"E		
AAQ2	Gumaria	23° 4'35.55" N	81°47'35.12"E	N	1st upwind
AAQ3	Jaithari	23° 3'3.37" N	81°47'32.55"E	S	1st downwind
AAQ4	Anjani	22°59'46.30" N	81°47'3.11"E	S	Crosswind of dominant wind direction near Mauhari RF
AAQ5	Kusmahai	23° 4'2.93"N	81°50'30.60"E	E	Crosswind near RF
AAQ6	Belia near RF	23° 4'1.86"N	81°45'31.24"E	W	Populated
AAQ7	Anuppur	23° 6'50.15"N	81°42'9.41"E	NW	Sensitive
AAQ8	Pataurătola	23° 4'51.91"N	81°50'32.81"E	NE	Crosswind
AAQ9	Murra	23° 6'50.15"N	81°42'9.41"E	SE	Crosswind

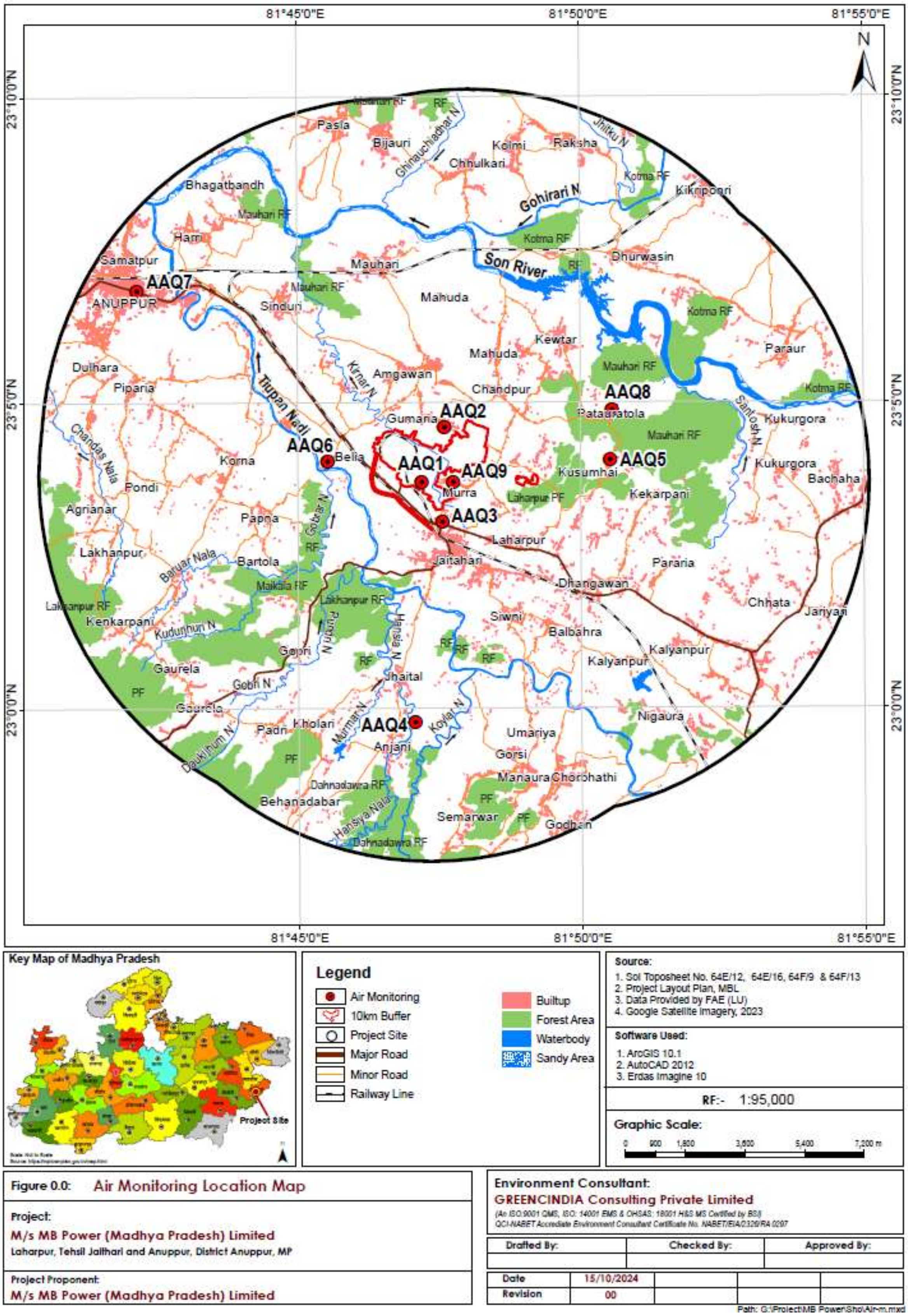


Figure 3-40: Air Sampling Locations.

3.8.5 Instruments Used for Sampling and Analytical Techniques

With a view to collecting the samples, Envirotech/SSEC Make Calibrated Respirable Dust Samplers (RDS-APM 460 BL) along with Gaseous attachment and Fine Particulate Matter (FPS-APM 550) have been used. The RDS is capable of drawing air at a flow rate of 0.95 to 1.3 m^3/min with very little pressure drop for RDS and FPS is designed to operate at an air flow rate of 1m^3/hr. Filter papers (EPM 2000, Whatman & Whatman 46.2 mm dia.) were used for the collection of samples to analyse them for particulate matters and heavy metals. Samples for analysing SO_2 & NO_2 were collected by drawing air at a flow-rate of 0.5 liters per minute (lpm) through an absorbing solution for the duration of 24 hrs. Sampling of Ozone (O_3) has been performed using 10 ml of absorbing solution in a standard impinger and sample for eight hours at the flow rate of 1 l/min. After sampling measure the volume of sample and transfer to a sample storage bottle without exposing the absorbing reagent to direct sunlight. Sampling and analysis methodology adopted is given in **Table 3-22**.

Table 3-22: Sampling & Analysis Methodology

Sl. No.	Parameter	Methodology	Protocol
1	Particulate Matter (PM_{10}) (µg/m^3)	Gravimetric method	IS-5182; Part-4
2	Particulate Matter ($PM_{2.5}$) (µg/m^3)	Gravimetric	IS-5182; Part-24
3	Sulphur Dioxide as SO_2 (µg/m^3)	West and Gaeke Method	IS-5182; Part-2
4	Nitrogen dioxide as NO_2(µg/m^3)	Jacob & Hochheiser modified	IS-5182; Part-6
5	Carbon monoxide (mg/m^3)	Chemical Method	IS-5182; Part-10
6	Ozone (µg/m^3)	Chemical Method	As per CPCB
7	Mercury	AAS method	As per CPCB
8	Ammonia (µg/m^3)	Indophenol method	
9	Arsenic (ng/m^3)	AAS method	
10	Benzene (µg/m^3)	GC analysis	
11	Benzo Pyrene (BaP) (ng/m^3)	GC analysis	
12	Nickel (ng/m^3)	AAS method	
13	Lead (µg/m^3)	AAS method	

3.8.6 AMBIENT AIR QUALITY RESULT

The analysis was carried out as per the method described in the applicable IS codes. Various statistical parameters like 98th percentile, average, standard deviation, maximum and minimum values have been computed from the observed raw data for all the AAQ monitoring locations. The results are shown in **Table 3-23.**

Table 3-23: Results of Ambient Air Quality Data

Parameters	AAQ 1	AAQ 2	AAQ 3	AAQ 4	AAQ 5	AAQ 6	AAQ 7	AAQ8	AAQ9
	Project Site	Ghumaria	Jaithari	Anjani	Kusmahai	Belia near RF	Anuppur	Patauratola	Murra
PM10 NAAQ Limit 100 µg/m³									
Min.	47.21	40.27	38.99	36.65	35.48	41.81	51.59	44.48	42.84
Max.	70.16	59.85	57.94	54.46	52.72	62.14	76.66	66.1	63.67
98percentile	69.77	59.51	57.61	54.16	52.44	61.79	76.23	65.75	63.28
PM2.5 NAAQ Limit 60 µg/m³									
Min.	25.52	16.25	15.73	14.79	14.31	16.87	20.82	17.95	17.28
Max.	42.58	27.1	26.24	24.66	23.88	28.14	34.72	29.94	30.58
98 percentile	42.04	26.76	25.9	24.35	23.59	27.78	34.28	29.14	30.15
SO_2 NAAQ Limit 80 µg/m³									
Min.	10.07	6.46	6.25	5.88	5.69	6.71	7.01	7.14	6.87
Max.	17.24	11.05	10.7	10.06	9.74	11.47	12	12.21	11.76
98 percentile	16.66	10.68	10.34	9.72	9.43	11.09	11.6	11.82	11.33
NO_2 NAAQ Limit 80 µg/m³									
Min.	15.41	11.95	11.57	10.87	10.53	12.41	12.97	13.2	12.71
Max.	20.22	15.68	15.18	14.27	13.81	16.28	17.02	17.32	16.68
98 percentile	19.86	15.4	14.91	14.02	13.53	15.94	16.67	16.97	16.67
CO NAAQ Limit 2.0mg/m³									
Min.	0.51	BDL (DL 0.5)	BDL (DL 0.5)	BDL (DL 0.5)	BDL (DL 0.5)	BDL (DL 0.5)	0.51	BDL (DL 0.5)	BDL (DL 0.5)
Max.	0.64	BDL (DL 0.5)	BDL (DL 0.5)	BDL (DL 0.5)	BDL (DL 0.5)	BDL (DL 0.5)	0.58	BDL (DL 0.5)	BDL (DL 0.5)

Parameters	AAQ 1	AAQ 2	AAQ 3	AAQ 4	AAQ 5	AAQ 6	AAQ 7	AAQ8	AAQ9
	Project Site	**Ghumaria**	**Jaithari**	**Anjani**	**Kusmahai**	**Belia near RF**	**Anuppur**	**Pataurätola**	**Murra**
98 percentile	0.63	BDL (DL 0.5)	BDL (DL 0.5)	BDL (DL 0.5)	BDL (DL 0.5)	BDL (DL 0.5)	0.58	BDL (DL 0.5)	BDL (DL 0.5)
O^3 (µg/m^3)	<20	<20	<20	<20	<20	<20	<20	<20	<20
Ammonia (µg/m^3)	<20	<20	<20	<20	<20	<20	<20	<20	<20
Benzene (µg/m^3)	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
B(a)P (ng/m^3)	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
PB (µg/m^3)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ni (ng/m^3)	<18	<18	<18	<18	<18	<18	<18	<18	<18
As (ng/m^3)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Hg(µg/m^3)	<1.0 (DL)	<1.0 (DL)	<1.0 (DL)	<1.0 (DL)	<1.0 (DL)	<1.0 (DL)	<1.0 (DL)	<1.0 (DL)	<1.0 (DL)

3.8.7 Observation

The 98th percentile value of PM_{10} varies between 76.23µg/m^3 at AAQ7 to 52.44 µg/m^3 at AAQ5 and the 98th percentile value of $PM_{2.5}$ varies between 42.04 µg/m^3 at AAQ1 to 23.59 µg/m^3 at AAQ5. The higher concentration of PM_{10} at Anuppur, due to local activities of the a densely populated settlement with poor quality of roads. Anthropogenic sources including fuel combustion, burning of bagasse and domestic cooking in some area and fuel combustion for vehicles in the study area. Concentration of $PM_{2.5}$ were observed in all sites remain within the limits except for locations within project site.

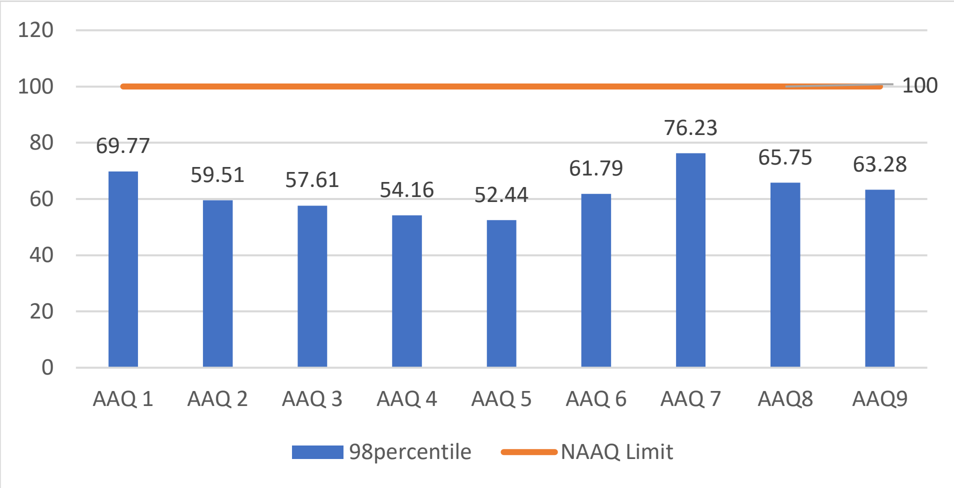


Figure 3-41: 98 percentiles of PM10 in µg/m3

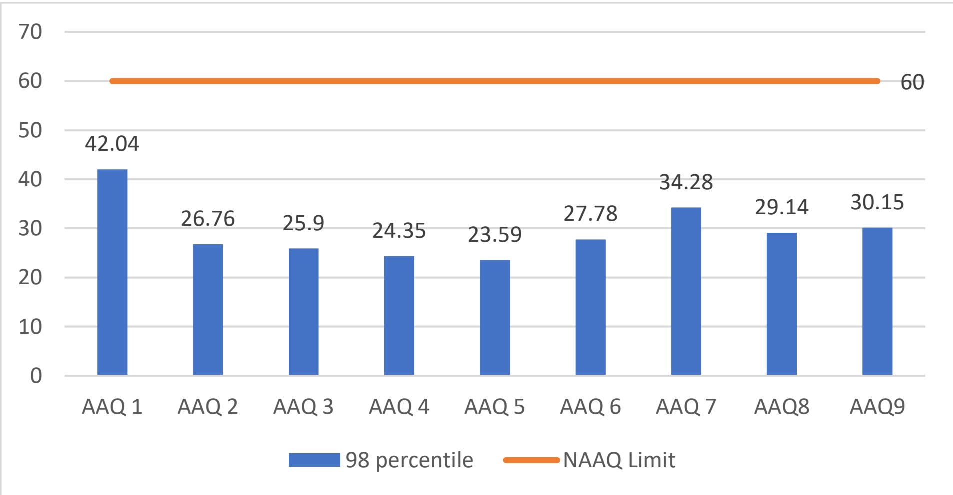


Figure 3-42: 98 percentiles of PM2.5 in µg/m3

The source of SO2 in the study area is mainly from burning fuels containing sulphur or emissions from coal combustion depending on the Sulphur content in the coal. Sulphur dioxide reacts with other substances in the atmosphere to form sulphate aerosols (USEPA, 1982) . Since most sulphate aerosols are part of PM2.5, they may have an important role in the health impacts associated with fine particulates (WHO, 1979) However, the values of Sulphur pollutants in this case were found well below the NAAQ standard. The 98th percentile value of SO2 in the study area ranges from 16.66 μ g/m3 in AAQ6 to 9.43 μ g/m3 in AAQ5.

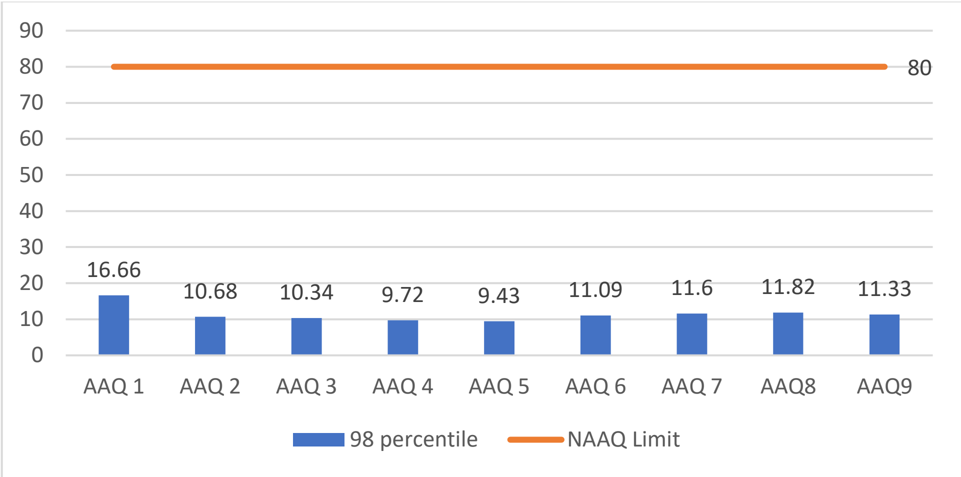


Figure 3-43: 98 percentiles of Sulphur Dioxide (SO2) in µg/m3

In the study area, the 98th percentile of NO_2 varies between 19.86 µg/m^3 at AAQ1 to 13.53 µg/m^3 at AAQ5. The values of Oxides of Nitrogen were found well below the NAAQ standard. The primary sources of NO_2 are motor vehicles, electric utilities and residential sources that burn fuels. NO_2 is one of the main ingredients involved in the formation of ground level ozone, which can trigger serious respiratory problems. It reacts to form nitrate particles, acid aerosols, as well as NO_2, which also cause respiratory problems (NAPAP 1991)[2].

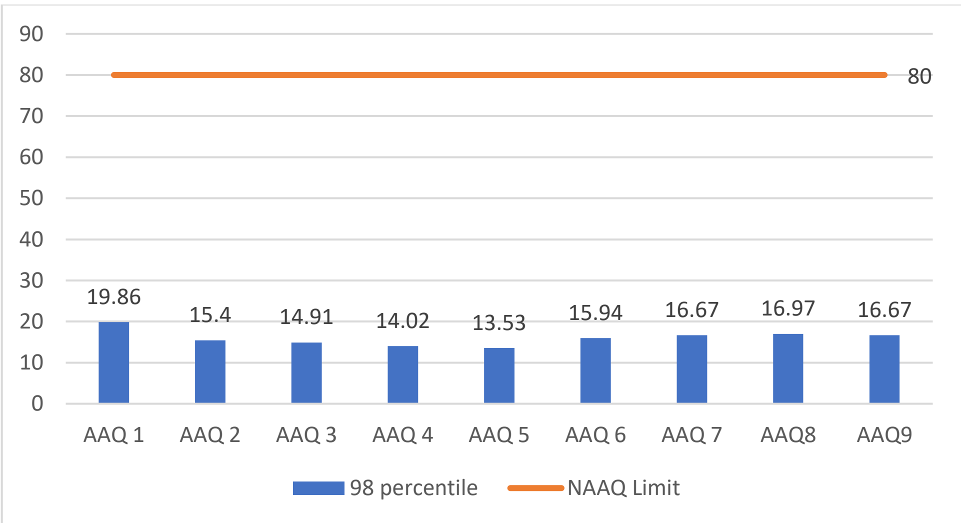


Figure 3-44: 98 percentiles of Nitrogen Dioxide (NO_2) in µg/m^3

[2] NAPAP (National Acid Precipitation Assessment Program).Various years, 1987–91, Washington, D.C.: Government Printing Office.

The CO in the study area varies from 1.10 mg/m^3 at AAQ1 to 0.20 mg/m^3 at AAQ10. The values recorded were below the prescribed standard of NAAQ.

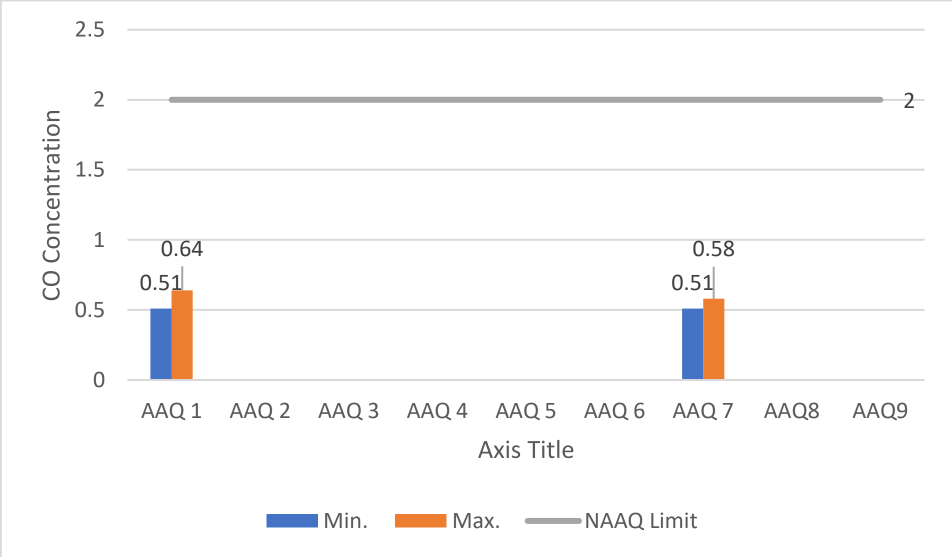


Figure 3-45: Minimum and Maximum of CO in mg/m^3.

3.8.8 AIR QULAITY INDEX (AQI)

Understanding AQI

Indian AQI defines eight AQI categories, namely Good, Moderately, Unhealthy for sensitive group, Unhealthy and very unhealthy. Each of these categories is decided based on ambient concentration values of air pollutants and their likely health impacts (known as health breakpoints). AQI categories and health breakpoints for the five pollutants are as follows:

Table 3-24: AQI Basics for zone and Particle Pollution

Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Minimal Impact
Light Green	Satisfactory	51 to 100	Minor breathing discomfort to sensitive people
Yellow	Moderate	101-200	Breathing discomfort to the people with lung, heart disease, children and older adults
Orange	Poor	201-300	Breathing discomfort to people on prolonged exposure
Red	Very Poor	201 to 300	Respiratory illness to the people on prolonged exposure
Maroon	Severe	>401 and higher	Respiratory effects even on healthy people

Source: www.airnow.gov (A website of Home of the US Air Quality Index)

Five major pollutants:

Environmental Protection Agency (EPA) established an Air Quality Index (AQI) for five major air pollutants regulated by the Clean Air Act. Each of these pollutants has national air quality standard set by EPA to protect public health.

- Ground level ozone
- Particle pollution (also known as particulate matter, including PM10 and PM2.5)
- Carbon monoxide
- Sulfur dioxide
- Nitrogen dioxide

Table 3-25: Air Quality Index in PM10 (µg/m3) in Proposed project.

Station	24 hr Avg. PM10	Daily AQI color	AQI Category	AQI in ug/m^3
Project Site	60.07		Moderate	53
Gumaria	51.24		Good	47
Jaithari	49.60		Good	45
Anjani	46.62		Good	43
Kusmahai	45.19		Good	42
Belia near RF	52.84		Good	48
Anuppur	65.50		Moderate	56
Pataura tola	56.54		Moderate	51
Murra	54.66		Good	50

Source: https://www.airnow.gov/aqi/aqi-calculator-concentration

Table 3-26: Air Quality Index in PM2.5 (µg/m3) in proposed project.

Station	24 hr Avg. PM2.5	Daily AQI color	AQI Category	AQI in ug/m^3
Project Site	34.29		Moderate	98
Gumaria	21.83		Moderate	75
Jaithari	21.13		Moderate	73
Anjani	19.86		Moderate	71
Kusmahai	19.35		Moderate	70
Belia near RF	22.49		Moderate	76
Anuppur	27.90		Moderate	86
Pataura tola	24.15		Moderate	79
Murra	23.34		Moderate	77

Source: https://www.airnow.gov/aqi/aqi-calculator-concentration

Table 3-27: Air Quality Index in SOx (µg/m3) in proposed project

Station	24 hr Avg. SO_x	Daily AQI color	AQI Category	AQI in ug/m^3
Project Site	13.57		Good	19
Gumaria	8.71		Good	11
Jaithari	8.43		Good	11
Anjani	7.92		Good	10
Kusmahai	7.65		Good	10
Belia near RF	8.97		Good	11
Anuppur	9.43		Good	13
Pataura tola	9.63		Good	13
Murra	9.34		Good	13

Source: https://www.airnow.gov/aqi/aqi-calculator-concentration

Table 3-28: Air Quality Index in NO2 (µg/m3) in proposed project.

Station	24 hr Avg. NO_2	Daily AQI color	AQI Category	AQI in ug/m^3
Project Site	17.74		Good	16
Gumaria	13.76		Good	12
Jaithari	13.32		Good	12
Anjani	12.52		Good	11
Kusmahai	12.12		Good	11
Belia near RF	14.18		Good	13
Anuppur	14.90		Good	13
Pataura tola	15.27		Good	14
Murra	14.69		Good	13

Source: https://www.airnow.gov/aqi/aqi-calculator-concentration

Table 3-29: Air Quality Index in CO (mg/m3) in proposed project,

Station	Resultant CO Cum.	Daily AQI color	AQI Category	AQI in ug/m^3
Project Site	0.55		Good	6
Gumaria	BDL			
Jaithari	BDL			
Anjani	BDL			
Kusmahai	BDL			
Belia near RF	BDL			
Anuppur	0.55		Good	6
Pataura tola	BDL			
Murra	BDL			

Source: https://www.airnow.gov/aqi/aqi-calculator-concentration

The AQI in the monitored location ranges from 192 at project site to 133 at Kusmahai. All the AQI levels for the monitored location and parameters show good quality of air except for levels of PM 10 at Project site, Anuppur and Pataura Tola. The levels of PM 2.5 show Moderate AQI in all the monitored location.

Figure 3-46: Air Quality Sampling during Post Monsoon.

3.9 NOISE ENVIRONMENT

3.9.1 FREQUENCY AND PARAMETERS OF SAMPLING

Noise levels were recorded at an interval of 60 minutes during the day and night times to compute the day equivalent, night equivalent and day-night equivalent level. The noise level was recorded continuous for 24 hours at an interval of 1 hour. The noise level was monitored once during the study period at each monitoring location. The noise level is recorded in dB(A).

3.9.2 INSTRUMENT USED FOR SAMPLING

Sound level meter (SL 4033) was used for measuring the noise levels. This instrument measures sound pressure level (SPL), maximum sound pressure level (max) and equivalent continuous noise level (Leq).

The SL4033 is a "Type 1" Sound Level Meter used is designed to meet the requirements of IS 9989:1981 RA 2023. The instrument has a frequency weighting of "A" type and allows the user to select Slow or Fast mode of measurement. A built-in Data Logger/SD card can record all the important Sound Level parameters in Non-Volatile Flash memory for 24 hours making detailed field data collection very simple. Record consists of the Leq, Sound Pressure Level and Sound Exposure Level (SEL) observed during the recording interval. A built-in Real Time Clock maintains a date and time stamp in the recorded data. **Table 3-30** shows the ambient noise quality standards as per CPCB.

Table 3-30: Ambient Noise Quality Standards as per CPCB

Type of Area	Limits in dB(A) Leq*	
	Day Time	Night Time
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

**dB (A) Leq denotes the time weighted average of the level sound in decibels on scale A which is relatable to human hearing*
Source: The Noise Pollution (Regulation and Control) Rules, 2000
Day and Night time shall mean from 6:00 a.m. to 10:00 p.m. and 10:00 p.m. to 6:00 a.m. respectively.

3.9.3 SELECTION OF MONITORING LOCATIONS

Assessment of ambient noise levels is an important parameter in preparation of impact assessment report. Noise levels are more annoying in the night time particularly in the residential area. The environmental impact of noise can have several effects varying from annoyance to hearing loss depending on loudness of noise levels. The monitoring for noise levels were done in 8 locations keeping considering the population and traffic of the area. **Figure 3-47** is showing the noise monitoring locations. **Table 3-31** shows the values recorded from these locations.

Table 3-31: Description of noise sampling locations

ID	Monitoring Locations	Lat	Long	Direction	Distance In Km
N1	Project Site	23° 3'42.20"N	81°47'10.56"E		-
N2	Gumaria	23° 4'35.55"N	81°47'35.12"E	N	0.36
N3	Jaithari	23° 2'59.30"N	81°47'29.50"E	S	0.47
N4	Anjani	22°59'46.3"N	81°47'3.11"E	S	6.40
N5	Laharpur	23° 2'46.03"N	81°48'52.55"E	E	2.27
N6	Belia near RF	23° 4'1.86"N	81°45'31.24"E	W	1.44
N7	Anuppur	23° 6'50.15"N	81°42'9.41"E	NW	8.55
N8	Murra	23° 3'41.20"N	81°47'44.20"E	SE	0.28

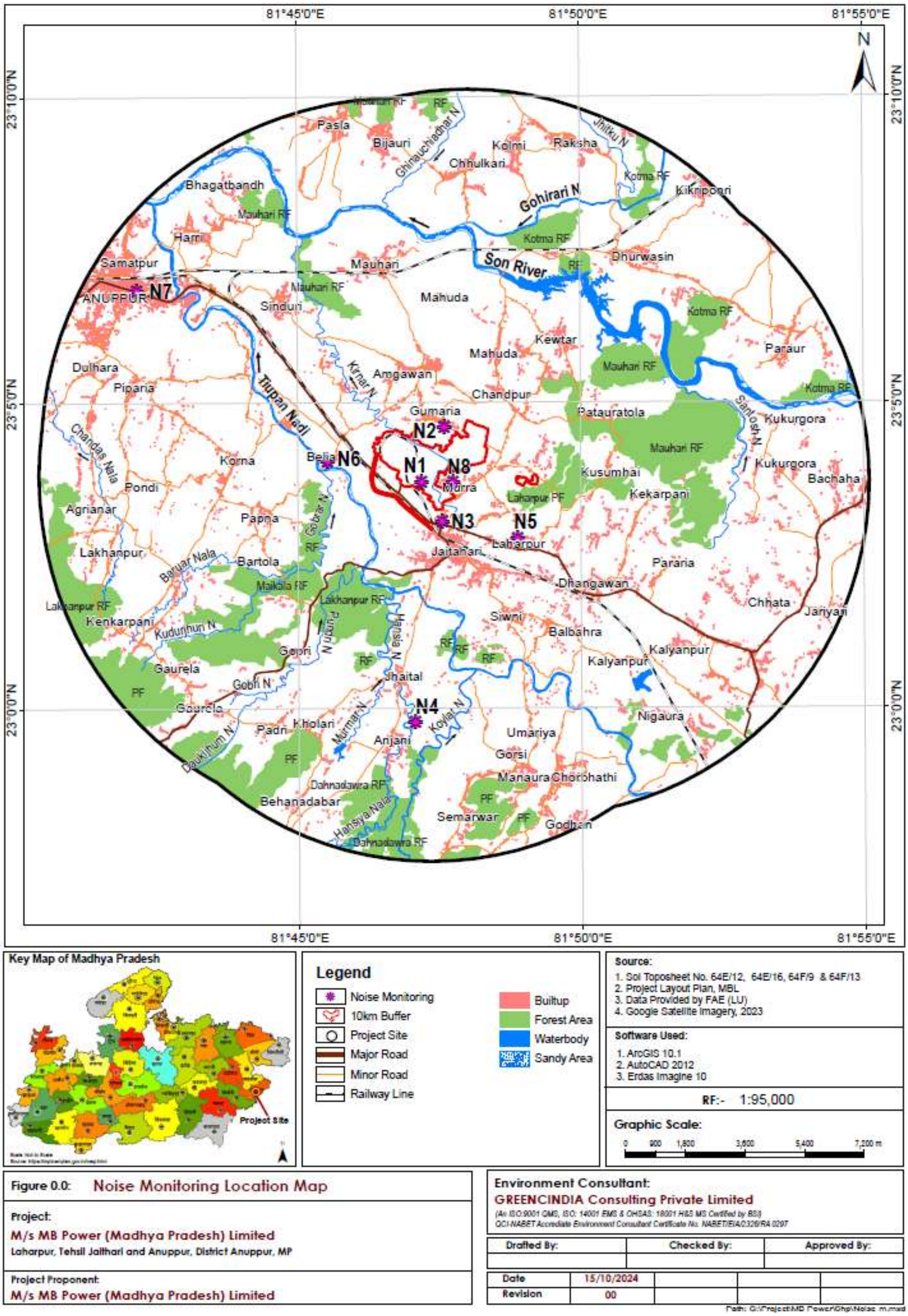


Figure 3-47: Noise Monitoring Locations.

Table 3-32: Noise parameters recorded at different locations

Name	Location/Village	Land use	Day - Leq-dB(A)	Limit Day - Leq-dB(A)	Night - Leq-dB(A)	Limit Night-Leq- dB(A)
N1	Project Site	Industrial	62.4	75	53.1	70
N2	Gumaria	Residential	52.6	55	43.2	45
N3	Jaithari	Residential	51.4	55	42.5	45
N4	Anjani	Residential	53.2	55	42.2	45
N5	Laharpur	Residential	52.1	55	43.1	45
N6	Belia near RF	Residential	51.7	55	42.8	45
N7	Anuppur	Residential	60.2	55	49.2	45
N8	Murra	Residential	51.8	55	42.4	45

DISCUSSION & CONCLUSION

Day Time: The day time noise levels showed maximum 62.4 dB(A) at (N1) Project Site to minimum 51.4 dB(A) at (N3) Jaithari. It is observed that the day time noise levels are high at (N7) Anuppur because of high anthropogenic activity.

Night Time: The night time noise levels showed maximum 53.1 dB(A) at N1 Project Site and minimum 42.2 dB(A) at Anjani. In study area during night time all locations observed noise value under prescribed limits for all zones except for Anuppur. Anuppur being the highest order settlement, District headquarter the higher anthropogenic activity the noise quality exceeds the prescribed standards. As per CPCB prescribed limit during night time is 45 dB (A) for rural/residential areas and 70 dB (A) for industrial zones.

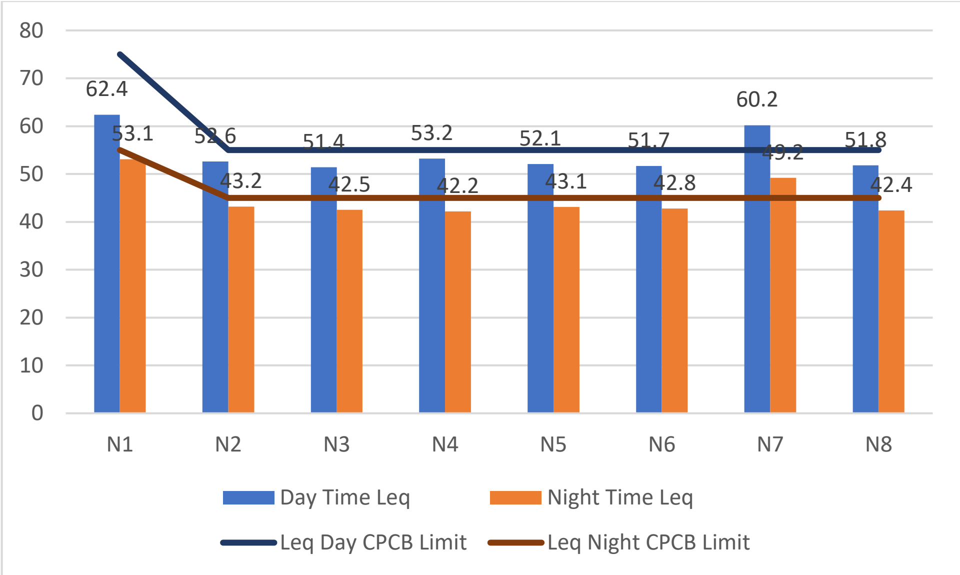


Figure 3-48: Sound pressure levels recorded at the monitoring stations

Figure 3-49: Noise sample collection for summer season

3.10 WATER ENVIRONMENT

3.10.1 FREQUENCY AND PARAMETERS

Water samples were collected once in a month during the study period and analysed for following selected physico-chemical and biological parameters.

- **Physical Parameters-** Temperature, Turbidity, Colour, Electrical Conductivity, TSS & TDS
- **Chemical parameters-** pH, DO, Alkalinity, Hardness, BOD, COD, NO_3, PO_4, Cl, F, SO_4, Na, K, Ca, Mg, Silica, Oil &Grease, Phenolic compounds
- **Heavy metals-** As, Hg, Pb, Cd, Cr^{-6}, Total Cr, Cu, Zn, Se, Fe
- **Bacteriological-** MPN and Total coliform

3.10.2 SAMPLE COLLECTION TECHNIQUE

The samples were collected as per IS standard procedures. The parameters such as Temperature, Turbidity, Colour, Electrical Conductivity, TSS & TDS were analyzed at the site at the time of collection of samples (with the help of handy sampler) while for other parameters, samples were collected, preserved and analyzed in laboratory. Samples were collected, preserved and analyzed as per methods given in Standard Methods for the Examination of Water and Waste Water (APHA& IS standard).

3.10.3 SAMPLING LOCATIONS

Six/Six samples each of surface and ground water have been collected to assess the water quality. The details of water quality sampling locations are given in **Table 3-33** and shown in **Figure 3-50**.

Table 3-33: Description of sampling locations for surface water and ground water

Code	Monitoring Locations	Lat	Long.	Distance (km)	Direction
GW1	Project Site				
GW2	Siwni	23° 1'32.77"N	81°48'44.73"E	3.7	SSE
GW3	Belia	23° 4'4.22"N	81°45'40.53"E	1.15	W
GW4	Murra	23° 3'44.09"N	81°47'35.73"E	0.18	E
GW5	Jaithari	23° 3'8.76"N	81°47'34.73"E	0.21	S
GW6	Laharpur	23° 2'46.59"N	81°48'59.01"E	2.2	SE
GW7	Gumaria	23° 4'36.09"N	81°47'33.40"E	0.4	N
SW01	Kirnar Nala Upstream	23° 3'19.44"N	81°47'35.83"E	0.07	SE
SW02	Kirnar Nala downstream	23° 4'33.09"N	81°46'40.26"E	0.02	NNW
SW03	Pond near Bamm Bhole Mandir n/v Jaithari village	23° 3'3.87"N	81°47'45.78"E	0.5	SE
SW04	Tipan Nadi	23° 4'19.86"N	81°45'5.62"E	2	NW

SW05	Project site Water reservoir	23° 4'24.28"N	81°48'5.48"E		NE
SW06	Gobrar Nala	23° 3'24.96"N	81°45'35.34"E	2	W
SW07	Koylar Nala	23° 0'19.73"N	81°47'49.74"E	5.3	SE
SW08	Hansia Nala	23° 0'39.53"N	81°46'36.48"E	5	S
SW09	Sone River	23° 6'56.08"N	81°48'53.22"E	4.4	NNE
SW10	Gohirari Nala	23° 7'44.26"N	81°48'29.36"E	5.6	NE

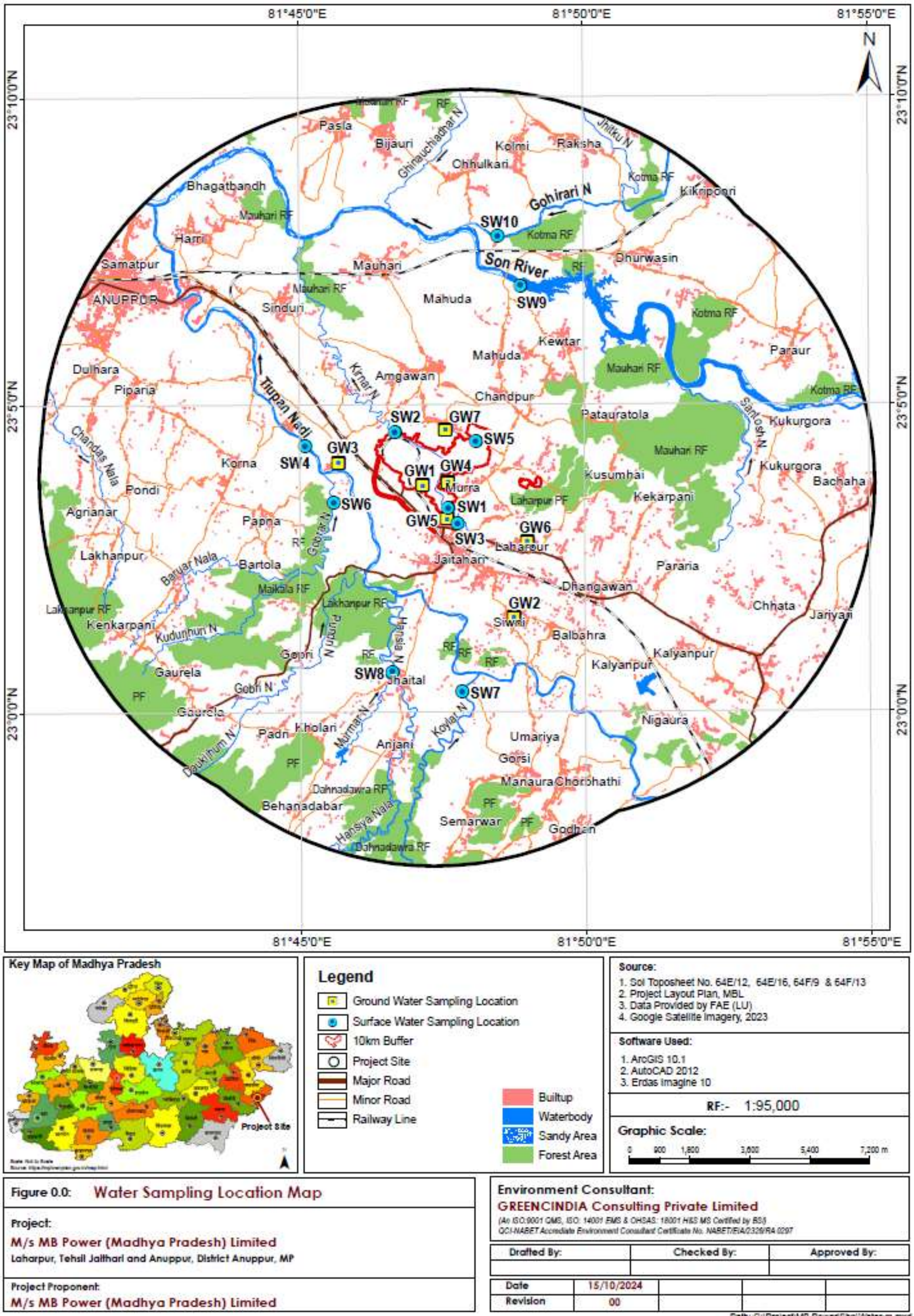


Figure 3-50: Water sampling locations

3.10.4 ANALYSIS OF WATER QUALITY

Water quality parameters of surface and ground water resources within the study area has been studied for assessing the water environment and evaluate anticipated impact of the project. Understanding the water quality is essential in preparation of environmental impact assessment and to identify critical issues with a view to suggest appropriate mitigation measures for implementation.

The purpose of this study is to:

- Assess the water quality characteristics for critical parameters;
- Evaluate the impacts on agricultural productivity, habitat conditions, recreational resources and aesthetics in the vicinity; and
- Predict impact on water quality by this project and related activities

The information required has been collected through primary surveys in October to December, 2024. Seven ground water and ten surface water samples were collected and analysed for physico-chemical, heavy metals and bacteriological parameters in order to assess the effect of industrial and agriculture activities. The location of ground water and surface water sampling is shown in **Figure 3-50**.

The samples were analyzed as per the procedures specified in 'Standard Methods for the Examination of Water and Wastewater' published by American Public Health Association (APHA) and IS 10500:2012. Samples for physico-chemical analysis were collected in polyethylene and glass bottle and preserved as per standard procedure (APHA 22ndedn.). Samples collected for metal content were acidified with 1ml HNO_3. Samples for bacteriological analysis were collected in sterilized bottles. The analytical procedures are described in **Table 3-34.**

Table 3-34: Parameter wise Water Sampling Procedure, Sample Size and Storage/Preservation

Sl. No	Parameter	Sample collection	Sample Size	Storage/ preservation
1	pH	Grab sampling, Plastic /glass container	100 ml	On site analysis
2	Conductivity	Grab sampling, Plastic /glass container	100 ml	On site parameter
3	TDS	Grab sampling, Plastic /glass container	100 ml	Refrigeration, can be stored for 7 days
4	Oil & Grease	Wide mouth glass container	500 ml	Add HCl to pH>2, refrigeration, 28 days
5	Hardness	Grab sampling, Plastic /glass container	100 ml	Add HNO_3 to pH<2, refrigeration; 6 months
6	Chlorides	Grab sampling, Plastic/ glass container	100 ml	Not required; 28 days
7	Sulphates	Grab sampling, Plastic /glass container	100 ml	Refrigeration; 28 days
8	Na^+ and K^+	Plastic container	100 ml	Not required; 6 months
9	Nitrates	Plastic containers	100 ml	Refrigeration; 48 hrs

Sl. No	Parameter	Sample collection	Sample Size	Storage/ preservation
10	Alkalinity	Plastic/ glass containers	100 ml	Refrigeration; 14 days
11	Heavy Metals	Plastic/ Glass rinsed with 1+1 HNO_3	500 ml	HNO_3 to pH>2; Grab sample; 6 months
12	Silica	Plastic/ Glass rinsed with 1+1 HNO3	500ml	HNO3 to pH>2; Grab sample; 6 months
13	COD	Plastic/ Glass	100	Cooling between 2 to 5˚C and store in dark
14	BOD	Plastic/ Glass	1000	Cooling between 2 to 5˚C and store in dark
15	DO	Plastic/ Glass	300	As soon as possible

Source: Standard Methods for the Examination of Water and Wastewater, Published By APHA, 22nd Edition, 2012 and 3025-Part 1.

Table 3-35: Standard National and International Analytical Procedure and Methods for Different Water Quality Parameters

Sl. No.	Parameters	Analytical Method	Reference
1	pH	pH Electrode	IS: 3025 (Part-11)
2	Turbidity	Nephelometric	IS: 3025 (Part-10)
3	Conductivity (at 25 ºC)	Conductivity Electrode	APHA 22nd edition, 2510 B:2012
4	Total Dissolve Solids	Gravimetric	IS: 3025 (Part-16)
5	Alkalinity as $CaCO_3$	Titrimetrically	IS: 3025 (Part-23)
7	Total Hardness as $CaCO_3$	Titrimetrically	IS: 3025 (Part-21)
8	Calcium as Ca	Titrimetrically	IS: 3025 (Part-40)
9	Magnesium as Mg	Calculation	APHA 22nd edition,3500 Mg B:2012
10	Sodium	Flame Photometric	APHA 22nd edition, 3500 Na B:2012
11	Potassium	Flame Photometric	APHA 22nd edition,3500 K- B:2012
12	Chloride as Cl	Argenometric	IS: 3025 (Part-32)
13	Sulphate as SO_4	Tubidimetric	IS: 3025 (Part-24)
14	Nitrate as NO_3	Spectrophotometric	IS: 3025 (Part-34)
15	Phosphate	Spectrophotometric	IS: 3025 (Part-31)
16	Fluoride as F	Ion-meter	APHA 22ndedition,4500 F- D:2012
17	Phenolic compound	Spectrophotometric	IS: 3025 (Part-43)
18	Cyanide	Spectrophotometric	IS: 3025 (Part-27)
19	Dissolve Oxygen	Winkler Method	IS:3025 (Part-38), Reaffirmed 2009
20	Oil & Grease	Gravimetric	IS:3025 (Part 39), Reaffirmed 2003
21	Arsenic	AAS	IS: 3025 (Part-37)

Sl. No.	Parameters	Analytical Method	Reference
22	Cadmium	AAS	IS: 3025 (Part-41)
23	Total Chromium	AAS	IS: 3025 (Part-52)
24	Iron	AAS	IS:3025 (Part-53), Reaffirmed 2009
25	Copper	AAS	IS: 3025 (Part-42)
26	Lead	AAS	IS: 3025 (Part-47)
27	Manganese	AAS	IS: 3025 (Part-59)
28	Mercury	AAS	IS: 3025 (Part-48)
29	Zinc	AAS	IS: 3025 (Part-49)
30	Silica	Molibdosilicate Method	APHA 22nd edition,4500-SiO2:2012
31	Selenium	Colorimetric Method	APHA 22nd edition,3500-Se:2012
32	Total Coliform	MPN Method	IS: 1622: 1981

3.10.4.1 SURFACE WATER QUALITY

Water pollution is the contamination of water bodies such as rivers, lakes and pollution occur when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds. There are many factors which lead to water pollution. It is essential that firstly understand the sources which contribute to the problem. There are point sources of water pollution that the contaminants which enter a waterway from a single source and non-point sources of water pollution that are diffused contaminants which do not originate from a single discrete source, both that raise the problem of water pollution.

Table 3-36: Physico-chemical characterisation of surface water for the Post Monsoon Season, 2024

S.No	Parameter	UoM	SW - 01 (Kirnar Nala Up)	SW - 02 (Kirnar Nala Down)	SW - 03 (Pond near Bam Bhole)	SW - 04 (Tipan River)	SW - 05 (Water Reservior PS)	SW - 06 (GobrR Nala)	SW - 07 (Koylar Nala)	SW - 08 (Hansia Nala)	SW - 09 (Sone River)	SW - 10 (Gohirari Nala)
1	Colour	Hazen	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
2	Odour	-										
3	Turbidity	NTU	3.6	4.1	4.7	6.1	2.6	1.6	2	7.2	2	4
4	pH	-	7.714	7.812	7.24	6.915	7.518	7.662	7.514	6.986	7.114	6.811
5	Conductivity	µS/cm	484	491	443.9	383.25	150.8	394	167.7	588.2	203.4	194.7
6	Total Dissolve Solids	mg/l	314.6	319.3	288.535	249.1125	98.02	256.1	109.005	382.33	132.21	126.555
7	Alkalinity as CaCO3	mg/l	174.6	176.72	155.78	168.2	58.8	144.6	71.62	210.6	68.56	56.8
8	Total Hardness as CaCO3	mg/l	188.15	191.22	196.16	156.10	50.46	160.13	64.50	224.18	86.40	88.15
9	Calcium as Ca	mg/l	47.2	49.6	54.8	40.4	18.4	45.6	21.6	20.8	32	28.8
10	Magnesium as Mg	mg/l	17.080956	18.5638	14.4150516	13.4187516	1.0971936	11.2423464	2.5672464	41.8547088	1.578528	3.9454452
11	Sodium	mg/l	24.6	25.5	32.6	20.4	13.5	17.4	12.4	23.5	10.43	11.2
12	Potassium	mg/l	1.1	1.26	1.05	0.95	0.64	1.44	0.94	1.25	0.84	0.92
13	Total Suspended Solids	mg/l	2.5	3.1	2.1	1.4	BDL	2.5	4.1	3.42	BDL	5.11
14	Chloride as Cl	mg/l	34.5	35.107	52.07228	20.0278	12.6	30.0417	10.6	30.45	16.02224	28.03892

S.No	Parameter	UoM	SW - 01 (Kirnar Nala Up)	SW - 02 (Kirnar Nala Down)	SW - 03 (Pond near Bam Bhole)	SW - 04 (Tipan River)	SW - 05 (Water Reservior PS)	SW - 06 (GobrR Nala)	SW - 07 (Koylar Nala)	SW - 08 (Hansia Nala)	SW - 09 (Sone River)	SW - 10 (Gohirari Nala)
15	Sulphate as SO4	mg/l	27.4	28.2	51.5	32.5	14.62	26.1	15.2	26.48	15.46	16.4
16	Nitrate as NO3	mg/l	11.1	11.3	6.5	10.6	3.26	8.4	7.1	14.56	6.4	11.6
17	Fluoride as F	mg/l	0.43	0.41	0.25	0.26	0.21	0.35	0.18	0.32	0.19	0.26
18	Phenolic compound as C6H5OH	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
19	Phosphate	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
20	Silica	mg/l	14.46	15.24	15.82	15.16	12.68	14.82	12.88	16.44	13.26	12.72
21	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
22	Cadmium	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
23	Chromium as Cr+6	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
24	Iron	mg/l	0.19	0.2	0.26	0.24	0.18	0.25	0.14	0.27	0.11	0.14
25	Copper	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
26	Lead	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
27	Mercury	mg/l	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
28	Zinc	mg/l	0.35	0.37	0.31	0.23	0.16	0.44	0.23	0.18	0.22	0.25
29	Dissolved Oxygen	mg/l	6.8	6.7	6.6	6.7	6.8	6.7	6.8	6.5	7	6.6
30	COD	mg/l	15.4	14.6	12.8	<10	11.5	16.2	11.6	21.6	<10	14.8

S.No	Parameter	UoM	SW - 01 (Kirnar Nala Up)	SW - 02 (Kirnar Nala Down)	SW - 03 (Pond near Bam Bhole)	SW - 04 (Tipan River)	SW - 05 (Water Reservior PS)	SW - 06 (GobrR Nala)	SW - 07 (Koylar Nala)	SW - 08 (Hansia Nala)	SW - 09 (Sone River)	SW - 10 (Gohirari Nala)
31	BOD, 27°C 3 days	mg/l	4.2	4.1	3.1	<2	3.1	4.6	2.8	6.2	<2	4.2
32	Total Coliforms	mg/l	140	143	170	50	110	350	140	220	33	60
33	Oil & Grease	mg/l	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
34	Total Chromium	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03

Table 3-37: Water Quality Criteria as per CPCB

Designated Best Use	Class of Water	Criteria
Drinking water source without conventional treatment but after disinfection	A	• Total Coliform Organism MPN/100ml shall be 50 or less • pH between 6.5 and 8.5 • Dissolved Oxygen 6mg/l or more • Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organized)	B	• Total Coliform Organism MPN/100ml shall be 500 or less • pH between 6.5 and 8.5 • Dissolved Oxygen 5mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	• Total Coliform Organism MPN/100ml shall be 5000 or less • pH between 6 to 9 • Dissolved Oxygen 4mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	D	• pH between 6.5 to 8.5 • Dissolved Oxygen 4mg/l or more • Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	• pH between 6.0 to 8.5 • Electrical Conductivity at 25°C micro mhos/cm Max.2250 • Sodium absorption Ratio Max. 26 • Boron Max. 2mg/l
	Below-E	• Not Meeting A, B, C, D & E Criteria

DISCUSSION

pH is an important chemical parameter that determines the suitability of water for various purposes. pH of water is very important for the biotic communities because an average pH is adopted by most of the aquatic organism. pH of the study area varied from 6.811 (SW10) in month of May to 7.714 (SW 01) in the Post Monsoon season, which is neutral to slightly alkaline in nature. TDS was observed in the range of 98.02 mg/l at SW05 to max. 481 mg/l at SW01 in the post monsoon season. Analysis of total suspended solids was observed 1.4 mg/l to 5.11mg/l. Conductivity of water samples indicated non saline in nature it was varied between 150.8 µS/cm at SW05 to 740 µS/cm at SW2 in the monitoring period. Nitrate and fluoride were under limit in post-monsoon season i.e. October to December, 2024.

Dissolve oxygen is one of the key factors of natural or wastewater; it is influenced by the physico-chemical parameter and biological activity in the water body such as rivers, lake. DO is a general indicator of water quality which shows the health and ability of the water body. It is source of Oxygen for respiration of aquatic organisms. A minimum concentration of 5 mg/l was considered necessary to maintain the fauna of the waterbody. Dissolved oxygen was recorded sufficient in the study area i.e min 6.5 mg/l (SW08) to max. 7 mg/l (SW09).

BOD in surface water found high which is varied between <2 mg/l in SW04 to 6.2 mg/l in SW08 during Post monsoon months. High BOD in surface water is due to decaying plants, animal waste, and other organic compounds added to water. Whereas COD also found moderate to high in surface water sample and it was observed min. <10 mg/l in S07 to max. recorded 21.6 mg/l in SW08 during study month. Reason behind high COD may be due to accumulation of solid waste, soluble organic compounds, residual food waste, emulsified oils and the dying bacterial cells.

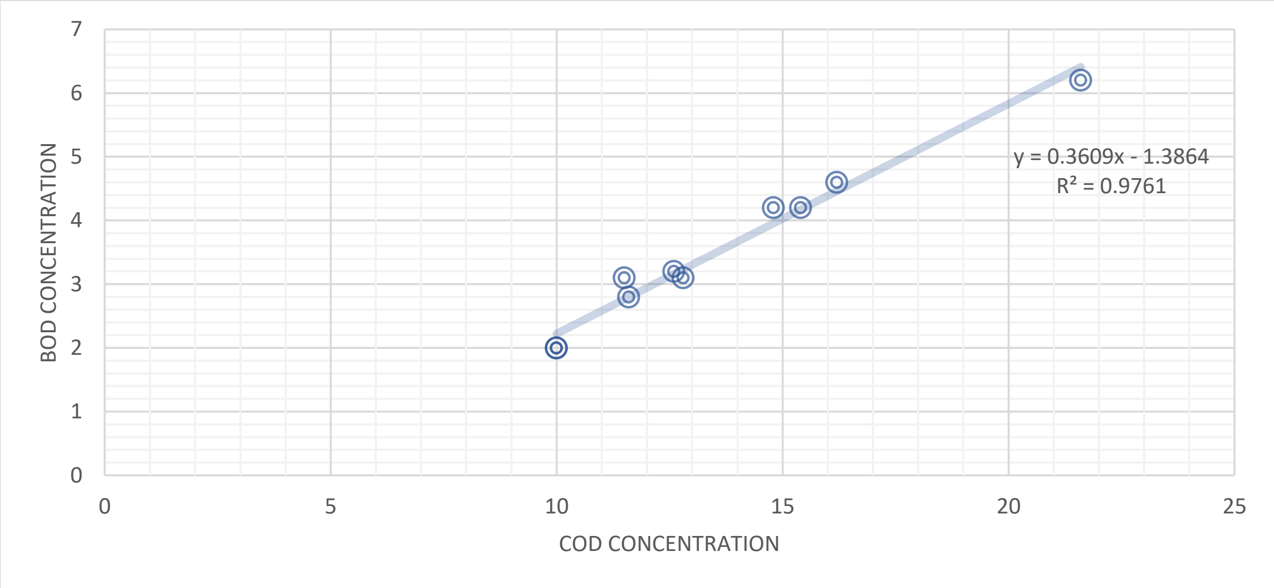


Figure 3-51: Relation between BOD and COD Concentration for the Post Monsoon period.

Comparing the values of pH, DO, BOD and total coliform with 'Use based classification of surface waters' published by Central Pollution Control Board given in **Table 3.37** and majority of the surface water samples meet the criteria C and D.

Hard water makes it difficult for domestic water users. Hardness is defined as the concentration of calcium and magnesium in water expressed as the equivalent of calcium carbonate ($CaCO_3$). The minimum total hardness of surface water samples in study area was found to be 50.46 mg/l in sample at SW05 and the maximum was observed as 276.22 mg/l in the sample at SW02 during the monitoring period. The range of $Ca^{2+}$and Mg^{2+} are also remaining within the acceptable limits 18.4-68.6 mg/l and 1.1- 41.85 mg/l respectively.

Alkalinity: The alkalinity of water is caused mainly due to OH^-, CO_3^-, HCO_3^- ions. Alkalinity is an estimate of the ability of water to resist change in pH upon addition of acid. The maximum alkalinity of water bodies samples was found to range between 56.8-255.72 mg/l in the study area.

Chloride: The minimum chloride concentration (10.6 mg/l) was found at SW07 and the maximum (54.07 mg/l) was recorded at SW02 during the post monsoon season.

Fluoride: The level of fluoride ranged between 0.18 mg/l at SW07 in April to 0.43 mg/l at SW01 and were found to be within the tolerance limit of surface water.

Nitrate: The nitrate in surface water ranged between 3.26 mg/l at SW05 to 15.6 mg/l at SW02 and were found to be within the tolerance limit of surface water.

INFERENCES

BOD and COD of the samples showed above limit as per class C of CPCB norms. High BOD is due to decaying plants, human or animal waste and other organic compounds added to water and high COD is may be due to accumulation of solid waste, soluble organic compounds, residual food waste, emulsified oils and the dying bacterial cells.

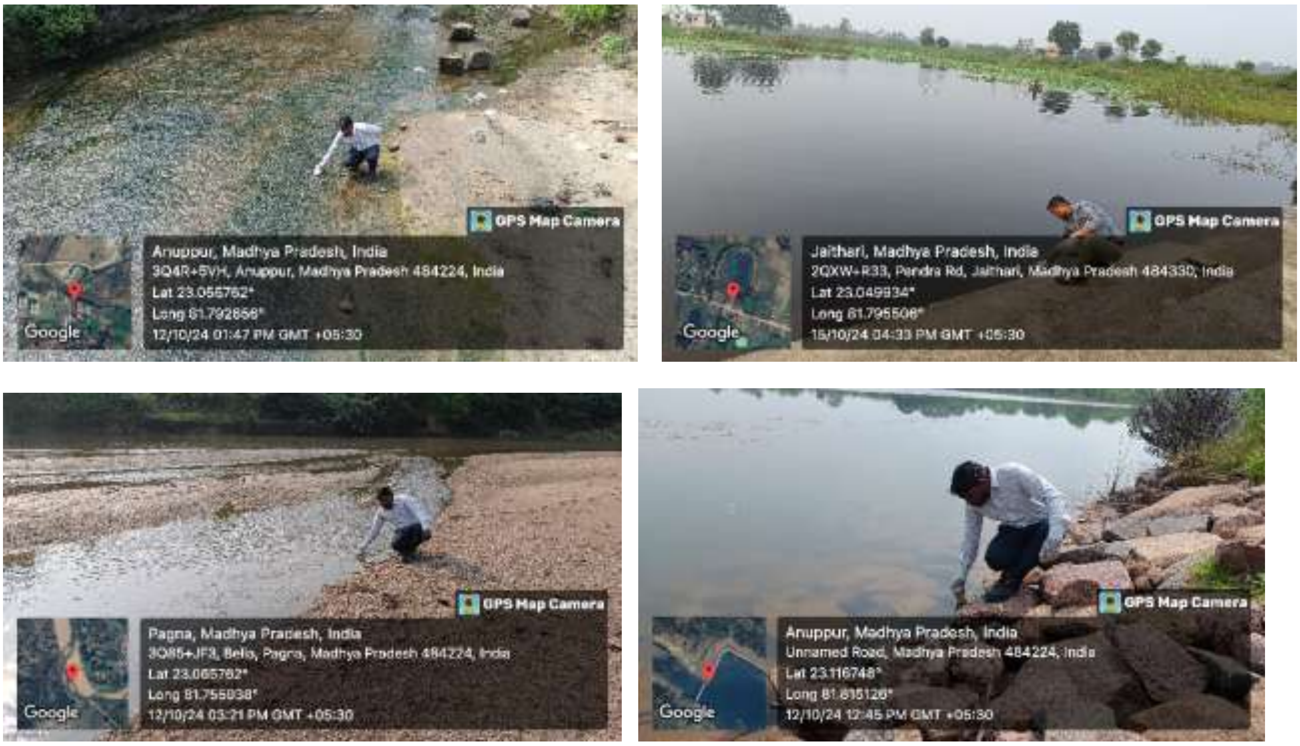


Figure 3-52: Surface water Sampling during Post monsoon season

3.10.4.2 GROUND WATER QUALITY

Selection of groundwater sampling location: Several types of wells can be available for groundwater monitoring:

- Monitoring wells (wells with single or multiple piezometers);
- Water supply wells (tube wells or dug wells used for domestic, municipal, agricultural or industrial water supply)

Reconnaissance survey was undertaken and monitoring locations were finalized based on:

- Drainage pattern and surface water bodies;
- Location of residential areas representing different activities/likely impact areas; and
- Likely areas, which can represent baseline conditions

Table 3-38: Physico-chemical characterisation of ground water samples, March.2024

S. No	Parameters	UoM	GW01 Project Site	GW 02 Siwni	GW03 Belia	GW04 Murra	GW05 Jaithari	GW06 Laharpur	GW07 Gumaria	IS 10500:2012 Acceptable limit	IS 10500:2012 Permissible limit
1	Colour	Hazen	<5	<5	<5	<5	<5	<5	<5	--	--
2	Odor	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	5	15
3	Turbidity	NTU	2	3.8	<1	5	2.4	3.8	4.5	1	5
4	pH	-	7.3	7	7.5	7.0	7.3	7.2	6.8	6.5-8.5	No Relaxation
5	Conductivity	µS/cm	535	880	538	650	677.9	874.3	749	--	--
6	Total Dissolve Solids	mg/l	347.75	572	349.7	422.5	440.635	568.295	486.85	500	2000
7	Alkalinity as CaCO3	mg/l	210.48	313.58	186.72	215.48	244.62	312.54	268.72	200	600
8	Total Hardness as CaCO3	mg/l	224.18	276.22	132.11	224.18	260.21	296.24	240.19	200	600
9	Calcium as Ca	mg/l	49.62	67.68	27.58	50.52	62.72	74.42	61.46	75	200
10	Magnesium as Mg	mg/l	24.37	26.06	15.37	23.82	25.17	26.83	21.07	30	100
11	Sodium	mg/l	24.86	54.11	51.98	31.26	35.14	54.26	46.48	--	--
12	Potassium	mg/l	0.42	0.66	0.35	0.28	0.36	1.12	1.26	--	--
13	Total Suspended Solids	mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	--	--
14	Chloride as Cl	mg/l	48.09	76.11	32.04	68.09	48.07	80.11	56.08	250	1000
15	Sulphate as SO4	mg/l	32.62	35.6	40.52	26.82	38.67	42.8	43.26	200	400
16	Nitrate as NO3	mg/l	4.26	5.12	2.26	6.15	7.72	10.2	4.88	45	No Relaxation

S. No	Parameters	UoM	GW01 Project Site	GW 02 Siwni	GW03 Belia	GW04 Murra	GW05 Jaithari	GW06 Laharpur	GW07 Gumaria	IS 10500:2012 Acceptable limit	IS 10500:2012 Permissible limit
17	Fluoride as F	mg/l	0.26	0.28	0.31	0.25	0.18	0.26	0.31	1.0	1.5
18	Phenolic compound as C6H5OH	mg/l	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.001	0.002
19	Phosphate	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	--	--
20	Silica	mg/l	7.26	8.11	7.48	7.17	10.28	11.58	8.62	--	--
21	Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.05
22	Cadmium	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	No Relaxation
23	Chromium as Cr+6	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	--	--
24	Iron	mg/l	0.14	0.24	0.18	0.26	0.19	0.22	0.15	0.3	No Relaxation
25	Copper	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05	1.5
26	Lead	mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01	No Relaxation
27	Mercury	mg/l	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.01	No Relaxation
28	Zinc	mg/l	0.32	0.41	0.36	0.31	0.35	0.44	0.41	5	15
29	Dissolved Oxygen	mg/l	7.2	7.1	7.1	7.2	7.2	7.1	7.2	--	--
30	COD	mg/l	<10	<10	<10	<10	<10	<10	<10	--	--
31	BOD, 27°C 3 days	mg/l	<2	<2	<2	<2	<2	<2	<2	--	--

S. No	Parameters	UoM	GW01 Project Site	GW 02 Siwni	GW03 Belia	GW04 Murra	GW05 Jaithari	GW06 Laharpur	GW07 Gumaria	IS 10500:2012 Acceptable limit	IS 10500:2012 Permissible limit
32	Total Coliforms	Per 100 ml	Absent	Absent	Absent	Absent	Absent	Absent	Absent	--	--
33	Oil & Grease	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**<0.5**	0.5	No Relaxation
34	Total Chromium	mg/l	**<0.03**	**<0.03**	**<0.03**	**<0.03**	**<0.03**	**<0.03**	**<0.03**	0.05	No Relaxation

Discussion:

pH: The data revealed that the pH value of ground water samples varied from 6.78 to 7.54. The water samples are slightly alkaline. The reasons for such conditions may be due to different types of buffers that may be present in the ground water and presence of weak basic salt in the soil.

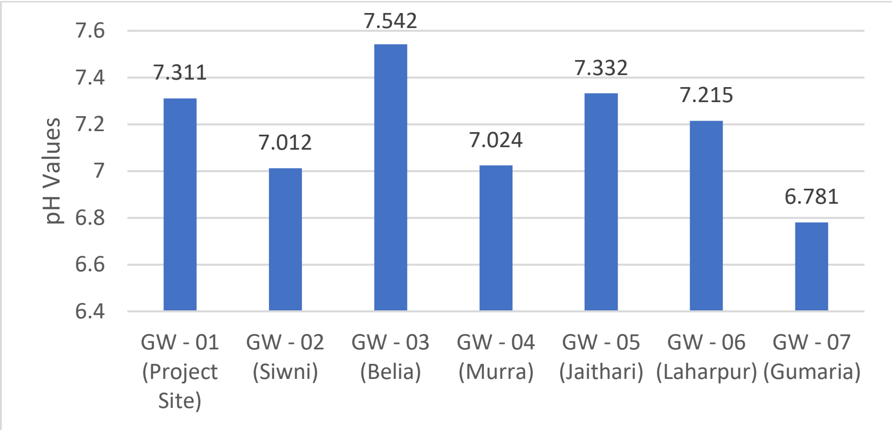


Figure 3-53: pH of the GW sample of study area

Electrical Conductivity (EC): Electrical conductivity of ground water ranged between 535 µS/cm to 88o µS/cm during the study period. The maximum value of EC was observed in at GW2 and the minimum value found in the sample at village at GW1. All samples showed non saline ground water.

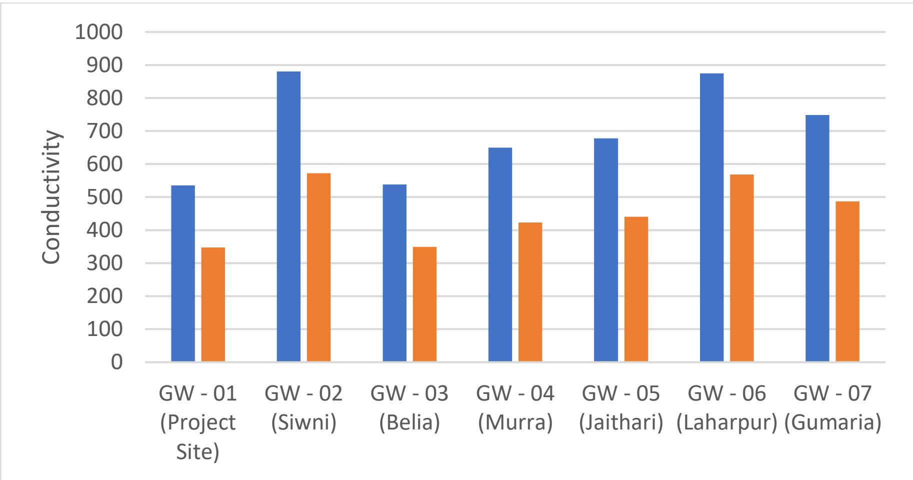


Figure 3-54: EC & TDS of the GW sample of study area

Total Dissolved Solid (TDS):
The total suspended solids are composed of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium, manganese, organic matter, salt and other particles (Mahananda *et al,* 2010). The study of ground water sample shows a positive correlation between TDS and EC (**Figure-3.54**). All samples are within the permissible limits of the IS10500:2012.

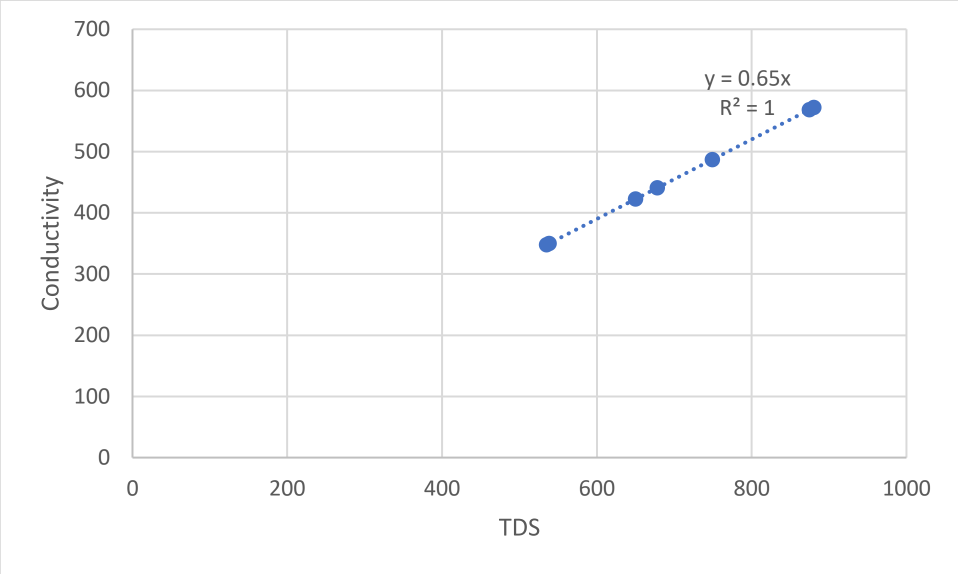


Figure 3-55: Correlation between EC & TDS.

Total Hardness (TH), Calcium (Ca^{2+}) and Magnesium (Mg^{2+}): Hard water makes it difficult for domestic water users. Hardness is defined as the concentration of calcium and magnesium in water expressed as the equivalent of calcium carbonate ($CaCO_3$). The maximum total hardness of ground water was found to be 296.2 mg/l in sample at GW5 in the post monsoon period and the minimum was observed as 132.1 mg/l in the sample at GW. 100% of the samples were within the permissible limit recommended by BIS (600 mg/l). The range of $Ca^{2+}$and Mg^{2+} are also remaining within the acceptable limits 27.58-74.42 mg/l and 15.36-26.8 mg/l respectively **(Figure- 3.55).**

Calcium or Magnesium salts or both causes almost all Hardness of water (Nirmala *et. al.,* 2012). High value of hardness during summer can be attributed to decrease in water volume and increase of rate of evaporation of water (Sahoo *et al.,* 2016).

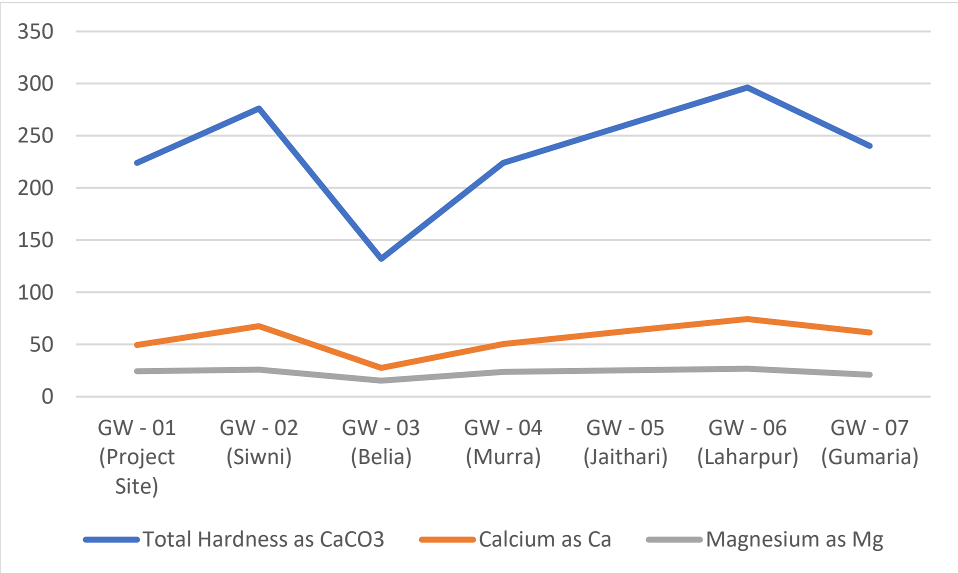


Figure 3-56: TH, Ca2+ & Mg2+ of the GW sample

Alkalinity: The alkalinity of water is caused mainly due to OH^-, CO_3^-, HCO_3^- ions. Alkalinity is an estimate of the ability of water to resist change in pH upon addition of acid. The alkalinity of Hand pump water was found to be 313.58 mg/l at GW02 and the minimum was observed as 186.72 mg/l at GW03 during the monitoring period.

Chloride: The maximum chloride concentration 80.1 mg/l was found at GW06 and the minimum 32.04 mg/l was recorded at GW03. The samples were compared with the BIS standard and all the samples were within the acceptable limit of 250 mg/l.

Fluoride: Fluoride in groundwater has drawn worldwide attention due to its considerable impact on human physiology. Though fluoride is considered as an essential element at very lower concentration for human beings, higher concentration leads to health defects. The minimum level of fluoride 0.18 mg/l was found in GW05 and the maximum value 0.31 mg/l was found at GW07. All samples were within permissible limits of 1.5 mg/l.

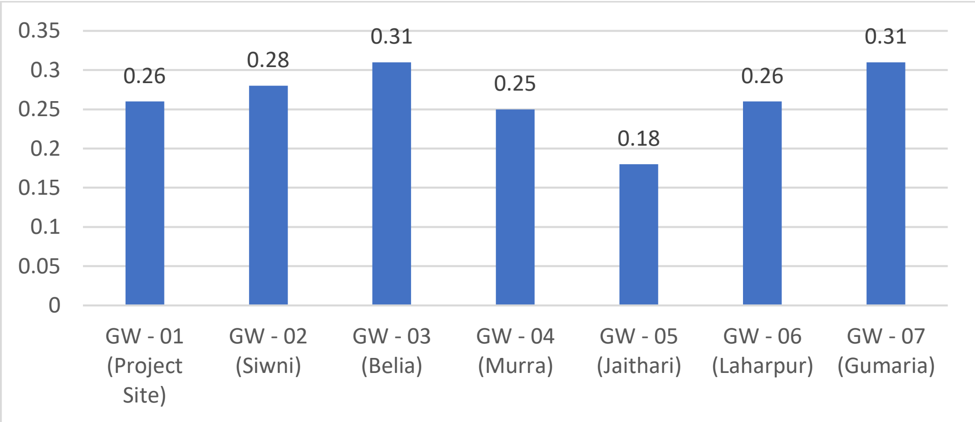


Figure 3-57: Fluoride concentration of the GW samples

Nitrate: The concentration of nitrate in ground water samples ranged from 2.26 mg/l at GW02 to 10.2 mg/l at GW05. All the samples were compared with the BIS standard and found within the acceptable limit of 45 mg/l.

Heavy Metals: Some of the metals are essential to sustain life - calcium, magnesium, potassium and sodium must be present for normal body functions. However, excess exposure to heavy metals can result in toxicity.

Zinc concentration in the ground water samples were within the acceptable limit of 5 mg/l prescribed by BIS. Other heavy metals like arsenic, cadmium, chromium, copper, lead and selenium were recorded below detection limit.

Dissolved oxygen in groundwater varied between 7.1 mg/l in GW02, 03 and 06 to 7.2 mg/l in rest of the monitoring locations. Nevertheless, measurement of DO is critical to the scientific understanding of the potential for chemical and biochemical processes in groundwater. Organic matter or oxidisable minerals present in different zone in soil profile rapidly deplete the dissolved oxygen. Besides, in deeper aquifers the dissolved organic matter concentration is very less except the shallow aquifers. Therefore, in aquifers where organic materials are less plentiful, groundwater contains not measurable concentrations of DO for deeper aquifers.

Groundwater is an important source of drinking water throughout the world (Chilton and Seiler, 2006) and it is often consumed with little or no treatment (Pedley *et al.,* 2006). Total coliform presence in groundwater sources can be used to indicate that the groundwater source may be vulnerable to contamination. But as on our study indicated absent of total coliforms was found in all groundwater samples in study area.

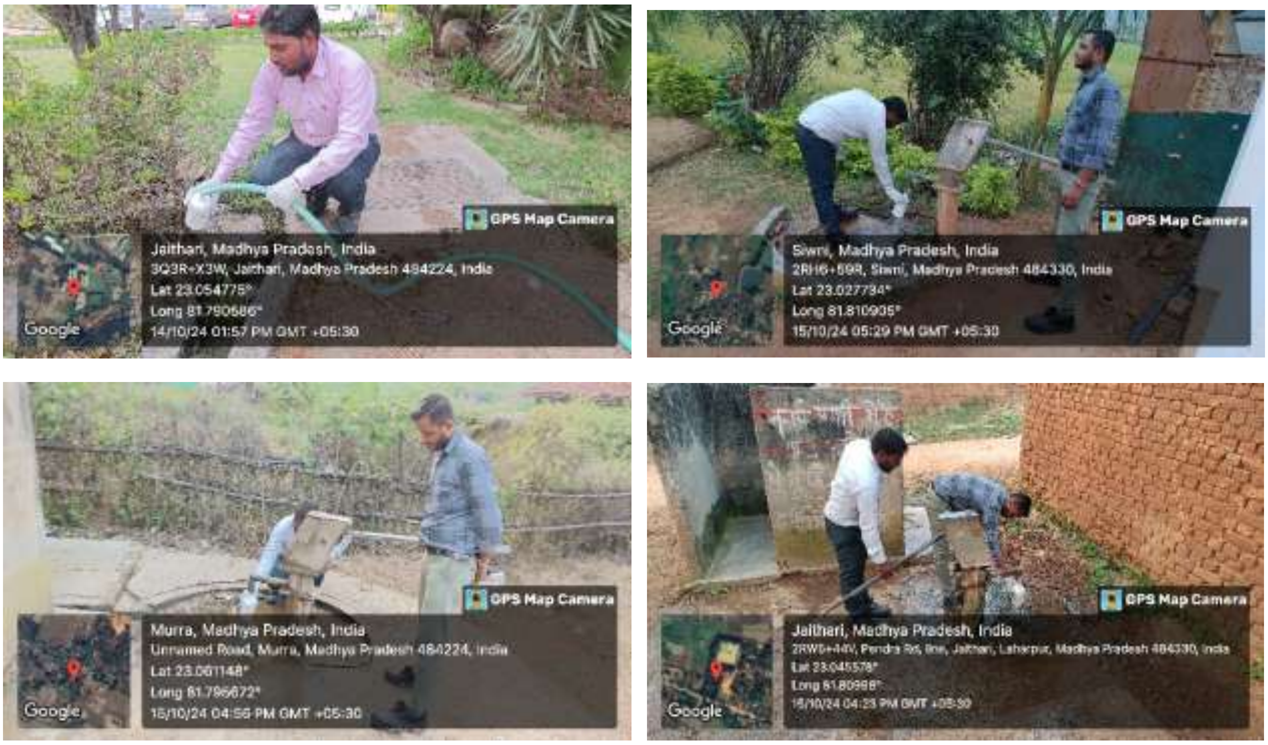


Figure 3-58: Ground water sample collection for Post Monsoon season.

3.11 Comparative Study of Baseline Data.

A comparative has been conducted to assess the Air, Water, Soil and Ambient Air quality from the previous baseline monitoring in Post Monsoon season in 2023 to Post Monsoon season, 2024. This study focuses on the 10 km radius study area, analysing data from common stations that were monitored both in 2023 and 2024 within the study area.

Ambient Air Quality: During 2023 study PM10 of maximum varies 78.7 µg/m^3 (Anuppur) to minimum 43.6 µg/m^3 (Anjani Village). PM 2.5 varied from maximum 42.3 µg/m^3 to minimum 22.7 µg/m^3 (Anjani village). The maximum value of SO_2 varies between 19.2 µg/m^3 (Anuppur) to 4.9 µg/m^3 (Anjani Village). NO_2 varies between 25.9 µg/m^3 (Anuppur) to 10.0 µg/m3 (Anjani village).

During 2024 The 98th percentile value of PM_{10} varies between 76.23µg/m^3 at Anuppur to 52.44 µg/m^3 at Kusumhai village and the 98th percentile value of $PM_{2.5}$ varies between 42.04 µg/m^3 at Project Site to 23.59 µg/m^3 at Kusumhai village. However, the values of Sulphur pollutants in this case were found well below the NAAQ standard. The 98th percentile value of SO2 in the study area ranges from 16.66

μ g/m3 in Belia to 9.43 μ g/m3 in Kusumgai village. In the study area, the 98th percentile of NO_2 varies between 19.86 μg/m^3 at Project Site to 13.53 μg/m^3 at Kusumhai.

So, it is concluded that the project site pollution level slightly increases w.r.t SO_2 and NO_2. Whereas Anuppur remains the highest polluted area for PM10 and PM 2.5.

But overall concluded that during 2023 and 2024 study ambient air quality indicated PM10, PM2.5, SO2 and NO2 are within standard limit of NAAQ, 2009.

Table 3-39: AAQ Comparison.

S. No.	Parameters	Study Year	
		2023	2024
1.	PM_{10}	78.7 μg/m^3 to 43.6 μg/m^3	76.23 μg/m^3 to 52.44 μg/m^3
2.	$PM_{2.5}$	42.3 μg/m^3 to 22.7 μg/m^3	42.04 μg/m^3 to 23.59 μg/m^3
3.	SO_2	19.2 μg/m^3 to 4.9 μg/m^3	16.66 μg/m^3 to 9.43 μg/m^3
4.	NO_2	25.9 μg/m^3 to 10 μg/m^3	19.86 μg/m^3 to 13.53μg/m^3

Soil Quality: In 2023 study, pH in soil observed neutral to slightly alkaline to neutral in in nature. EC observed average, texture of soil is sandy loam whereas nutrient level in soil showed nitrogen was sufficient, phosphorous was medium and potassium very less to average. So, it was concluded that nutrient level is sufficient for the irrigation within study area.

Whereas during 2024 study, pH value recorded in the study area varies from "Slightly Alkaline" as per ICAR report. Conductivity was observed to be "average". The soil texture of the study area varies between sandy clay to Sandy loamy. The nitrogen in the study area presents as "good" to "better", phosphorus in the study area present is classified as "less" to "medium", potassium in the study area present is classified as "very less" to "medium".

Overall quality of soil remaining same except for the nitrogen content which have increased slightly from the previous study.

Therefore, though the NPK content in the soil have decreased slightly in the monitored location, it is concluded that the NPK content is satisfactory for the growth of seasonal crops. During both years of study, it was concluded that study area showed that NPK content is improve in 2024.

Table 3-40: Comparison of Soil Parameters.

S. No.	Parameters	Study Year	
		2023	2024
1.	**pH**	Slightly Alkaline to neutral	Slightly Alkaline
2.	**EC**	130 μmhos/cm to 80 μmhos/cm	210 μmhos/cm to 112 μmhos/cm
3.	**Texture**	Clay, Clay loam and Sandy Loam	Clay, Loamy Sand
4.	**Nitrogen**	235.22 kg/ ha 175.97 kg/ha	244.8 kg/ha to 124.26 kg/ha

5.	**Phosphorus**	48.19 kg/ha to 32.0 kg/ha	47.26 kg/ha to 26.48 kg/ha
6.	**Potassium**	229.55 kg/ha to 105.45 kg/ha	205.4 kg/ha to 92.1 kg/ha

Ambient Noise: During 2023 noise study observed during day time varies between 61.4 dB(A) at Plant site (industrial area) and 58.7 dB (A) at Anuppur to 51.9dB(A) in Belia village, whereas during night time it varied between 50.6dB(A) in Plant Site (industrial area) and 44.4 dB(A) in Anuppur to 41.8 dB(A) in Belian village.

The day time noise levels showed maximum 62.4 dB(A) at Project Site (industrial area) and in Anuppur to minimum 51.4 dB(A) at Jaithari. The night time noise levels showed maximum 53.1 dB(A) at Project Site (industrial area) and Anuppur and minimum 42.2 dB(A) at Anjani during the 2024 baseline monitoring.

The noise level at the project site is the highest for being in the industrial area, whereas Anuppur have the highest level of Ambient Noise among the residential area, even exceeding the standard norms.

Table 3-41: Comparison of Ambient Noise Levels.

S. No.	Parameters	Study Year	
		2023	2024
1.	**Day Time**	61.4 dB(A) to 51.9 dB(A)	62.4 dB(A) to 51.4 dB(A)
2.	**Night Time**	50.6 dB(A) to 41.8 dB(A)	53.1 dB(A) to 42.2 dB(A)

So, it was concluded that noise study conducted during 2023 and 2024 the noise level increase in 10km study area.

Surface water: In 2023 study, the chemical analysis of surface water samples reveals that there is a variation in a chemical composition of water samples from the nearby water bodies. The pH of the water bodies ranges from 7.37 to 7.65 indicating from normal in nature. The odour was found agreeable at all the nine sampling locations. Total hardness (120 to 315.8 mg/l), Total dissolved solids (213 to 544 mg/l), total suspended solids observed BDL, total alkalinity (90 to 310 mg/l) and conductivity (320 to 800 µS/cm). The maximum value of COD and BOD (36 mg/l and 8.5 mg/l, respectively) value was found at Pond near Bhole Mandir in Jaithari village. The nutrients level was found i.e. sulphate (21.23 to 65.32 mg/l), nitrate (2.96 to 5.04 mg/l), calcium (30.4 to 93.2 mg/l), magnesium (7.90 to 20.12 mg/l), chloride (52.21 to 98.55 mg/l), fluoride (0.36 to 0.58 mg/l), sodium (11.0 to 25.0 mg/l), potassium (2.0 to 7.0 mg/l), iron (0.09 to 0.16 mg/l), zinc (0.42 to 0.82 mg/l) and phosphate (0.03 to 0.21 mg/l). The Dissolved oxygen varies from 6.7 to 7.4 mg/l which indicates that the water quality is quite satisfactory at all locations.

During the 2024 monitoring, the pH of the study area varied from 6.811 (SW10) to 7.714 (SW 01), which is neutral to slightly alkaline in nature. TDS was observed in the range of 98.02 mg/l at SW05 to max. 481 mg/l at SW01, total suspended solids was observed 1.4 mg/l to 5.11mg/l. Conductivity of water samples indicated non saline in nature it was varied between 150.8 µS/cm at SW05 to 740 µS/cm at SW2. Dissolved oxygen was recorded sufficient in the study area i.e., min 6.5 mg/l (SW08) to max. 7 mg/l (SW09) BOD in surface water found high which is varied between <2 mg/l in SW04 to 6.2 mg/l in SW08 during Post monsoon months. The minimum total hardness of surface water samples in study area was found to be 50.46 mg/l in sample at SW05 and the maximum was observed as 276.22 mg/l in the sample at SW02 during the monitoring period. The range of $Ca^{2+}$and Mg^{2+} are also remaining within the acceptable limits 18.4-68.6 mg/l and 1.1- 41.85 mg/l respectively. The minimum chloride concentration (10.6 mg/l) was found at SW07 and the maximum (54.07 mg/l). The level of fluoride ranged between 0.18 mg/l at SW07 in April to 0.43 mg/l at SW01 and were found to be within the tolerance limit of surface water. The nitrate in surface water ranged between 3.26 mg/l at SW05 to 15.6 mg/l at SW02 and were found to be within the tolerance limit of surface water.

Comparing the values of pH, DO, BOD and total coliform with ‘Use based classification of surface waters’ published by Central Pollution Control Board and majority of the surface water samples meet the criteria C and D.

Therefore, it is concluded that all the monitoring stations have good and safe physical and chemical quality for aquatic biodiversity.

Table 3-42: Comparison of Surface water parameters

S. No.	Parameters	Study Year	
		2023	2024
1.	**pH**	7.37 to 7.65	6.8 to 7.7
2.	**EC**	320 µmho/cm to 800 µmho/cm	150.8 µS/cm to 740 µS/cm
3.	**TDS**	213 mg/l to 544 mg/l	98.02 mg/l to 481 mg/l
4.	**Nitrate**	2.96 mg/l to 5.04 mg/l	3.26 mg/l to 15.6 mg/l
5.	**BOD**	<0.2 mg/l to 8.5 mg/l	<0.2 mg/l to 6.2 mg/l
6.	**COD**	<1 mg/l to 36mg/l	11 mg/l to 21 mg/l

Ground water: In 2023 study, annual surface analysis data shows pH neutral to slightly alkaline. TDS of GW indicated under permissible limit and conductivity indicated non saline nature of water. Nitrate samples observed under permissible limit as per IS10500:2012. BOD a of ground water samples indicated less than 2 mg/l and COD observed <4 mg/l. Total coliform absent in groundwater.

Whereas, during pre-monsoon, 2024 study, pH in GW indicated slightly alkaline. All samples were within permissible limits. Nitrate were under limit acceptable limit as per IS1050:2012. BOD & COD in groundwater observed below detection limit. Total coliform is absent in groundwater.

Therefore, it is concluded that the ground water not contaminated since 2023 to 2024 as compare with IS 10500:2012.

Table 3-43: Comparison of Ground water parameters

S. No.	Parameters	Study Year	
		2023	**2024**
1.	**pH**	6.56 to 7.65	6.8 to 7.5
2.	**EC**	480 µmho/cm to 816 µmho/cm	535 µS/cm to 880 µS/cm
3.	**TDS**	328 mg/l to 555 mg/l	347.75 mg/l to 572 mg/l
4.	**Nitrate**	3.25 mg/l to 8.91 mg/l	2.26 mg/l to 10.2 mg/l
5.	**Fluoride**	0.39 mg/l to 0.87 mg/l	0.18 mg/l to 0.31 mg/l
6.	**Chloride**	82.52 mg/l to 128.27 mg/l	32.04 mg/l to 80.11 mg/l
7.	**Total coliform**	Absent	Absent
8.	**BOD**	<2	<2
9.	**COD**	<10	<10

3.12 TRAFFIC SCENARIO

Traffic survey has been conducted for 24 hours at 1 location at Pendra road (~0.3 km in W direction). The traffic survey monitoring was done in Dec. 2024 to predict the future traffic growth and the load on the plant road and surroundings due to the expansion project.

Table 3-44: Locations of Traffic Survey.

S. No	Traffic Survey Location	Geographical Coordinates	Type of Carriageway	Distance & direction from the plant site
1	Pendra Road	23° 3'31"N 81°46'48"E	2 Lane (undivided)	(0.3 km in W direction)

The above-mentioned locations/ selected survey point is given in **Table 3-44.** Measurements of Traffic density were made continuously for 24 hours by visual observation and counting of vehicles under six categories, viz., Motor cycle/ Scooter, Passenger Car/ Van/ Auto Rickshaw, Tractor, Buses/Trucks, Troller, Cycles/ Cycle Rickshaw. Total numbers of vehicles per hour under the six categories were determined. The details of the traffic volume count have been provided in **Table 3-45** given below:

Table 3-45: Existing Traffic Scenario

Sl No	Vehicle type	Vehicle/ day	PCU Factor	PCU/day
	(A)	(B)	(C)	= (B*C)
1	Motor cycle or Scooter	543	0.5	271.5
2	Passenger Car, Pickup van, Auto-rickshaw	538	1	538
3	Tractor	199	1.5	298.5
4	Trucks/Bulker & Buses	249	3	747
5	Trollers	96	4.5	432
6	Cycles/ Cycles Rikshaw	258	2	516
Total		**1883**		**2803**

Source: (i) Traffic Survey by GCPL (ii) IRC: 106-1990 (iii) IRC: 64-1990

Table 3-46: Existing Traffic Scenario and LOS (Level of Service)

Sl No	Traffic Survey Point	V (Volume in PCU/day)	C (Capacity in PCU/ day)	Existing V/C Ratio	LOS
1	Pendra Road	2,803	15,000	0.1868	A

Relation between V/C ratio &LoS

V/C Ratio	LoS	Performance
0.0-0.2	A	Represents a condition of free flow
0.2-0.4	B	Represents a zone of stable flow
0.4-0.6	C	The general level of comfort and convenience declines noticeably at this level
0.6-0.8	D	Represents the limit of stable flow
0.8-1.0	E	Represents operating condition when traffic volumes are at or close to the capacity level

The results of the survey, the existing passenger car unit (PCU) of each location were compared with the capacity of each type of road as suggested by Indian Road Congress thus determining the existing Level of Service (LoS) for each location. The existing conditions shows **A Level of service** at Pendra Road which represents a condition of free flow (**Table 3.46**).

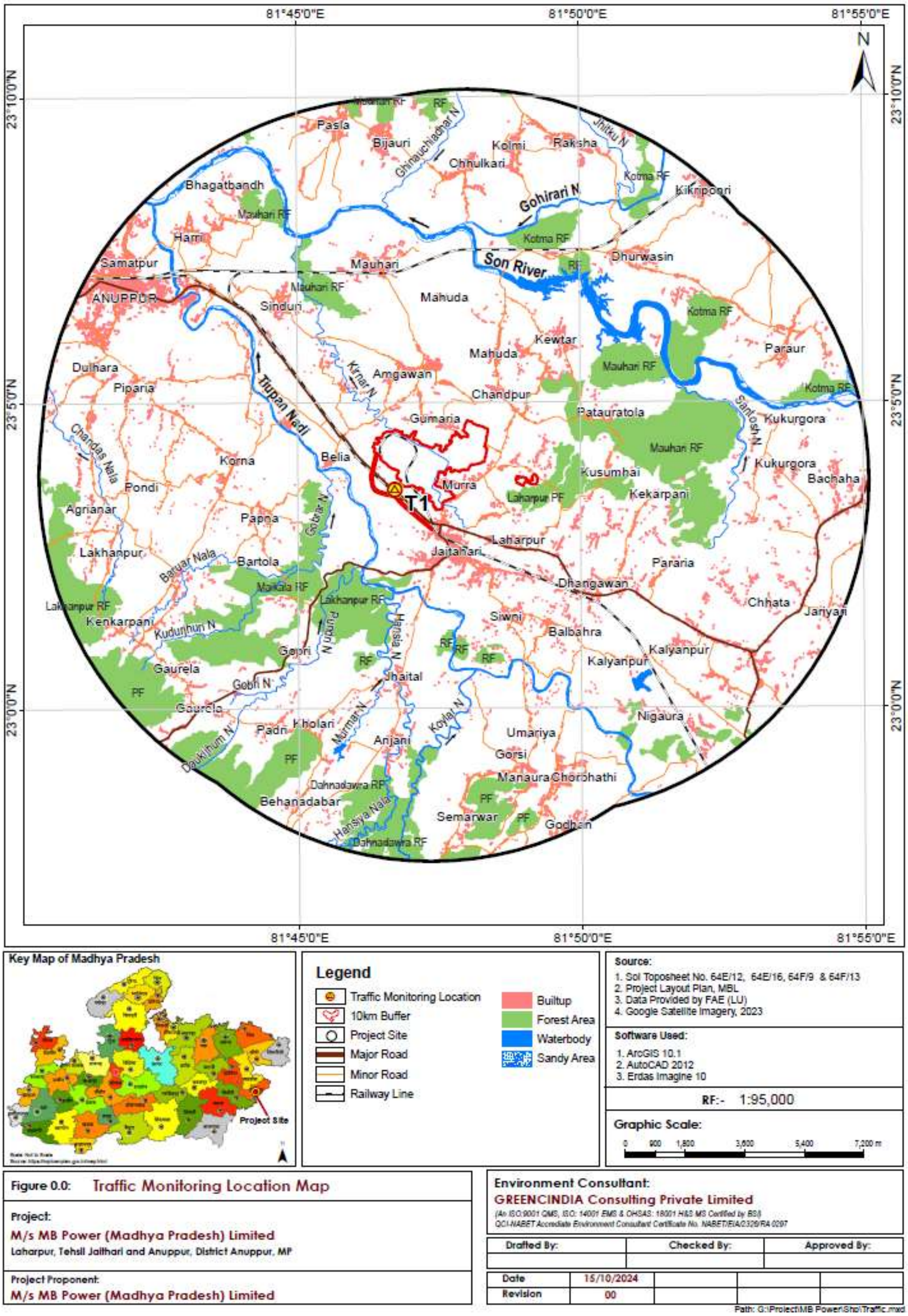


Figure 3-59: Traffic Study Locations

3.13 TERRESTRIAL ECOLOGICAL SURVEY AND BIODIVERSITY STUDY

Plants and animals are particularly vulnerable to environmental stress. Changes in the composition of biological communities are evident through shifts in the distribution pattern, frequency, density, and abundance of natural flora and fauna species within the ecosystem. These changes can be measured over time and linked to current environmental conditions. Baseline ecological information is gathered through literature reviews and quadrat surveys in forest areas of the study region. The baseline terrestrial ecology study area included all ecological zones likely to be affected.

The ecological survey depends on primary survey and secondary literature review and assesses habitat types, vegetation patterns, and created an inventory of flora and fauna within a 10km radius from the project site's boundary. The biological assessment aimed to identify any rare, endangered, or threatened species of flora or fauna in both the core and buffer zones, as well as any ecologically sensitive areas within the buffer zone that might be impacted.

To achieve these objectives, a detailed study was conducted using the following methods:

- Field surveys to collect primary data
- Interviewing local residents to gather information about local plants, animals, and their uses
- Collecting ethno-biological data

This report reviews published secondary data and presents the findings from the general ecological survey conducted in the area. The terrestrial ecological status of the area is detailed below.

3.13.1 FOREST TYPE

Located in Central India, Madhya Pradesh is the second largest State covering an area of 3,08,252 sq km which is 9.38% of the geographical area of the country and is bordered on the west by Gujarat, on the northwest by Rajasthan, on the northeast by Uttar Pradesh, on the east by Chhattisgarh, and on the south by Maharashtra. The State lies between 21°17' N to 26°52' N latitude and 74°08' E to 82°49' E longitudes. Physiographically, the State can be divided into four regions, viz the low lying areas in north and north-west of Gwalior, Malwa Plateau, Satpuda and Vindhyan Ranges. Madhya Pradesh has a subtropical climate. The annual rainfall ranges 800 mm to 1,800 mm and the annual temperature varies from 22°C to 25°C. The State is drained by a number of rivers, which include Narmada, Tapti, Son, Betwa, Shipra and Chambal. The State has 50 districts, of which 21 are tribal districts. The State does not have any hill district. As per the 2011 census, Madhya Pradesh has a population of 72.63 million accounting to 6 percent of India's population. The rural and urban population stands at 72.37% and 27.63% respectively. Tribal population of the State is 21.09%. The population density of the State is 236 per sq km, which is much lower than the national average. The 19th Livestock census 2012 has reported a total livestock population of 36.33 million.

As per ISFR 2019, Madhya Pradesh is a forest rich State and is ranked first among the States in terms of the RFA. The State has a sizeable tribal and rural population which is dependent on the forests for their livelihood and basic needs. As per the Champion & Seth Classification of Forest Types (1968), the forests in Madhya Pradesh belong to five Forest Type Groups, which are further divided into 21

Forest Types. Madhya Pradesh is a pioneering State in the implementation of the Joint Forest Management (JFM) movement in the country. The State has a strong JFM network through 15,228 JFMC/VSS/EDCs covering an area of 66,874 sq km. In order to provide benefits to forest dwellers in collection and trade of forest produce, the Madhya Pradesh State Minor Forest Produce (Trading & Development) Co-operative Federation was formed in 1984. The Federation co-ordinates collection, processing and marketing of Tendu leaves, Sal Seed, Kullu Gum and other NTFPs through Primary Forest Produce Co-operative Societies. The Madhya Pradesh Rajya Van Vikas Nigam Ltd. Undertakes the scientific harvest of forests and its regeneration. Recorded Forest Area (RFA) in the State is 94,689 sq km of which 61,886 sq km is Reserved Forests, 31,098 sq km is Protected Forests and 1,705 sq km is Unclassed Forests. In Madhya Pradesh, during the period 1st January 2015 to 5th February 2019, a total of 12,785.98 hectares of forest land was diverted for nonforestry purposes under the Forest Conservation Act, 1980 (MoEF & CC, 2019). Ten National Parks and 25 Wildlife Sanctuaries constitute the Protected Area network of the State covering 3.51% of its geographical area. There are 6 Tiger Reserves in the State covering an area of 6117.26 sq km. Eco-sensitive zones have been declared for 19 protected areas. The State with a population of 526 Tigers, is recognized as Tiger State of India.

The thermal power plant falls in the Anuppur district of the state of Madhya Pradesh and the 10 km radius around it is called the study area for this report. A major river Tipan (1 km, WSW) and Sone River flows at 4.7 km in the NE direction from the project site.

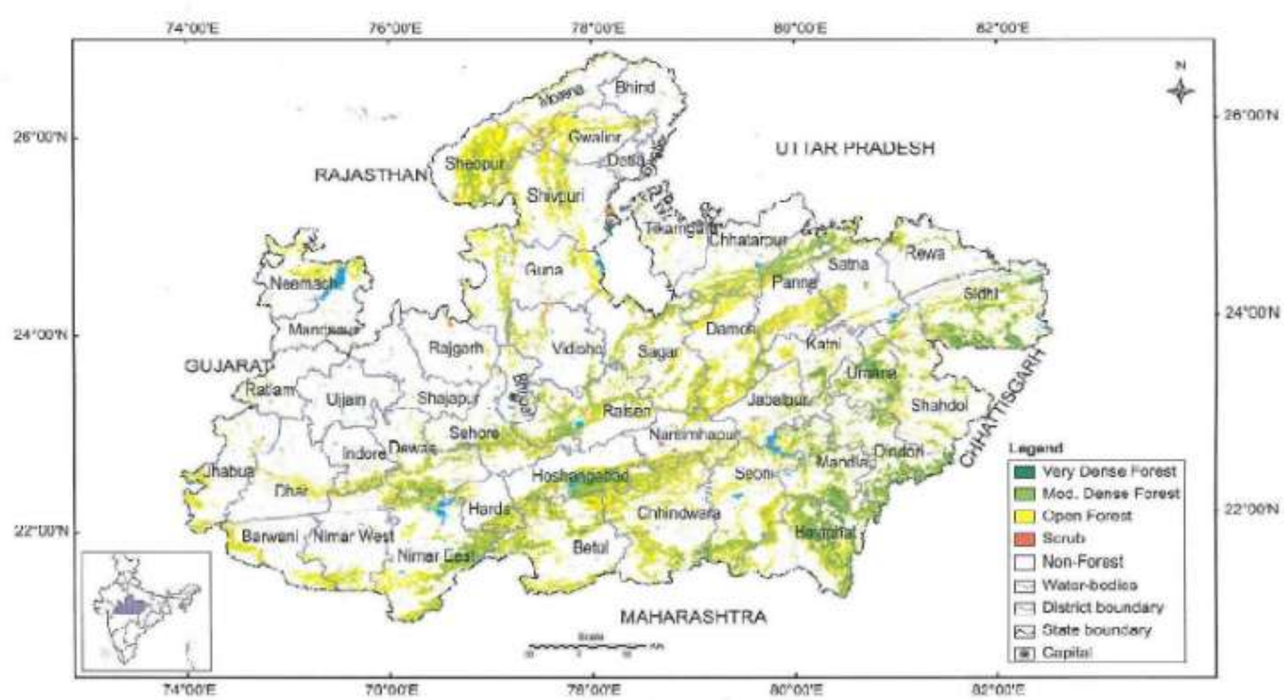


Figure 3-60: Forest cover map of Madhya Pradesh

3.13.2 FLORAL STUDY

Study of biological environment is one of the important aspects in Environmental Impact Assessment in view of the need for conservation of Environmental quality. Ecological study was carried out by ecology team of GCPL. Reconnaissance study of the area was done to obtain flora & Fauna structure of the area. Stakeholder consultation with villagers, government officials, gram panchayat, teachers, workers, etc were carried out. Forest officials were also consulted and data based on their records were also collected.

During the survey, an inventory of the various plant groups discovered in the study region was created. 19 Near Threatened species, 24 vulnerable species, 7 Endangered species & 2 Critically Endangered species were identified in the study area. In the research region, 192 species of flora were identified. Out of which 85 species of trees and small trees,19 species of Grasses, 29 species of Climbers, 24 species of Shrubs & 36 species of Herbs have been recorded in the study area based on primary observation as well as based on information collected from the secondary data.

The crops sown in the area are wheat (*Triticum sp.*), tuhar (pulses- *Cajanas cajan*), paddy (*Oryza sativa*), grams etc. Oilseeds like peanut and sesame seeds are also commonly grown in this area.

Additional study on biodiversity of the study area as per specific ToR 1.10 was conducted by Indira Gandhi National Tribal University, Amarkantak during January, 2025. The additional study report on biodiversity analysis is attached in **Annexure 7.2**.

Table 3-47: Inventory of Trees, Shrubs, Herbs and Climbers recorded from the study area

Sl No.	Common Name	Scientific Name	Family	Core Zone	Buffer zone	IUCN Conservation Status
Trees						
1	Safed Siris	*Acacia nilotica*	Fabaceae	+	+	LC
2	Kala Siris	*Acacia lebbek*	Fabaceae	-	+	LC
3	Haldu	*Adina cordifolia*	Rubiaceae	-	+	NE
4	Bael	*Aegle marmelos*	Rutaceae	+	+	NT
5	Dhabra	*Anogeissus latifolia*	Combretaceae		+	NE
6	Neem	*Azadirachta indica*	Meliaceae	+	+	LC
7	Salai	*Boswellia serata*	Burseraceae	+	+	NE
8	Amla	*Embllica officinalis*	Phyllanthaceae	+	+	LC
9	Kachnar	*Bauhinia purpuraca*	Fabaceae		+	LC
10	Ashta	*Bauhinia racemose*	Fabaceae		+	NE
11	Kashai	*Bridelia retusa*	Phyllanthaceae	+	+	LC
12	Aachar	*Buchanania lanzan*	Anacardiaceae		+	vu
13	Palash	*Butea monosperma*	Fabaceae		+	LC
14	Amaltash	*Cassia fistula*	Fabaceae		+	LC
15	Galgal	*Cochiospermum religlosum*	Bixaceae	+	+	vu
16	Dhobin	*Dalbergia paniculata*	Fabaceae		+	LC
17	Kalla	*Dilenia pentagyna*	Dilleniaceae		+	

Sl No.	Common Name	Scientific Name	Family	Core Zone	Buffer zone	IUCN Conservation Status
18	Tendu	*Diospvros melanoxylon*	Ebenaceae		+	NE
19	Shisam	*Dalbergia latifolia*	Fabaceae		+	LC
20	Pangra	*Erythrina suberosa*	Fabaceae		+	NE
21	Nilgiri	*Eucalyptus spp*	Myrtaceae	+	+	NE
22	Bard	*Ficus bengalensis*	Moraceae		+	NE
23	Gular	*Ficus glomerata*	Moraceae		+	LC
24	Kotgular	*Ficus hispida*	Moraceae		+	LC
25	Pipal	*Ficus religiosa*	Moraceae	+	+	LC
26	Shonpakar	*Ficus tomentosa*	Moraceae	+	+	LC
27	Kakoi	*Flacourtia indica*	Salicaceae		+	LC
28	Papra	*Gardenia latifolia*	Rubiaceae		+	
29	Kekar	*Garuga pinnata*	Burseraceae		+	
30	Gamari	*Gmeline arborea*	Lamiaceae		+	LC
31	Dhaman	*Grewia tiliifolia*	Malvaceae		+	NE
32	Chirol	*Holopterea integrifolia*	Ulmaceae	+	+	NE
33	Bhanrshal	*Hymenodictyon excelsum*	Rubiaceae		+	DD
34	loukhandi	*lxora arborea*	Rubiaceae		+	NE
35	Pula	*Kevadia calycine*	Malvaceae		+	LC
36	Jhingal	*Lannea coromandelica*	Anacardiaceae		+	LC
37	Sheja	*Lagerstroemia parviflora*	Lythraceae	+	+	NE
38	Bilsena	*Limonia acidissima*	Rutaceae		+	
39	Mahua	*Madhuca indica*	Saootaceae	+	+	NE
40	Rolli	*Mallotus philippensis*	Euohorbiaceae		+	LC
41	Aam	*Mangifera indica*	Anacardiaceae	+	+	DD
42	Kari	*Miliusa tomentosa*	Annonaceae	+	+	
43	Kem,Mundi	*Mitragyna parvifolia*	Rubiaceae		+	NE
44	Jaimangal	*Oroxylum indicum*	Bignoniaceae		+	
45	Tinsha	*Ougeinia oojeinensis*	Fabaceae		+	
46	Bijasal	*Pterocarpus marsupium*	Fabaceae		+	vu
47	Shonohadar	*Radermachera xylocarpa*	Bignoniaceae		+	
48	Menfall	*Catunaregam spinosa*	Rubiaceae		+	
49	Shemal	*Bombax ceiba*	Bombacaceae		+	LC
50	Kushum	*Schleichera oleosa*	Sapindaceae	+	+	LC
51	Maukha	*Schrebera swietenioides*	Oleaceae		+	EN
52	Shal	*Shorea robusta*	Dipterocarpace ae	+	+	LC
53	Kullu	*Sterculia urens*	Malvaceae		+	LC
54	Jamun	*Syzygium cumini*	Mvrtaceae	+	+	LC
55	Katjamun	*Syzygium heyneanum*	Mvrtaceae	+	+	
56	Emli	*Tamarindus indica*	Fabaceae	+	+	LC
57	Sagaun	*Tectona grandis*	Lamiaceae	+	+	EN
58	Harra	*Terminalia chebula*	Combretaceae		+	LC

Sl No.	Common Name	Scientific Name	Family	Core Zone	Buffer zone	IUCN Conservation Status
59	Arjun	*Terminalia arjuna*	Combretaceae	+	+	LC
60	Bahera	*Terminalia bellerica*	Combretaceae	+	+	LC
61	Shaj	*Terminalia tomentosa*	Combretaceae		+	LC
62	Tilban	*Wendiandia exserta*	Rubiaceae		+	
63	Ber	*Ziziphus jujuba*	Rhamnaceae	+	+	LC
64	Ghant	*Ziziphus xylopyra*	Rhamnaceae		+	LC
65	Karanj	*Pongamia pinnata*	Fabaceae		+	LC
Shrubs						
1	Junglee Bhindi	*Abelmoschus ficulneus*	Malvaceae		+	NT
2	Kanghi	*Abutilon indicum*	Malvaceae		+	NT
3	Adusa	*Justicia adhatoda*	Acanthaceae		+	vu
4	Sated aak	*Calotropis gigantea*	Asel epiadaceae		+	vu
5	Gulabiaak	*Calotropis procera*	Asel epiadaceae		+	LC
6	Karonda	*Carissa carandus*	Apocynaceae		+	LC
7	Bhrangi	*Clerodendrum multiflorum*	Verbenaceae	+	+	NT
8	Sehud	*Euphorbia neriifolia*	Euphorbiaceae		+	vu
9	Chandarjot	*Jatropha curcas*	Euphorbiaceae			
10	Gudsakri	*Grewia helicterifolia*	Tilaceae		+	NT
11	Gangeren	*Grewia hirsuta*	Tilaceae		+	NT
12	Ratanjot	*Jatropha curcas*	Euphorbiaceae		+	LC
13	Chameli	*Jasminum officinale*	Oleaceae			
14	Lantana	*Lantana camara*	Verbenaceae	+	+	LC
15	Khakholi	*Maytenus senegalensis*	Celastraceae			
16	Meetha Neem	*Murraya koenigii*	Rutaceae		+	LC
17	Kaner	*Nerium oleander*	Apocynaceae	+		
18	Arandi	*Ricinus communis*	Euphorbiaceae		+	NT
19	Kangua	*Urena lobata*	Malvaceae	+	+	LC
20	Nirgudi	*Vitex negundo*	Verbenaceae		+	LC
21	Dhataki	*Woodfordia fruticosa*	Lythraceae			
22	Ber	*Ziziphus mauritiana*	Rhamnaceae		+	LC
23	Jharberi	*Ziziphus nummularia*	Rhamnaceae		+	LC
Herbs						
1	Chirchir	*Achyranthes aspera*	Amaranthaceae	+	+	LC
2	Chakora	*Cassia tora*	Fabaceae	+	+	VU
3	Bankulthi	*Cajanas scarabaeoides*	Fabaceae	+	+	LC
4	Salparni	*Desmodium gangeticum*	Leguminosae		+	LC
5	Gokhru	*Echinops echinatus*	Asteraceae		+	LC
6	Dudhi	*Euphorbia hirta*	Euphorbiaceae	+	+	LC
7	Amarbel	*Cuscuta reflexa*	Convolvulaceae		+	LC
8	Ratnamala	*Indigofera linifolia*	Fabaceae		+	NT

Sl No.	Common Name	Scientific Name	Family	Core Zone	Buffer zone	IUCN Conservation Status
9	Janglimethi	*Sida acuta*	Malvaceae		+	LC
10	Bantulsi	*Hyptis suaveolens*	Lamiaceae		+	LC
11	Chia	*Lindenbergia philippensis*	Orobanchaceae		+	VU
12	Sadabahar	*Catharanthus roseus*	Apocynaceae		+	LC
13	Satyanashi	*Argemone mexicana*	*Papaveraceae*		+	LC
14	Kala jeera	*Cyanthillium cinereum*	Asteraceae		+	NT
15	Makoa	*Solanum nigrum*	Solanaceae		+	LC
16	Changori	*Oxalis corniculata*	Oxal daceae		+	LC
Climber						
1	Kali dhudhchi	*Abrus precatorius*	Fabaceae		+	VU
2	Roni	*Senegalia pennata*	Mimosaceae	+	+	LC
3	Satavar	*Asparagus racemosus*	Liliaceae	+	+	VU
4	Sated palash bel	*Butea parviflora*	Fabaceae		+	DD
5	Kanfuti	*Cardiospermum halicacabum*	Sapindaceae		+	VU
6	Junglee anoor	*Cayratia auriculata*	Vitaceae		+	LC
7	Amarbel	*Ayratia trifolia*	Vitaceae	+	+	LC
8	Pahad Bel	*Cissampelos pareira*	Menispermace ae	+	+	NT
9	Kundru	*Coccinia grandis*	Cucurbitaceae		+	LC
10	Jaljamini	*Cocculus hirsutus*	Menispermaceae		+	LC
11	Dalbergia	*Dalbergia volubilis*	Fabeaceae	+	+	NT
12	Vish kand	*Dioscorea alata*	Dioscoreaceae		+	VU
13	Bechandi	*Dioscorea hispida*	Dioscoreaceae		+	VU
14	Kalihari	*Glorioso superba*	Liliaceae		+	EN
15	Sariva	*Hemidesmus indicus*	Asclep iadaceae		+	NT
16	lpomea	*lpomoea hederifolia*	Convolvulaceae	+	+	LC
17	Kaladana	*lpomoea nil*	Convolvulaceae		+	LC
18	Putmi	*lpomoea pes-tigridis*	Convolvulaceae		+	VU
19	Chinahoor	*Marsdenia tenacissima*	Asclep iadaceae		+	VU
20	Padora	*Momordica dioica*	Cucurbitaceae		+	EN
21	Gandhprasha rini	*Paederia scandens*	Rubiaceae		+	EN
22	Porana	*Porana paniculata*	Convolvulacea e		+	LC
23	Ram Datun	*Smilax zeylanica*	Smilacaceae	+	+	VU
26	Junglee chachinda	*Trichosanthes cucumerina*	Cucurbitaceae		+	EN
Grass						
1	Needle grass	*Aristida adscensionis*	Poaceae		+	LC
2	Bamboo	*Dendrocalamus strictus*	Poaceae		+	LC

Sl No.	Common Name	Scientific Name	Family	Core Zone	Buffer zone	IUCN Conservation Status
3	Kel	*Dicanthium annulatum*	Poaceae		+	LC
4	Bhurbhusi	*Eragrostis tenella*	Poaceae		+	LC
5	Ghaas	*Heteropogon contortus*	Poaceae		+	LC
6	Chrysopogn	Chrysopogon fulvus	Poaceae		+	LC
7	Doob	Cynodon dactylon	Poaceae	+	+	LC
8	Bamboo	Dendrocalamus strictus	Poaceae	+	+	NT
9	Kail	Dichanthium annulatum	Poaceae		+	LC
10	Urai	Vetiveria zizanioides	Poaceae		+	LC
11	Gunher	Themeda quadrivalvis	Poaceae		+	LC
12	Munj	Saccharum bengalense	Poaceae		+	LC
13	Moya	Pennisetum hohenackeri	Poaceae		+	LC

3.13.3 PHYTO-SOCIOLOGICAL STUDY

To understand the floristic composition, a Phyto-sociological study of vegetation in reference to trees, shrub & herb layer was conducted in three forest patches in the study area of the proposed project. The direction and distance of these locations from the project site is provided in **Table 3.35.** At each selected site, random vegetation sampling was done with the help of quadrat (Size 10m X 10 m for tree & shrub layer and $1m^2$ quadrat for herb layer). In each quadrat number and name of all the tree, shrub and herb species was counted. Quantitative analysis of vegetation for frequency, density and abundance was calculated following Curtis and Mc. Intosh (1950) method. Their relative values were calculated and summed to get important value index (IVI). The IVI is a composite index based on measures of relative frequency (RF), relative density (RD) and relative abundance (RAB) (Muller – Dombois and Ellenberg, 1974). Species diversity index was calculated using Shannon-Weiner index (1963) Shanon Weiner diversity index was calculated by following formula:

$H = - \Sigma Pi \text{ Log } Pi$

Where: H = Shanon Weiner diversity index

Pi = ni/N where ni is number or biomass or IVI of individual species and N is the total number or biomass or IVI of all individuals. In the present study IVI (Importance Value Index) has been taken into consideration for evaluation of diversity index. Since IVI includes many of the attributes at a time, therefore consideration of IVI was preferred on number over for Shanon-Weiner diversity index. The diversity index gives an indication about the status of community, higher the value of index indicates more stability of the community. The location of the Monitoring stations in mentioned in **Figure 3.61.**

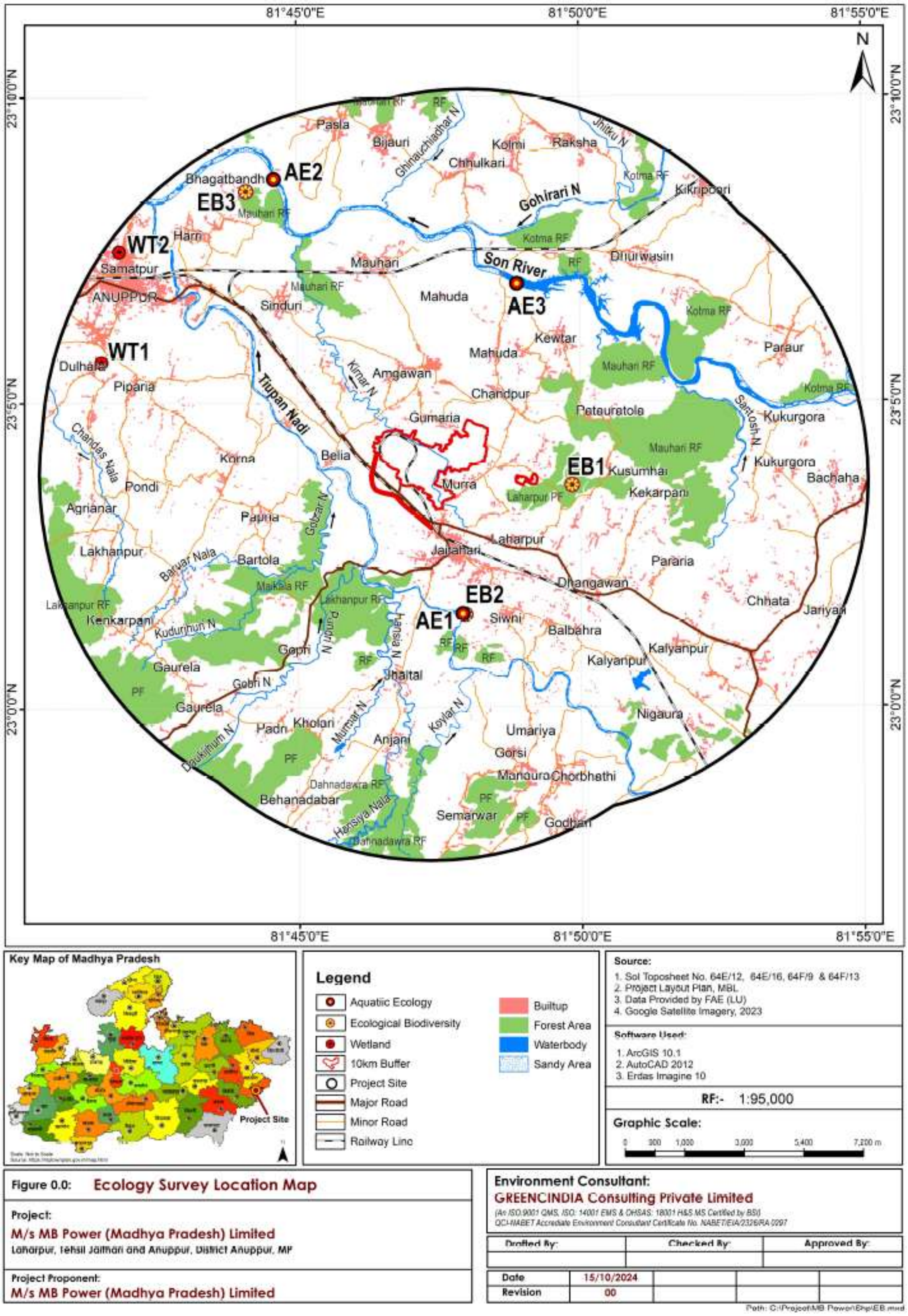


Figure 3-61: Terrestrial & Aquatic Ecology Study Locations

Table 3-48: Co-ordinates of Terrestrial and Aquatic Ecology Study

S. No.	Locations	Lat.	Long	Distance	Direction
Terrestrial Ecology Study Locations					
EB 1	EB 1 (Laharpur RF)	23° 3'38.25"N	81°49'51.44"E	2.72	E
EB 2	EB 2 (Lakhanpur RF near Tipan R)	23° 1'31.24"N	81°47'57.48"E	3.15	SSE
EB 3	EB 3 (Mauhari RF)	23° 8'27.44"N	81°44'6.05"E	8.38	NW
Aquatic Ecology Study Locations					
AE 1	AE 1 (Tipan River)	23° 1'32.02"N	1°47'54.65"E	3.2	SSE
AE 2	AE 2 (Sone River)	23° 8'39.32"N	1°44'35.66"E	8.34	NW
AE 3	AE 3 (MB Barrage)	23° 6'56.14"N	1°48'53.36"E	4.43	NNE
Wetland Ecology Study Location					
WT 1	WT 1-Dulha talab	23° 5'40.16"N	81°41'41.43"E	8.15	NW
WT 2	WT2- Samtapur Talab	23° 7'28.43"N	81°41'51.07"E	9.54	WNW

The phyto-sociological parameters for different types of vegetation- trees and shrubs for the three different locations is provided in the following tables.

Table 3-49: Phyto-sociological analysis of trees in EB 1 location

S. No.	Botanical Name	Frequency	Abundance	Density	IVI
1	*Tectona grandis*	20.0	150.0	30.00	52.09
2	*Mangifera indica*	20.0	100.0	20.00	31.73
3	*Emblica officinalis*	20.0	200.0	40.00	46.64
4	*Melia azedarach*	20.0	150.0	30.00	42.54
5	*Delonix regia*	20.0	150.0	30.00	49.32
6	*Azadirachta indica*	20.0	100.0	20.00	32.55
7	*Zizyphus jujuba*	10.0	200.0	20.00	27.49
8	*Holoptelea integrifolia*	10.0	100.0	10.00	17.63

Table 3-50: Phyto-sociological analysis of shrubs in EB 1 location

S. No.	Botanical Name	Frequency	Abundance	Density	IVI
1	*Jatropha curcas*	20	250.00	50.00	88.25
2	*Nerium oleander*	10	200.00	20.00	45.30
3	*Jasminum officinale*	20	150.00	30.00	75.80
4	*Woodfordia fruticosa*	20	150.00	30.00	61.75

5	*Carissa opaca*	10	100.00	10.00	28.90

Table 3-51: Phyto-sociological analysis of trees in EB 2 location

S. No.	Botanical Name	Frequency	Abundance	Density	IVI
1	*Pongamia pinnata*	20.0	100.0	20.00	35.20
2	*Albizia lebbeck*	20.0	100.0	20.00	28.48
3	*Sterculia urens*	20.0	100.0	20.00	27.38
4	*Diospyros melanoxylon*	20.0	150.0	30.00	37.86
5	*Emblica officinalis*	20.0	150.0	30.00	43.74
6	*Ficus religiosa*	20.0	250.0	50.00	52.98
7	*Terminalia arjuna*	10.0	100.0	10.00	15.50
8	*Azadirachta indica*	20.0	250.0	50.00	58.86

Table 3-52: Phyto-sociological analysis of shrubs in EB 2 location

S. No.	Botanical Name	Frequency	Abundance	Density	IVI
1	*Carissa opaca*	20	250.00	50.00	63.87
2	*Lantana camara*	20	250.00	50.00	77.06
3	*Hibiscus rosa-sinensis*	20	150.00	30.00	54.64
4	*Sida cordifolia*	30	133.33	40.00	62.70
5	*Casearia tomentosa*	20	100.00	20.00	41.73

Table 3-53: Phyto-sociological analysis of trees in PSS 3 location

S. No.	Botanical Name	Frequency	Abundance	Density	IVI
1	*Adina cordifolia*	30.0	200.0	60.00	64.67
2	*Terminalia arjuna*	20.0	100.0	20.00	22.24
3	*Buchnania lanzan*	20.0	150.0	30.00	26.61
4	*Albizia lebbeck*	20.0	150.0	30.00	29.12
5	*Acacia nilotica*	20.0	100.0	20.00	25.96
6	*Cassia fistula*	30.0	266.7	80.00	63.25
7	*Bauhinia racemosa*	20.0	200.0	40.00	37.01
8	*Pongamia pinnata*	20.0	150.0	30.00	31.14

Table 3-54: Phyto-sociological analysis of shrubs in PSS 3 location

S. No.	Botanical Name	Frequency	Abundance	Density	IVI
1	*Casearia tomentosa*	30	166.67	50.00	82.36
2	*Zizyphus jujuba*	20	150.00	30.00	60.78
3	*Holarrhena pubescens*	20	200.00	40.00	76.17
4	*Targestes erecta*	30	166.67	50.00	80.69

Figure 3-62: Terrestrial Ecology Study.

3.13.4 FAUNAL STUDY

The state-of the art method have been used for ecological impact assessment study. The present study was exploratory in nature based on primary as well as secondary data. Following step wise approach was followed in order to achieve the conformity with the scope of work for baseline data collection

Step 1: Reconnaissance Survey- A reconnaissance survey was undertaken to understand the complexity of terrain, habitats available, approach for various locations of buffer zone of TPP and potential areas for species enumeration.

Step 2: Secondary Data Collection- Available secondary data through published research papers, books and periodicals and PhD thesis from the area was reviewed and enlisted to confirm the presence of species. Secondary data was also collected on the historical surveys in the area. Management plan of the protected area was also reviewed. Consultation with the locals and forest officials were also made.

Step 3: Primary Data Collection-Primary surveys were undertaken to understand the actual baseline and analyse the impacts of the proposed project on ecological baseline.

3.13.4.1 MAMMALS

Mammals are the most challenging groups to do research on due to their relatively low abundance at which they are found, and the vast range of environmental niches they may inhabit. Tracks and scats can possibly be used with practically all mammals. It might not be able to identify an animal if one cannot actually catch it or see it. Animal presence clues like footprints or scats can be interpreted in a useful way. In addition to this, the species can be positively identified using bones, teeth, and skulls.

3.13.4.2 BIRDS

The methods used to sample birds are often among the simplest, although the enormous diversity in any given area and the range of cries and colour changes within species themselves can make sampling birds more difficult. For this, the following data collection techniques were used. In populated areas, the periods in between were employed, although early morning and late evening were more frequently used in desolate areas. Additionally, efforts were made to locate any nearby avian roosting, breeding, or nesting locations.
(i) Visual and call census: It involved identifying species visually (either by naked eye or by binocular). Bird calls are extremely useful in surveying birds.
(ii) Additional signs: The identification of old eggs, nests and feathers or other signs (like owl pellets) give a valuable information on the presence of a species in the surveyed area.

3.13.4.3 REPTILES & AMPHIBIANS

For the purpose of cataloguing and counting the amphibians and reptiles, a thorough search strategy was used along the water hedges of all aquatic environments. Active searches are conducted actively and purposefully at a set time and place when the habitat is physically disturbed in an effort to find animals that may be hiding. Conversely, a passive search may involve simply observing animals for a fixed time.

3.13.5 FAUNAL STATUS

No Schedule-I species were found during the field survey within 10 km radius of the plant site. Though in public consultation mention of multiple Schedule I species like Elephant, Jackle Leopard were mentioned. A number of faunal terrestrial species comprising mammals, avi fauna, reptiles, Amphibians & fishes were recorded from the study area. Among fauna, 26 species of mammals, 81 species of avi fauna, 45 species of reptiles, 23 species of amphibians & 14 species of fishes were recorded from the study area. No National Park, Sanctuary, Biosphere Reserve, identified Migratory Corridor of wild animals exists within 10 km radius study area, authenticated letter from PCCF, Bhopal is attached in **Annexure 3-1**. The copy of Authenticated map from DFO, Anuppur (MP) regarding "No RF, Wildlife Sanctuary, National Park in the 10 km study area is enclosed as **Annexure- 3-2** with this EIA / EMP Report. The primary ecological surveys were carried out during the monitoring period of October, 2024 to December, 2024. Additional study on biodiversity of the study area as per specific ToR 1.10 was conducted by Indira Gandhi National Tribal University, Amarkantak during January, 2025. The additional study report on biodiversity analysis is attached in **Annexure 7.2**. The following list shows the compiled result of the species identified in the study area.

Table 3-55: List of Animals in the study area

S.No.	Species	Common name	Local name	WPA status	IUCN Status	Occurrence reported	Source
Mammals							
1	*Macaca mullata*	Rhesus macaque	Ratulia	Schedule II	Least concerned	High	Primary Survey
2	*Semnopithecus entellus*	Hanuman Langur	Karia Banar	Schedule II	Least concerned	Moderate	Primary Survey
3	*Rusa unicolor*	Sambar	Samar	Schedule I	Vulnerable	Moderate	Secondary litera, Public Consultation
4	*Muntiacus muntjak*	Munjack	Ghotri	Schedule I	Least concerned	Low	Secondary Sources, Public Consultation
6	*Axis axis*	Spotted deer	Cheetal	Schedule II	Least concerned	Moderate	Primary Survey
7	*Antilope cervicapra*	Blackbuck	Sambhar	Schedule I	Least concerned	Low	Secondary Sources, Public Consultation
8	*Sus scrofa*	Boar	Baraha	Schedule II	Least concerned	High	Primary Survey
9	*Melursus ursinus*	Sloth bear	Reech	Schedule I	Vulnerable	Moderate	Public Consultation
10	*Canis aureas*	Indian Jackal	Bigwa	Schedule I	Least concerned	Low	Secondary Sources, Public Consultation
11	*Hyaena hyaena*	Reida	Striped hyena	Schedule I	Near threatened	Low	Secondary Sources, Public Consultation

S.No.	Species	Common name	Local name	WPA status	IUCN Status	Occurrence reported	Source
12	*Cuon alpinus*	Wild dog	Sonhar kutta	Schedule I	Endangered	Low	Secondary Sources, Public Consultation
13	*Vulpes bengalensis*	Sikta	Indian fox	Schedule I	Least concerned	High	Secondary Sources, Public Consultation
14	*Panthera tigris*	Bagh	Tiger	Schedule I	Endangered	Low	Secondary Sources, Public Consultation
15	*Panthera pardus*	Leopard	Tendua	Schedule I	Vulnerable	Low	Secondary Sources, Public Consultation
16	*Prionailurus rubiginosus*	Rusty spotted cat	Bhod bilra	Schedule I	Near threatened	Moderate	Secondary Sources,
17	*Urva javanicus*	Indian mongoose	Timra	Schedule I	Least concerned	High	Secondary Sources, Public Consultation
18	*Lepus nigricollis*	Indian hare	Kharha	Schedule II	Least concerned	High	Secondary Sources
19	*Suncus murinus*	Shrew	Chhu Chhu	Not listed	Least concerned	High	Secondary Sources
20	*Hystrix indica*	Indian crested porcupine	Sehi	Schedule I	Least concerned	Low	Secondary Sources
21	*Funambulus palmarum*	Three striped squirrel	Chhiddi	Schedule II	Least concerned	High	Primary Survey
22	*Rattus rattus*	House rat	Musa	Not listed	Least concerned	High	Primary Survey
23	*Rattus norvegicus*	Brown rat	Ghus	Not listed	Least concerned	High	Primary Survey
24	*Pipistrellus tenuis*	Least pipistrelle	Gidli	Not listed	Least concerned	High	Secondary Sources
25	*Pteropus medius*	Indian flying fox	Gedura	Not listed	Near threatened	High	Secondary Sources
26	*Elephas maximus*	Elephant	Hathi	Schedule I	Endangered	Low	Secondary Sources, Public Consulation

S.No	Species	Common name	WPA status	IUCN Status
		Avian Fauna		
1	*Phalacrocorax niger* (Vieillot, 1817)	Little cormorant	Schedule II	Least concerned
2	*Phalacrocorax carbo* (Linnaeus, 1758)	Great cormorant	Schedule II	Least concerned
3	*Phalacrocorax fuscicollis* Stephens, 1826	Indian cormorant	Schedule II	Least concerned
4	*Bubulcus ibis* (Linnaeus, 1758)	Cattle egret	Schedule II	Least concerned
5	*Egretta garzetta* (Linnaeus, 1766)	Little egret	Schedule II	Least concerned

6	*Ardea alba* Linnaeus, 1758	Great egret	Schedule II	Least concerned
7	*Mesophoyx intermedia* Wagler, 1829	Intermediate egret	Schedule II	Least concerned
8	*Pseudibis papillosa* (Temminck, 1824)	Black ibis	Schedule II	Least concerned
9	*Vanellus indicus* (Boddaert, 1783)	Red-wattled Lapwing	Schedule II	Least concerned
10	*Vanellus malabaricus* (Boddaert, 1783)	Yellow-wattled Lapwing	Schedule II	Least concerned
11	*Streptopelia senegalensis* (Linnaeus, 1766)	Laughing dove	Schedule II	Least concerned
12	*Streptopelia chinensis* (Scopoli, 1786)	Spotted dove	Schedule II	Least concerned
13	*Halcyon smyrnensis* (Linnaeus, 1758)	White-breasted kingfisher	Schedule II	Least concerned
14	*Alcedo atthis* (Linnaeus, 1758)	Common kingfisher	Schedule II	Least concerned
15	*Coracias benghalensis* (Linnaeus, 1758)	Indian roller	Schedule II	Least concerned
16	*Copsychus saularis* (Linnaeus, 1758)	Oriental magpie-robin	Schedule II	Least concerned
17	*Copsychus fulicatus* (Linnaeus, 1766)	Indian robin	Schedule II	Least concerned
18	*Argya striata* (Dumont, 1823)	Jungle babbler	Schedule II	Least concerned
19	*Prinia inornata* (Sykes, 1832)	Plain prinia	Schedule II	Least concerned
20	*Corvus splendens* (Vieillot, 1817)	House crow	Not listed	Least concerned
21	*Corvus macrorhynchos* (Wagler, 1827)	Jungle crow	Schedule II	Least concerned
22	*Passer domesticus* (Linnaeus, 1758)	House sparrow	Schedule II	Least concerned
23	*Acridotheres tristis* (Linnaeus, 1766)	Common myna	Schedule II	Least concerned
24	*Acridotheres fuscus* (Wagler, 1827)	Jungle mayna	Schedule II	Least concerned
25	*Cinnyris asiatica* (Latham, 1790)	Purple sunbird	Schedule II	Least concerned
26	*Pycnonotus cafer* (Linnaeus, 1766)	Red vented bulbul	Schedule II	Least concerned
27	*Dendrocitta vagabunda* (Latham, 1790)	Indian treepie	Schedule II	Least concerned
28	*Psittacula derbiana* (Fraser, 1852)	Rose ringed parakeet	Schedule I	Near threatned
29	*Psittacula eupatria* (Linnaeus, 1766)	Alexandrine Parakeet	Schedule II	Near threatned
30	*Psittacula cyanocephala* (Linnaeus, 1766)	Plum headed Parakeet	Schedule II	Least concerned

31	*Argya malcomi* (Sykes, 1832)	Large grey babbler	Schedule II	Least concerned
32	*Argya caudatus* (Dumont, 1823)	Common babbler	Schedule II	Least concerned
33	*Copsychus malabaricus* (Scopoli, 1786)	White-rumped shama	Schedule II	Least concerned
34	*Motacilla maderaspatensis* Gmelin, 1789	White-browed wagtail	Schedule II	Least concerned
35	*Motacilla cinerea* Tunstall, 1771	Grey wagtail	Schedule II	Least concerned
36	*Motacilla alba* Linnaeus, 1758	White wagtail	Schedule II	Least concerned
37	*Motacilla flava* Linnaeus, 1758	Western yellow wagtail	Schedule II	Least concerned
38	*Motacilla citreola* Pallas, 1766	Citrine wagtail	Schedule II	Least concerned
39	*Butorides striatus* (Linnaeus, 1758)	Little Heron	Schedule II	Least concerned
40	*Ardeola grayii* (Sykes, 1832)	Indian pond heron	Schedule II	Least concerned
41	*Nycticorax nycticorax* (Linnaeus, 1758)	Black-crowned night heron	Schedule II	Least concerned
42	*Anthus rufulus* Vieillot, 1818	Piddy field pipit	Schedule II	Least concerned
43	*Streptopelia tranquebarica* (Hermann, 1804)	Red Collared Davo	Schedule II	Least concerned
44	*Orthotomus sutorius* (Pennant, 1769)	Common tailor bird	Schedule II	Least concerned
45	*Pericrocotus erythropygius* (Jerdon, 1840)	White-bellied minivet	Schedule II	Least concerned
46	*Pycnonotus leucogenys* (Gray, 1835)	Himalyan bulbul	Schedule II	Least concerned
47	*Anthus similis* (Jerdon, 1840)	Long-billed pipit	Schedule II	Least concerned
48	*Anthus hodgsoni* Blackwelder, 1907	Olive-backed pipit	Schedule II	Least concerned
49	*Anthus sylvanus* (Hodgson, 1845)	Upland pipit	Schedule II	Least concerned
50	*Zapornia akool* (Sykes, 1832)	Brown crake	Schedule II	Least concerned
51	*Centropus bengalensis* (Gmelin, 1788)	Lesser coucal	Schedule II	Least concerned
52	*Machlolophus aplonotus* (Vigors, 1831)	Black-lored tit	Schedule II	Least concerned
53	*Anthus richardi* Vieillot, 1818	Richard's pipit	Schedule II	Least concerned
54	*Hirundo smithii* Leach, 1818	Wire-tailed swallow	Schedule II	Least concerned
55	*Tephrodornis pondicerianus* (Gmelin, 1789)	Common wood shrike	Schedule II	Least concerned

56	*Anastomus oscitans* (Boddaert, 1783)	Open bill	Schedule II	Least concerned
57	*Coturnix coromandelica* (Gmelin, 1789)	Rain quail	Schedule II	Least concerned
58	*Merops oreintalis* Latham, 1801	Green bee eater	Schedule II	Least concerned
59	*Parus major* Linnaeus, 1758	Great tit	Schedule II	Least concerned
60	*Anthus trivialis* (Linnaeus, 1758)	Tree pipit	Schedule II	Least concerned
61	*Ficedula parva* (Bechstein, 1792)	Red throat flycatcher	Schedule II	Least concerned
62	*Cisticola juncidis* (Rafinesque, 1810)	Fan-tailed Warbler	Schedule II	Least concerned
63	*Prinia sylvatica* Jerdon, 1840	Jungle prinia	Schedule II	Least concerned
64	*Oenanthe deserti* (Temminck, 1825)	Desert wheatear	Schedule II	Least concerned
65	*Lymnocryptes minimus* (Brünnich, 1764)	Jack snipe	Schedule II	Least concerned
66	*Columba livia* Gmelin, 1789	Rock pigeon	Schedule II	Least concerned
67	*Oenanthe fusea* (Blyth, 1851)	Brown rock chat	Schedule II	Least concerned
68	*Cyornis tickelliae* Blyth, 1843	Tickell’s blue flycatcher	Schedule II	Least concerned
69	*Alcippe poioicephala* (Jerdon, 1841)	Brown-cheeked fulvetta	Schedule II	Least concerned
70	*Lanius vittatus* Valenciennes, 1826	Bay-backed shrike	Schedule II	Least concerned
71	*Centropus sinensis* (Stephens, 1815)	Greater coucal	Schedule II	Least concerned
72	*Cyanoderma ruficeps* (Hume, 1873)	Rufous-fronted babbler	Schedule II	Least concerned
73	*Lonchura striata (*Linnaeus, 1766)	White-rumped munia	Schedule II	Least concerned
74	*Tachybaptus ruficollis* (Pallas, 1764)	Little grebe	Schedule II	Least concerned
75	*Dicrurus caerulescens* (Linnaeus, 1758)	White-bellied drongo	Schedule II	Least concerned
76	*Saxicola caprata* (Linnaeus, 1766)	Pied bushchat	Schedule II	Least concerned
77	*Laticilla burnesii* (Blyth, 1834)	Rofous-vented grass babbler	Schedule I	Near threatned
78	*Lanius schach* Linnaeus, 1758	Long-tailed shrike	Schedule II	Least concerned
79	*Emberiza melanocephala* Scopoli, 1769	Black-headed bunting	Schedule II	Least concerned
80	*Saxicola torquatus* (Linnaeus, 1766)	Common stone chat	Not Listed	Least concerned

81	*Dicrurus macrocercus* Vieillot, 1817	Black Drongo	Schedule II	Least concerned
		Reptile		
1	*Hemidactylus flaviviridis* Rüppell, 1835	Northern House Gecko	Not listed	Least concerned
2	*Hemidactylus frenatus* Duméril & Bibron, 1836	Common House Gecko	Not listed	Least concerned
3	*Hemidactylus platyurus* (Schneider, 1797)	Flat-tailed housw gecko	Not listed	Least concerned
4	*Hemidactylus brookii* Gray, 1845	Broook's house Gecko	Not listed	Least concerned
5	*Ophisops jerdonii* (Blyth, 1853)	Jerdon's cabrita	Not listed	Least concerned
8	*Lygosoma punctata* (Gmelin, 1799)	Common snake skink	Not listed	Least concerned
9	*Eutropis macularia* (Blyth, 1853)	Bronze grass skink	Not listed	Least concerned
10	*Eutropis carinata* (Schneider, 1801)	Keeled Indian Mabuya	Not listed	Least concerned
11	*Ophisops microlepis* Blanford, 1870	Small scale lacerta	Not listed	Least concerned
12	*Calotes minor* (Hardwicke & Gray, 1827)	Hardwicke's bloodsucker	Appendix III Schedule IV	Least concerned
13	*Calotes versicolor* (Daudin, 1802)	Oreintal garden lizard	Not listed	Least concerned
14	*Sitana spinaecephalus* Deepak, Vyas, & Giri, 2016	Spiny headed fan-thraoted lizard	Not listed	Least concerned
15	*Psammophilus dorsalis* Smith, 1935	Peninsular rock Agama	Schedule II	Least concerned
16	*Chamaeleon zeylanicus* Laurenti, 1768	Indian Chameleon	Schedule I	Least concerned
17	*Varanus bengalensis* (Daudin, 1802)	Bengal monitor	Schedule I	Near threatened
18	*Batagur kachuga* (Gray, 1831)	Red-crowned roofed turtle	Schedule I	Critically endangered
19	*Nilssonia gangetica* (Cuvier, 1825)	Indian soft-shelled turtle	Schedule I	Endangered
20	*Melanochelys trijuga (Schweigger, 1812)*	Indian black turtle	Schedule II	Least concerned
21	*Cyclemys gemeli* (Fritz, Guicking, Auer, Sommer, Wink & Hundsdörfer, 2008)	Asian leaf turtle	Schedule II	Near threatened
22	*Amyda cartilaginea* (Boddaert, 1770)	Asian soft-shelled turtle	Schedule I	Vulnerable
23	*Nilssonia hurum* (Gray, 1831)	Indian peacock soft-shelled turtle	Schedule I	Endangered

24	*Cuora amboinensis* Daudin, 1802	Southeast Asian box turtle	Schedule I	Endangered
25	*Hardella thurjii* (Gray, 1831)	Brahminy river turtle	Schedule I	Endangered
26	*Morenia petersi* (Anderson, 1879)	Indian eyed turtle	Schedule I	Endangered
27	*Eryx conicus* (Schneider, 1801)	Common sand boa	Not listed	Near threatened
28	*Eryx johnii* (Russell, 1801)	Red sand boa	Schedule I	Near threatened
29	*Python molurus* (Linnaeus, 1758)	Indian rock python	Schedule I	Near threatened
30	*Amphiesma stolata (*Linnaeus, 1758)	Buff striped keelback	Schedule II	Least concerned
31	*Argyrogene fasciolatus* (Shaw, 1802)	Banded racer	Schedule II	Least concerned
32	*Coelognathus helena* (Daudin, 1803)	Trinket snake	Schedule II	Least concerned
33	*Lycodon aulicus* (Linnaeus, 1758)	Common wolf snake	Schedule II	Least concerned
34	*Dendrelaphis tristis* (Daudin, 1803)	Common bronzeback	Schedule II	Least concerned
35	*Oligodon arnesis* (Shaw, 1802)	Banded kukri snake	Schedule II	Vulnerable
36	*Ptyas mucosa* (Linnaeus, 1758)	Indian rat snake	Schedule I	Least concerned
37	*Fowlea piscator* (Schneider, 1799)	Chekered keelback	Schedule I	Least concerned
38	*Bungarus caeruleus* (Schneider, 1801)	Common krait	Schedule II	Least concerned
39	*Naja naja* (Linnaeus, 1758)	Indian cobra	Schedule I	Least concerned
40	*Ophiophagus hannah* (Cantor, 1836)	King cobra	Schedule I	Vulnerable
41	*Indotyphlops braminus* (Daudin, 1803)	Brahminy blind snake	Schedule II	Least concerned
42	*Daboia russelii* (Shaw & Nodder, 1797)	Russel's viper	Schedule I	Least concerned
43	*Echis carinatus* (Schneider, 1801)	Saw-scaled viper	Schedule II	Least concerned
44	*Bungarus fasciatus* (Schneider, 1801)	Banded krait	Schedule II	Least concerned
45	*Craspedocephalus gramineus* (Shaw, 1802)	Bamboo pit viper	Not listed	Least concerned
Amphibians				
1	*Clinotarsus curtipes* (Jerdon, 1854)	Bicolored frog	Not listed	Near threatened
2	*Duttaphrynus melanostictus* (Schneider, 1799)	Assian common toad	Not listed	Least concern
3	*Euphlyctis cyanophlyctis* (Schneider, 1799)	Indian skittering frog	Schedule II	Least concern

4	*Fejervarya cepfi* Garg & Biju, 2017	Burrowing frog	Not listed	Data deficient
5	*Firouzophrynus stomaticus (*Lütken, 1864)	Indian marbled toad	Not listed	Least concern
6	*Hoplobatrachus crassus* (Jerdon, 1854)	Jerdon's bullfrog	Not listed	Least concern
7	*Hoplobatrachus tigerinus* (Daudin, 1802)	Indian bullfrog	Schedule II	Least concern
8	*Hydrophylax bahuvistara* (Padhye, AD, Jadhav A, Modak N, Nameer PO, Dahanukar, 2015)	Widespread fungoid frog	Not listed	Data deficient
9	*Ichthyophis beddomei* Peters, 1880	Yellow striped caecilian	Not listed	Least concern
10	*Ichthyophis bombayensis* Taylor, 1960	Bombay caecilian	Not listed	Data deficient
11	*Microhyla ornata* (Duméril and Bibron, 1841)	Ornate narrow-mouthed frog	Not listed	Least concern
12	*Microhyla rubra* (Jerdon, 1854)	Red narrow-mouthed frog	Not listed	Least concern
13	*Minervarya syhadrensis* (Annandale, 1919)	Bombay wart frog	Not listed	Least concern
14	*Polypedates maculatus* (J.E.Gray, 1830)	Indian tree frog	Not listed	Least concern
15	*Pseudophilautus amboli* (Biju and Bossuyt, 2009)	Amboli bush frog	Not listed	Critically endangered
16	*Sphaerotheca breviceps* (Schneider, 1799)	Indian burrowing frog	Not listed	Least concern
17	*Sphaerotheca dobsonii* (Boulenger,1882)	Mangalore bullfrog	Not listed	Least concern
18	*Sphaerotheca rolandae* (Dubois, 1983)	Sri Lanka bullfrog	Not listed	Least concern
19	*Uperodon globulosus* (Günther, 1864)	Indian balloon frog	Not listed	Least concern
20	*Uperodon systoma* (Schneider, 1799)	Marbled balloon frog	Not listed	Least concern
21	*Uperodon taprobanicus* (Parker, 1934)	Indian painted frog	Not listed	Least concern
22	*Uperodon variegatus* (Stoliczka, 1872)	Termite nest frog	Not listed	Least concern
23	*Xanthophryne koynayensis* (Soman, 1963)	Chrome yellow toad	Schedule I	Endangered
Fishes				
1	*Catla catla*	Katla	-	Least concern
2	*Labeo rohita*	Rohu	-	Least concern
3	*Labeo calbasu*	Kalbasu	-	Least concern

4	*Labeo bata*	Bhanga	-	Least concern
5	*Cirrhinus mrigala*	Mrigal	-	Least concern
6	*Tor tor*	Mahaseer	-	Data deficient
7	*Mystus seenghala*	Singhad	-	-
8	*Mystus cavasius*	jagla	-	Least concern
9	*Channa punctatus*	Jhunda	-	-
10	*Ophiocephalus striatus*	Bhunda, Soar	-	Least concern
11	*Ophiocephalus punctatus*	Karr	-	-
12	*Chela bacala*	Chalar	-	
13	*Nandus marmoratus*	Chamer	-	
14	*Barilius spp.*	Chahel	-	Least concern

3.13.6 AQUATIC ECOLOGY

The aquatic ecology of Anuppur, is characterized by its river systems, especially the Tipan River and Son River and several ponds and wetlands. Studies indicate that the water quality is affected by both natural and anthropogenic factors, including contamination from industrial and agricultural activities. The region's groundwater, heavily relied upon for irrigation and drinking, faces quality issues due to contamination. Additionally, the area is rich in aquatic biodiversity, supporting various fish species and aquatic plants.

3.13.6.1 Study of Phytoplanktons

Methodology

1. **Sample Collection**

- **Location Selection**: Different sampling sites representing different aquatic environments have been provided in **Figure 3.59**
- **Collection Tools**: A plankton net with a mesh size 55µ was used for capturing phytoplankton.
- **Sample Volume**: 1-2 litres of water were collected from locations.

2. **Preservation**

- **Fixatives**: Used Lugol's iodine solution or formaldehyde for immediate preservation.
- **Storage**: Stored samples in dark, cool conditions to prevent degradation.

3. **Laboratory Analysis & Identification**

- **Sedimentation**: Allow samples to settle for 24-48 hours to concentrate phytoplankton at the bottom.
- **Taxonomic Keys**: Standard taxonomic keys and guides were employed.

- **Morphological Features**: Focus on cell shape, size, color, and colony formation was given to identify the phytoplanktons and also reference from text books and online available material was done.

Inventory of phytoplanktons recorded from the study area is provided in **Table 3.50**. These groups represent common genera that are often found in freshwater systems, reflecting a variety of ecological niches and environmental conditions.

Table 3-56: Inventory of Phytoplanktons from study area

Sl No.	Phyto-plankton
Cyanophyceae (Blue-green Algae)	
1	*Microcystis*
2	*Anabaena*
3	*Oscillatoria*
4	*Nostoc*
5	*Spirulina*
6	*Synechocystis*
Submerged, Emergent and Floating plants/weeds	
1	*Hydrilla*
2	*Ranuculus aquatalis*
3	*Vallisnneria*
4	*Potamogeton*
5	*Pistia*
6	*Azolla*
7	*Eichhorina*
8	*Salvinia*
9	*Limnophilia heterophyll*
Chlorophyceae (Green Algae)	
1	*Chlorella*
2	*Scenedesmus*
3	*Pediastrum*
4	*Spirogyra*
5	*Volvox*
6	*Closterium*
Bacillariophyceae (Diatoms)	
1	*Navicula*
2	*Nitzschia*
3	*Fragilaria*
4	*Coconeis*
5	*Synedra*
Euglenophyceae (Euglenoids)	
1	*Euglena*
2	*Phacus*
3	*Trachelomonas*

Dinophyceae (Dinoflagellates)	
1	*Ceratium*
2	*Peridinium*

3.13.6.2 Study of Zooplanktons

1. **Sample Collection**

- **Location Selection**: Sampling sites representing different aquatic habitats as shown in **Figure 3-59** were used to study zooplankton diversity.
- **Collection Tools**: A plankton net with a mesh size of 50-200 µm, depending on the target zooplankton size was used.
- **Collection Technique**:
  - **Vertical Haul**: Lower the net to a known depth and then haul vertically.
  - **Horizontal Tow**: Drag the net horizontally for a set distance or duration.
  - **Integrated Sample**: Combine multiple vertical and horizontal samples.

2. **Preservation**

- **Fixatives**: Immediately preserved samples in 4% formalin or Lugol's iodine solution.
- **Storage**: Samples were kept in dark, cool conditions to avoid degradation.

3. **Laboratory Analysis & Identification**

- **Sedimentation**: Allow samples to settle for 24-48 hours to concentrate phytoplankton at the bottom.
- **Taxonomic Keys**: Standard taxonomic keys and guides were employed.
- **Morphological Features**: Focus on cell shape, size, color, and colony formation was given to identify the phytoplanktons and also reference from text books and online available material was done.

Inventory of zooplanktons recorded from the study area is provided in **Table 3.50**. These groups represent common genera that are often found in freshwater systems, reflecting a variety of ecological niches and environmental conditions.

Table 3-57: Inventory of zooplanktons recorded from the study area

Sl. No.	Zooplanktons
Rotifera	
1	*Brachionus*
2	*Keratella*
3	*Asplanchna*
4	*Polyarthra*
5	*Notholca*
6	*Philodin*
Cladocera	
1	*Daphnia*

Sl. No.	Zooplanktons
2	*Ceriodophynia*
3	*Moina*
Copepoda	
1	*Cyclops*
2	*Diaptomus*
3	*Eucyclops*
Protozoa	
1	*Paramecium*
2	*Vorticella*
3	*Difflugia*
4	*Arcella*

3.13.6.3 Benthic Macro-invertebrates

Methodology

1. **Sample Collection**

- **Kick Sampling**: A D-frame net to disturb the substrate and collect dislodged macroinvertebrates is used.
- **Surber Sampler**: Employed a Surber sampler for quantitative sampling in specific areas.
- **Core Sampling**: Extracted sediment cores for benthic macroinvertebrate sampling.

2. **Preservation**

- **Immediate Preservation**: Preserved collected samples in 70% ethanol or formalin on-site.
- **Labeling**: Properly labelled each sample with site, date, and other relevant information.

3. **Laboratory Analysis**

- **Sorting**: Rinsed samples and sorted macro invertebrates from debris by hand.
- **Identification**: Identified macro invertebrates to the lowest practical taxonomic level using keys and guides.

The commonly found benthic biota is given below:

Table 3-58: Inventory of macro invertebrates recorded from study area

Sl. No.	Macro invertebrates
1	*Tiara scabra*
2	*Parregsiajavideus*
3	*Plentala spp.*
4	*Lymnaeaacuminata*
5	*Polichaeteyvorm*
6	*Pilaglobosa*
7	*Hirudinariagranulosa*
8	*T. tuberculata*

Sl. No.	Macro invertebrates
9	*Argalaspp*
10	*Ostracodes spp.*

3.13.6.4 Study of Fishes

Secondary sources and stakeholder consultations and visit to the fish markets were made to create an inventory of the fishes found in and around the study area. The following species were reported to be present.

- **Cypriniformes**:

- *Labeo rohita* (Rohu)
- *Labeo fimbriatus*
- *Catla catla* (Catla)
- *Tor tor* (Mahasheer)
- *Cirrhinus mrigala* (Mrigal)
- *Puntius sophore*
- *Ctenopharyngodon idella* (Grass carp)
- *Puntius puntius*
- *Hypophthalmichthys molitrix* (Silver carp)
- *Cyprinus carpio* (Common carp)

- **Siluriformes**:

- *Clarias batrachus* (Magur)
- *Heteropneustes fossilis* (Singhi)
- *Mystus vittatus*
- *Wallago attu (Parhan)*

- **Perciformes**:
- *Channa punctata* (Spotted snakehead)
- *Channa marulius*
- *Anabas testudineus* (Koi)

- **Osteoglossiformes:**
- *Notopterus chitala*
- *Notopterus notpoterus*

3.13.7 Study of Wetlands

As per the Interactive Wetland Map available on Wetlands of India Portal, within the 10km radius of the project site no Ramsar Wetland or significant wetland located, however, two wetlands belonging to other categories are within 10km radius. Other ponds like water bodies are also present within 10 km radius but there will be no interference from the project in these ponds.

Table 3-59: Important Wetland within 10 km radius of project site.

S. No.	Wetland	Lat. Long	Area in Ha	Category	Distance from project site
1	Dulha talab	23° 5'40.16"N 81°41'41.43"E	14.40	Man -Made	8.15km
2	Samtapur Talab	23° 7'28.43"N 81°41'51.07"E	6.84	Man -Made	9.54

Table 3-60: Inventory of aquatic flora and fauna recorded in Dulha Talab and Samtapur Talab

Category	Scientific Name/Species	Common Name
Free-Floating Plants	*Eichhornia crassipes*	Water Hyacinth
	Pistia stratiotes	Water Lettuce
	Azolla pinnata	Mosquito Fern
	Lemna minor	Duckweed
	Salvinia molesta	Floating Fern
Submerged Plants	*Hydrilla verticillata*	Hydrilla
	Vallisneria spiralis	Tape Grass
	Ceratophyllum demersum	Hornwort
	Najas indica	Water Nymph
	Potamogeton crispus	Curly Pondweed
Emergent Plants	*Typha angustifolia*	Cattails
	Cyperus rotundus	Nut Grass
	Sagittaria sagittifolia	Arrowhead
	Ipomoea aquatica	Water Spinach
	Phragmites karka	Reed Grass
Marginal Plants	*Colocasia esculenta*	Taro
	Alternanthera sessilis	Sessile Joyweed
	Polygonum glabrum	Knotweed
	Hygrophila auriculata	Marsh Barbel
	Bacopa monnieri	Water Hyssop
Fish Species	*Catla catla*	Catla
	Labeo rohita	Rohu
	Cirrhinus mrigala	Mrigal Carp

	Channa striata	Snakehead Murrel
	Heteropneustes fossilis	Stinging Catfish
Amphibians	*Hoplobatrachus tigerinus*	Indian Bullfrog
	Euphlyctis cyanophlyctis	Indian Skittering Frog
	Duttaphrynus melanostictus	Asian Common Toad
Reptiles	*Cyrtodactylus nebulosus*	Clouded Indian Gecko
	Pangshura smithii	Brown Roofed Turtle
Birds (Waders)	*Ardea cinerea*	Grey Heron
	Ardeola grayii	Indian Pond Heron
	Egretta garzetta	Little Egret
	Anas platyrhynchos	Mallard Duck
	Fulica atra	Common Coot
	Porphyrio porphyrio	Purple Swamphen
	Gallinula chloropus	Common Moorhen
	Jacana jacana	Bronze-winged Jacana
	Ceryle rudis	Pied Kingfisher
	Alcedo atthis	Common Kingfisher
Invertebrates	*Daphnia* spp.	Water Fleas
	Bosmina spp.	Cladocera
	Cyclops spp.	Copepods
	Gerris spp.	Water Striders
	Notonecta spp.	Backswimmers
	Chironomus larvae	Midge Larvae
	Bellamya bengalensis	Freshwater Snail
	Pila globosa	Apple Snail
	Macrobrachium rosenbergii	Freshwater Prawn
	Caridina spp.	Freshwater Shrimp
Mammals	*Canis lupus familiaris*	Dog
	Bos taurus	Cow
	Bandicota indica	Indian Mole Rat

The result of collected water samples from the wetland area given below-

Table 3-61: Water quality data of Wet lands.

Parameter	UoM	Samtapur talab	Dulha talaab
Colour	Hazen	<5	<5
Odor	-		
Turbidity	NTU	3.1	4.6
pH	-	7.514	7.441
Conductivity	µS/cm	634	265
Total Dissolve Solids	mg/l	412.1	172.25
Alkalinity as CaCO3	mg/l	264.56	138.52
Total Hardness as CaCO3	mg/l	258.46	116.24
Calcium as Ca	mg/l	74.18	38.26
Magnesium as Mg	mg/l	17.79550722	5.03126154
Sodium	mg/l	24.6	11.56
Potassium	mg/l	1.1	0.56
Total Suspended Solids	mg/l	5.8	22.4
Chloride as Cl	mg/l	28.46	14.26
Sulphate as SO4	mg/l	37.4	7.483
Nitrate as NO3	mg/l	4.36	1.84
Fluoride as F	mg/l	0.38	0.26
Phenolic compound as C6H5OH	mg/l	**<0.0002**	**<0.0002**
Phosphate	mg/l	**<0.05**	**<0.05**
Silica	mg/l	4.85	6.44
Arsenic	mg/l	**<0.01**	**<0.01**
Cadmium	mg/l	**<0.002**	**<0.002**
Chromium as Cr+6	mg/l	**<0.03**	**<0.03**

Iron	mg/l	0.11	0.09
Copper	mg/l	**<0.02**	**<0.02**
Lead	mg/l	**<0.005**	**<0.005**
Mercury	mg/l	**<0.0005**	**<0.0005**
Zinc	mg/l	0.22	0.18
Dissolved Oxygen	mg/l	6.2	6.8
COD	mg/l	11.1	<10
BOD, 27°C 3 days	mg/l	<2	<2
Total Coliforms	mg/l	47	210
Oil & Grease	mg/l	**<2.0**	**<2.0**
Total Chromium	mg/l	**<0.03**	**<0.03**

Site visit to these wetlands and data collection indicated the following:

- Samtapur Talab: The health of Samtapur wetlands is not good, as it exhibits a high density of floating plants, likely indicative of nutrient enrichment (primarily nitrogen and phosphorus) resulting in eutrophication. This condition may stem from sources such as agricultural runoff, wastewater discharge, or other anthropogenic inputs. Visible pollution suggests poor water quality and potential accumulation of organic and inorganic pollutants. Accumulated debris or visible contaminants such as plastics or chemical residues suggest inputs of solid waste or untreated effluent. Reduced biodiversity due to habitat changes, with native aquatic species potentially displaced. Increased likelihood of algal blooms, which can exacerbate oxygen depletion.
- Dulha Talab: The wetland exhibits characteristics indicative of moderate ecological health, with a balance between anthropogenic impacts and natural functions. While it supports some native biodiversity and maintains partial ecosystem services, signs of stress are evident, suggesting moderate levels of degradation or disruption. Aquatic plants (emergent, submerged, or floating) were present but not overly dominant. Minor to moderate pollution evident, such as occasional debris or mild discoloration of water. Potential for localized algal growth but no extensive blooms.

Recommendations

- Periodical cleanliness drives to keep the surroundings of the wetlands free from solid waste and prevent contamination.
- Regular monitoring of biodiversity to prevent further degradation.
- Control of invasive species to promote native vegetation growth.

- Implementation of measures to reduce nutrient inflows, such as buffer zones or natural filters to safe guard the wetlands from contamination from the floral waste and oil and grease from the temples in the vicinity.
- Community awareness programs to minimize solid waste and chemical runoff.

Figure 3-63: WT 1, Dulha Talab.

Figure 3-64: WT 2, Samta Talab.


Figure 3-65: Surrounding Biodiversity.

3.14 SOCIAL ENVIRONMENT

The project site is located at Villages Laharpur, Murra, Guwari, Belia & Jethari in Jethari tehsil, Anuppur District.In this section the profile of the socio-economic conditions of the people in the 10 km radius of project site has been described. The demographic and socio-economic parameters i.e. population growth, density, gender ratio, health, work force participation, occupational structure, literacy etc. plays an important role in determining the impact of the proposed mining activity directly or indirectly on the human population of the study area.

3.14.1 DEMOGRAPHIC CHARACTERISTICS OF THE STUDY AREA

The 10 km radius study area includes both the tehsils of Jaithari and Anuppur. There are 72 villages and two Census towns in the study area. These villages have total population of 1,03,195 (in 2001) & 1,23,189 (in 2011). The average household size in the study area was found to have reduced from 4.93 in 2001 to 4.45 in 2011. According to the survey, gender ratio of study area was 971 in 2001 and 984 in 2011. The details are given in **Table 3.62 & Table 3.63**.

Table 3-62: Demographic Profile of the Study Area

Study Area	Number of Villages	Total Population		Male		Female		Gender Ratio	
		2001	2011	2001	2011	2001	2011	2001	2011
within 2 km	7	13,385	14,907	6,837	7,652	6,548	7,255	957.73	948.12
2km to 5km	16	20,890	25,838	10,620	13,038	10,270	12,800	967.04	981.75
5km to 7km	18	15,833	19,367	7,957	9,594	7,876	9,773	989.82	1018.66
7km to 10 km	33	53,087	61,066	26,952	30,781	26,135	30,285	969.69	983.89
Total	**74**	**1,03,195**	**123189**	**52,366**	**61,065**	**50,829**	**60,113**	**971**	**984**

(Source: Primary Census Abstract of India 2001 & 2011 and District and Census Handbook 2001 & 2011)

Table 3-63: Demographic Features of the Study Area

Study Area	Number of Villages	Total Population		Number of House Hold		House Hold Size	
		2001	2011	2001	2011	2001	2011
within 2 km	7	13,385	14,907	2,702	3,303	4.95	4.51
2km to 5km	16	20,890	25,838	4,207	5,884	4.97	4.39
5km to 7km	18	15,833	19,367	3,227	4,523	4.91	4.28
7km to 10 km	33	53,087	61,066	10,803	13,961	4.91	4.37
Total	**74**	**1,03,195**	**123189**	**20,939**	**27,671**	**4.93**	**4.45**

(Source: Primary Census Abstract of India 2001 & 2011 and District and Census Handbook 2001 & 2011)

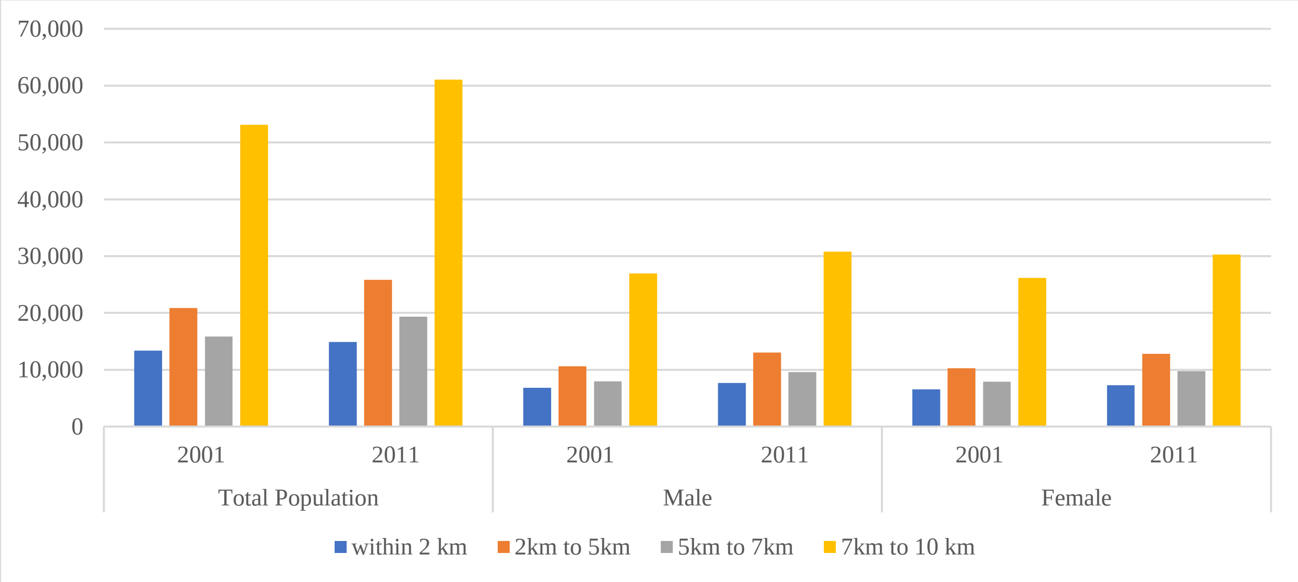


Figure 3-66: Demographic Profile of Study Area

3.14.2 VULNERABLE GROUP

As of the 2011 census, the study area encompasses a Scheduled Caste population of approximately 7.76% and a Scheduled Tribe population of 38.20%. The data is further broken down based on different distance ranges, providing insights into the distribution of scheduled caste and scheduled tribe populations within specific areas. The percentages represent the proportion of these populations in relation to the total population of each distance range within the study area. (Refer **Table 3.64**).

Table 3-64: Vulnerable Group

Study Area	Number of Villages	Total Population		SC				ST			
		2001	2011	2001	2011	2001 (%)	2011 (%)	2001	2011	2001 (%)	2011 (%)
within 2 km	7	13,385	14,907	894	1,191	6.68 %	7.99 %	4,356	4,795	32.54 %	32.17 %
2km to 5km	16	20,890	25,838	1,150	1,872	5.51 %	7.25 %	7,599	8,849	36.38 %	34.25 %
5km to 7km	18	15,833	19,367	747	1,071	4.72 %	5.53 %	9,468	10,703	59.80 %	55.26 %
7km to 10km	33	53,087	61,066	4,077	5,424	7.68 %	8.88 %	20,477	22,715	38.57 %	37.20 %
Total	**74**	**1,03,195**	**123189**	**6,868**	**9,558**	**6.66 %**	**7.76 %**	**41,900**	**47,062**	**40.60 %**	**38.20 %**

(Source: Primary Census Abstract of India 2001 & 2011 and District and Census Handbook 2001 & 2011)

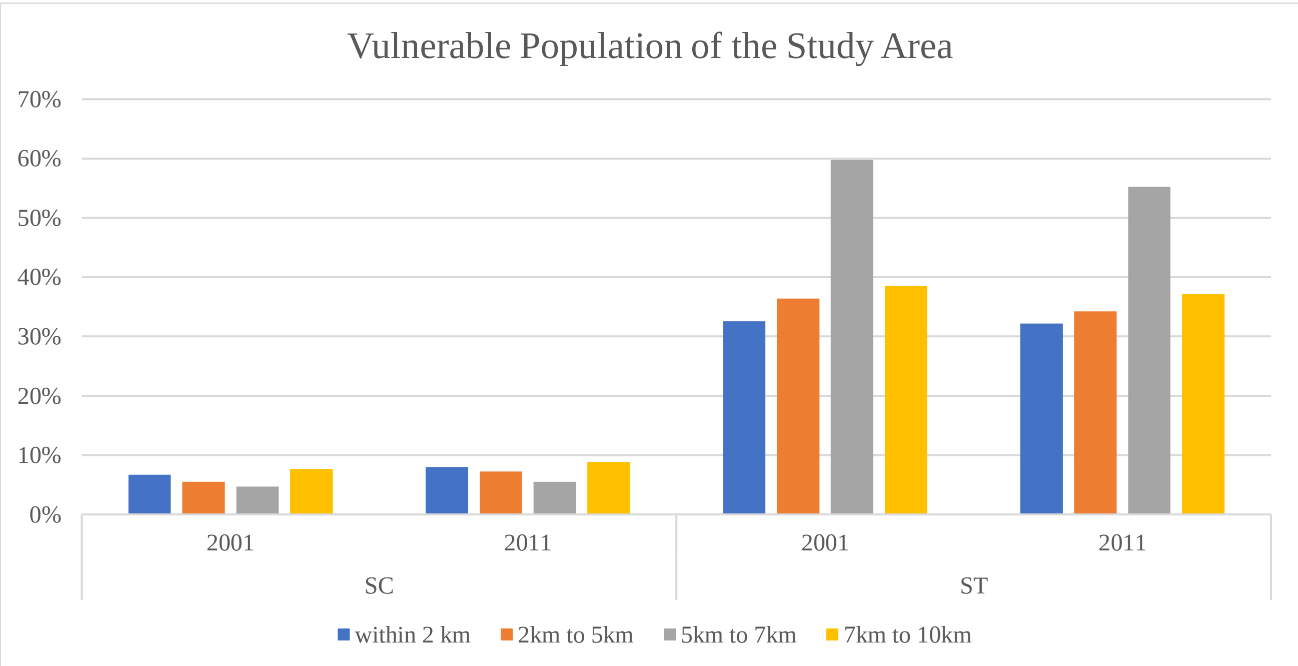


Figure 3-67: Vulnerable Population in the Study Area

3.14.3 LITERACY RATE

Literacy is one of the most significant indicators of human and social development. This not only reflects on the educational attainment of the population but also reflects on the status of women, caste equation and economic condition of a particular area. It also shows the skill level of the people and their capability to get trained and work. **Table 3.65** indicates the gender-wise literacy rate of the people in the study area. The female literacy rate of the study area has increased with time (35% in 2001 & 49% in 2011), whereas the male literacy rate which was 59% in 2001 have increased to 67% in 2011. Which are significantly lower than the national (74%, 82.14% for male and 65.46% for female) and the state (78.73% for male and 59.24% for female) literacy rate.

Table 3-65: Literacy Rate

Parameters	Number of Villages	Male Literate				Female Literate			
		2001	2011	2001 (%)	2011 (%)	2001	2011	2001 (%)	2011 (%)
within 2 km	7	4,507	5513	66%	72%	2,808	3962	43%	55%
2km to 5km	16	6,030	8420	57%	65%	3,137	5793	31%	45%
5km to 7km	18	4,094	5908	51%	62%	2,290	4284	29%	44%
7km to 10 km	33	16,265	21276	60%	69%	9,632	15570	37%	51%
Total	**74**	**30,896**	**41,117**	**59%**	**67%**	**17,867**	**29,609**	**35%**	**49%**

(Source: Primary Census Abstract of India 2001 & 2011 and District and Census Handbook 2001 & 2011)

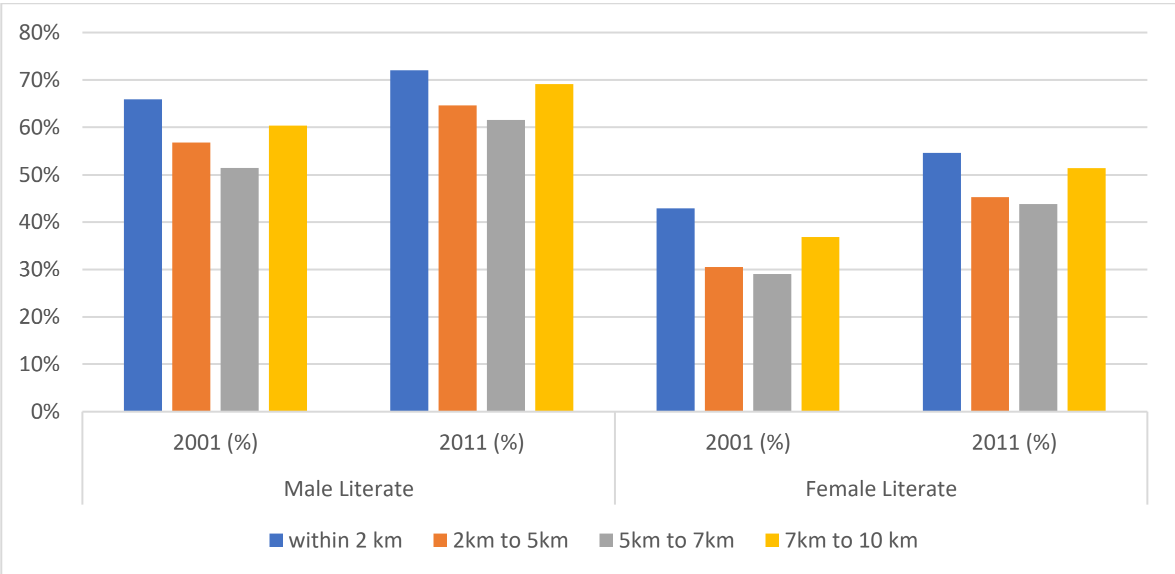


Figure 3-68: Literacy Rate in the Study Area

3.14.4 WORK PARTICIPATION

3.14.4.1 OCCUPATIONAL STRUCTURE

As per the District Census Handbook, Anuppur, the villages around the study area, people mainly earn from agriculture and animal rearing. From **Table 3.66**, it can be said that the percentage of non-workers is high (>50%) in the study area as compared to the total workers. It can also be seen that the percentage of workers have increased marginally from 2001 to 2011.

Table 3-66: Occupational Structure of the Study Area

Parameters	Number of Villages	Total Population		Total Workers		Main Workers		Marginal Workers		Non - Workers	
		2001	2011	2001 (%)	2011 (%)	2001 (%)	2011 (%)	2001 (%)	2011 (%)	2001 (%)	2011 (%)
within 2 km	7	13,385	14,907	39%	44%	25%	29%	14%	15%	61%	56%
2 km to 5 km	16	20,890	25,838	45%	49%	28%	30%	18%	19%	55%	51%
5 km to 7 km	18	15,833	19,367	51%	53%	33%	34%	18%	19%	49%	47%
7 km to 10 km	33	53,087	61,066	41%	46%	28%	30%	12%	16%	59%	54%
Total	**74**	**1,03,195**	**123189**	43%	47%	28%	30%	14%	17%	57%	52%

(Source: Primary Census Abstract of India 2001 & 2011 and District and Census Handbook 2001 & 2011)

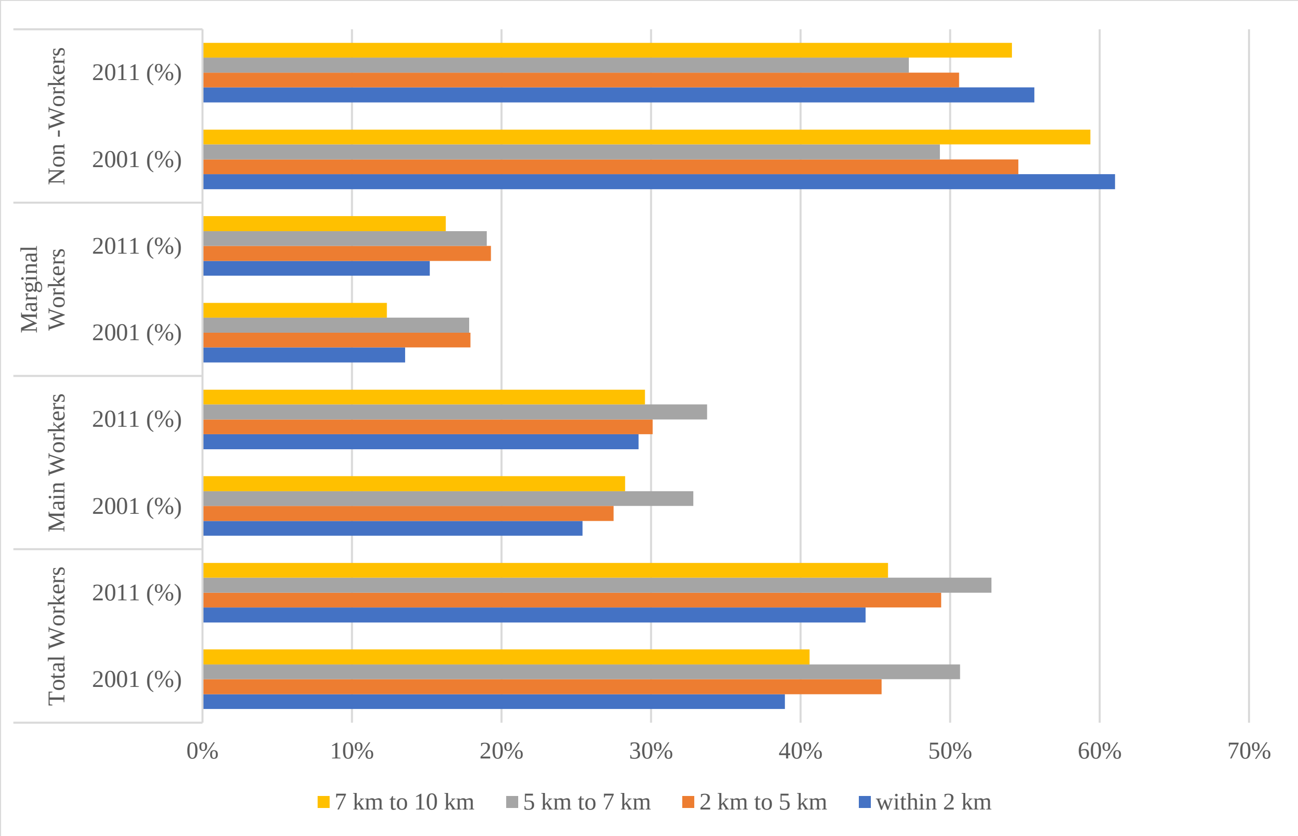


Figure 3-69: category of workers in the Study Area

3.14.5 INFRASTRUCTURE

3.14.5.1 EDUCATIONAL FACILITIES:

There is a total of 129 Primary Schools, 49 Middle Schools, 14 Secondary School and 5 Senior Secondary Schools in the study area as per Census 2011. It can be seen that there has been a substantial increase in the number of middle and secondary schools over the 10 years in the study area. This is a very healthy sign which is reflected in the increase of literacy rate of the area.

Table 3-67: Educational Facilities in the Study Area

Parameters	Number of Villages	Primary School		Middle School		Secondary School		Senior Secondary School	
		2001	2011	2001	2011	2001	2011	2001	2011
within 2 km	7	8	9	0	3	0	1	0	0
2km to 5km	16	25	26	4	14	0	2	0	1
5km to 7km	18	25	32	9	10	5	6	0	3
7km to 10 km	33	42	62	11	22	3	5	1	1
Total	**74**	**100**	**129**	**24**	**49**	**8**	**14**	**1**	**5**

(Source: Primary Census Abstract of India 2001 & 2011 and District and Census Handbook 2001 & 2011)

3.14.5.2 HEALTH FACILITIES:

The healthcare facilities present in the study area did not have any significant improvement except for the increase in number of primary health sub-centers. Mother and Child Welfare Centers have reduces significantly. Overall, Health Care facilities are poor compared to the population it serves. (Refer **Table 3.68**).

Table 3-68: Health Facilities in the Study Area

Parameters	Number of Villages	Mother & Child Welfare Centre		Primary Health Centre		Primary Health Sub-Centres		Community Health Centre	
		2001	2011	2001	2011	2001	2011	2001	2011
within 2 km	7	1	0	0	0	0	0	0	0
2km to 5km	16	7	4	0	0	2	7	0	0
5km to 7km	18	6	2	0	0	0	5	0	0
7km to 10 km	33	10	3	1	1	3	6	0	1
Total	**74**	**24**	**9**	**1**	**1**	**5**	**18**	**0**	**1**

(Source: Primary Census Abstract of India 2001 & 2011 and District and Census Handbook 2001 & 2011)

3.14.5.3 BANKING AND POST OFFICE FACILITIES:

Number of banking infrastructures like Cooperative banks have increased whereas infrastructure like Post offices (from 11 in 2001 to 4), Commercial Bank (from 1 to 0) and Agricultural Society (from 4 to 3) have decreased in 2011. The census data for the infrastructures are given in the **Table 3.69**.

Table 3-69: Banking & Post Office Facilities in the Study Area

Parameters	Number of Villages	Post Office		Commercial Bank		Coop Bank		Agricultural Society	
		2001	2011	2001	2011	2001	2011	2001	2011
within 2 km	7	1	0	0	0	0	0	0	0
2 km to 5km	16	3	1	0	0	0	1	2	1
5 km to 7 km	18	4	2	0	0	0	0	0	0
7 km to 10 km	33	3	1	1	0	0	2	2	2
Total	**74**	**11**	**4**	**1**	**0**	**0**	**3**	**4**	**3**

(Source: Primary Census Abstract of India 2001 & 2011 and District and Census Handbook 2001 & 2011)

3.14.5.4 DRINKING WATER FACILITIES:

One of the most important factors responsible for the emergence of a settlement is availability of water. Many water sources such as wells, hand pumps, tanks, etc. are available in rural areas. In the villages under study, the main source of water is tap water, well, followed by hand pump and service reservoirs. The list of water sources is given in **Table 3-70.**

Table 3-70: Drinking Water Facilities in the Study Area

Parameters	Number of Villages	Tap		Well		Tank		Tube well		Handpump	
		2001	2011	2001	2011	2001	2011	2001	2011	2001	2011
within 2 km	7	0	0	6	6	4	6	0	3	6	6
2km to 5km	16	1	1	16	16	6	12	2	7	14	16
5km to 7km	18	0	1	18	18	9	16	2	9	16	18
7km to 10 km	33	2	1	31	31	11	27	1	9	29	31
Total	**74**	**3**	**3**	**71**	**71**	**30**	**61**	**5**	**28**	**65**	**71**

(Source: Primary Census Abstract of India 2001 & 2011 and District and Census Handbook 2001 & 2011)

Figure 3-70: Public Consultation at different locations.

4. Impacts Assessment & Mitigation Measures

4.1 INTRODUCTION

Environmental impact is the change to the surrounding environment caused by anthropogenic activities, either directly or indirectly and positive or Impact Identification is a method of "mapping" the environmental effects of the project's major components and alternatives. After that, impact predictions are made. A variety of quantitative and qualitative tools and procedures are used to predict the impacts of project operations on physical, ecological and social components of the environment. This chapter identifies and estimates the likely impacts on various environmental parameters as a result of the proposed activities' construction and operation. An environment mitigation measure details pollution mitigation and control measures based on prediction results in order to minimize negative environmental impacts.

Any developmental project may cause impacts on the surrounding environment unless proper environmental mitigation measures are adopted. For plants undergoing expansion within the existing plant area can minimize the major possible impacts.

In this chapter, an attempt is made to quantify the possible environmental impacts on various features such as air quality, noise level, water use and quality, land-use, ecological status, soil quality and socio-economic factors.

The construction and operational phase of the proposed project comprises various activities each of which may have an impact on some or other environmental parameters. The above-mentioned aspects have been studied to identify the impacts of the proposed expansion. The magnitude and significance of the environmental pollution caused by the project depends on extent of project activity. On the basis of the impact analysis, the mitigating action and future monitoring requirement are focused in the Environmental Management Plan (EMP) (Chapter 10) for minimizing adverse impacts. The impact identification has been done using a Matrix given in **Table 4-1 & 4-2.**

Table 4-1: Environment Impact Identification Matrix for Construction Phase

Environmental Parameters	Activities during Construction Phase					
	Site Preparation	Transportation and Storage of Construction Material/ Equipment	Civil Construction Activities	Mech. & Elec. Erection Activities	Influx of Labour & Construction of Temporary Houses	Transportation and Disposal of Construction Debris
Ambient Air	●	●	●	●		●
Water Resource	●				●	●
Water Quality		●	●	●	●	●
Ambient Noise	●	●	●	●		●
Flora and Fauna	●					●

Environmental Parameters	Activities during Construction Phase					
	Site Preparation	**Transportation and Storage of Construction Material/ Equipment**	**Civil Construction Activities**	**Mech. & Elec. Erection Activities**	**Influx of Labour & Construction of Temporary Houses**	**Transportation and Disposal of Construction Debris**
Soil Quality		●				●
Public Utilities		●				
Socio-economic			❍	❍	●	

● Adverse Impacts ❍ Beneficial Impacts

Table 4-2: Environment Impact Identification Matrix for Operation Phase

Environmental Factors	Activities during Operation Phase					
	Plant Operation	**Unloading and Storage of Coal**	**Coal Combustion**	**Water withdrawal & Treatment**	**Ash Handling**	**Disposal and Storage of Gypsum**
Ambient Air	●	●	●		●	
Water Resource				●	●	●
Water Quality	●	●		●	●	●
Ambient Noise	●	●				
Flora and Fauna			●	●	●	
Soil Quality			●		●	●
Public Utilities				●	●	●
Socio-economic	❍					

● Adverse Impacts ❍ Beneficial Impacts

4.2 IDENTIFICATION OF ACTIVITIES AND ITS IMPACT

A brief description of impacts by the proposed project is given in **Table 4.3 and 4.4.**

Table 4-3 :Description of identifiable impacts during Construction Phase

Sl. No.	Activities	Parameters	Description of Impacts
1	Site Preparation	Ambient Air	Fugitive Dust Emissions Air Emissions from construction equipment & machinery
		Water Resource	Extraction of water and disposal of sewage
		Ambient Noise	Noise Emissions from use of construction equipment & machinery
		Flora and Fauna	Deposition of air pollutants on flora and disturbance to fauna from noise generation.

Sl. No.	Activities	Parameters	Description of Impacts
2	Transportation and Storage of Construction Material/ Equipment	Ambient Air	Noise and air emissions from vehicles Fugitive dust emissions due to traffic movement Spillage and fugitive emissions of construction materials
		Water Quality	Spillage of construction material and flow into streams Run-off from storage areas of construction material
		Ambient Noise	Noise Emissions from movement of construction equipment & machinery
		Soil Quality	Deposition of spilled construction material on soil
		Public Utilities	Increased flow of traffic Congestion on roads
3	Civil Construction Activities	Ambient Air	Air Emissions from Construction Machinery Fugitive Dust Emissions due to Movement of Traffic
		Water Quality	Run-off from Construction Areas containing construction material
		Ambient Noise	Noise Emissions from Construction Machinery
		Socio Economic	Employment and secondary activities
4	Mechanical & Electrical Erection Activities	Ambient Air	Noise & air emissions from machines/ activities
		Water Quality	Run-off from erection areas containing oils, paints
		Ambient Noise	Noise generation from erection activities.
		Socio Economic	Employment and secondary activities
5	Influx of Labour & Construction of Temporary Houses	Water Resource	Extraction of water and disposal of sewage
		Water Quality	Domestic wastewater from labour colonies
		Socio Economic	Stress on infrastructure Stress on social relations
6	Transportation & Disposal of Construction Debris	Ambient Air	Gaseous emissions from construction and transport vehicles. Fugitive dust emissions due to movement of heavy construction vehicles Fugitive emissions of debris materials
		Water Quality	Spillage/ spread of debris material and flow into streams Run-off from disposal areas
		Ambient Noise	Noise generation from construction and transport vehicles
		Soil Quality	Spillage/ spread/ deposition of debris

Table 4-4: Description of identifiable impacts during Operation Phase

Sl. No.	Activities	Parameters	Description of Impacts
1	Plant Operation	Ambient Air	Air emission due to operation and transportation of coal. Fugitive dust emission due to material handling, movement of trucks and oil tankers
		Water Quality	Spillage of coal/ oil and flow into streams
		Flora and Fauna	Dust emission due to operation and transportation of coal. Fugitive dust emission due to material handling, movement of trucks and oil tankers Bird hit on new transmission lines
		Public Utilities	Increased flow of traffic Congestion of roads
		Socio-Economic	Primary and secondary employment
2	Unloading and Storage of Coal	Ambient Air	Fugitive dust emissions and noise from coal handling areas
		Water Quality	Effluents for CHP/ oil storage areas Effluents from dust extraction/suppression systems Run-off from coal stock yard
		Ambient Noise	Noise emission due to operation and transportation of coal. Noise emission due to material handling, movement of trucks and oil tankers
3	Coal combustion	Ambient Air	Stack emissions
		Soil Quality	Deposition of dust on soil
		Flora and Fauna	Deposition of dust and gaseous pollutants on leaves
4	Water withdrawal & Treatment	Water Resource	Reduced availability to downstream users Reduced flow in downstream direction/change in regime
		Water Quality	Generation of Effluents and Sludge from Treatment Plant Clarifier Sludge Filter Backwash DM Plant Regeneration Waste Tube Settler Sludge
		Flora and Fauna	Entrapment/ impingement of organisms
5	Ash Handling	Ambient Air	Air pollution due to fugitive nature of coal ash
		Water Resource	Water needs for ash disposal

Sl. No.	Activities	Parameters	Description of Impacts
		Water Quality	Leachate from ash dyke may affect ground water quality
		Soil Quality	Spill out of ash may accumulate in soil leading to change in soil structure.
6	Disposal and Storage of Gypsum	Water Resource	Water needs for FGD and gypsum disposal
		Water Quality	Generation of effluents and sludge
		Soil Quality	Generation of effluents and sludge

4.3 OVERALL IMPACTS & MITIGATION MEASURES

Some of the impacts identified in various construction & operation phases are insignificant and do not warrant much attention whereas some others are important especially with respect to the existing site context. Therefore, such impacts which are significant and require a detailed analysis for decision-making or formulating adequate management measures have been identified. This section deals with an assessment of impact of various activities during construction & operation phase on environmental conditions. The methodology of assessment is based upon identification and description of the project activities as well as environmental components followed by predicting the impact of the proposed project and associated activities on the environment. The environmental components that are likely to be influenced during construction phase are: (i) Air environment, (ii) Noise level, (iii) Water resources, (iv) Soil quality; (v) Water quality; (vi) Biological environment and (vii) Socio-economic status of the area. The identification of impacts and mitigation/ minimizing measures of the proposed activity during construction phase and operation phase is detailed in **Table 4.5 & Table 4.6** respectively.

A. Impacts due to Construction of the project:

Table 4-5: Identification of Impacts & Mitigation Measures-Construction Phase

Sl. No.	Aspects	Impact identified	Mitigation Measures
A	**Land Environment**		
A.1	Soil Quality	Soil compaction may occur due to movement of trucks bringing construction material and transporting construction debris which may affect the soil characteristics like soil fertility, infiltration rate, porosity etc. This ultimately restricts the growth of deep-rooted plants which finally leads to stagnation of succession.	• Truck movement shall be carried out through existing roads. Any unpaved roads shall be avoided to prevent accidents. • Trucks shall be covered with tarpaulin and overloading shall be avoided.

Sl. No.	Aspects	Impact identified	Mitigation Measures
		Contamination of the soils of surrounding area due to spillage of construction materials such as cement, sand etc.	
	Soil Quality	Excavation, leveling, and the removal of existing vegetation are examples of construction operations that inevitably disrupt the top soil. The primary causes of soil effects during the building phase will be topsoil loss in the construction areas and soil pollution in the surrounding regions from construction materials such cement, sand, oils, etc. Strong rains throughout monsoon seasons would cause the impacts to be more noticeable.	• Appropriate soil conservation measures associated with improved construction techniques would minimize such local impacts. • Preserve & conserve the top soil for refilling and plantation
A.2	Public utilities	Transportation of construction materials shall be by road which will increase the traffic load and may lead to congestion.	• Transportation of construction materials shall be through Pendra Road which will be able to accommodate the vehicles that will be required for transportation of necessary materials to and from the site. • Traffic study, LOS remain same
B	**Air Environment**		
B.1	Air Quality	Dust will be the main pollutant affecting the ambient air quality of the area during the construction phase. Activities such as site preparation, operation of heavy machineries and vehicle movement shall generate fugitive dust. Vehicle movement shall also emit gaseous pollutants.	• Necessary dust suppression measures like water sprinkling using road tankers and barricading the construction site wherever possible. will be deployed to mitigate the dust emissions. • Suitable surface treatment to the roads and regular sprinkling of water shall be provided which will reduce the dust generation.

Sl. No.	Aspects	Impact identified	Mitigation Measures
			• Proper tuning of vehicles will be done and pollution certificate to keep the gas emissions under check will be made compulsory. • Necessary pollution control measures as per the requirement under local laws and regulations, and otherwise also, will be provided.
	Air Quality	The movement of equipment at site, dust emitted during the leveling, grading, earthworks, foundation works, vehicle movement on unpaved roads and other construction related activities, exhaust emissions from diesel generators, vehicles and other heavy construction equipment deployed at site will be the main sources of air pollution during the construction period. Due to the short duration of the planned action, any impacts on ambient air quality during construction activities are expected to be short term.	• Transport vehicles and construction equipment/machineries will be properly maintained to reduce air emissions • Equipment will be periodically checked and maintained time to time. • Exhaust vent of DG set will be kept at proper height to ensure quick dispersion of gaseous emissions • Sprinkling of water on roads and construction site, growing sufficient vegetation are some of the measures that would greatly reduce the impacts during the construction phase. • Implementing proper upkeep and maintenance of vehicles, and using Pollution under Control (PUC) certified vehicles for transport machinery.

Sl. No.	Aspects	Impact identified	Mitigation Measures
B.2	Noise Level	The operation of construction equipment will generate noise. The noise produced during the construction will have significant impact on the existing ambient noise levels. There will be noise generation from construction equipment and material handling equipment. Vehicles carrying construction materials will also generate noise.	• Any machinery or equipment generating excessive noise levels will be taken out for maintenance. • Use of proper personal protective equipment will be encouraged which will mitigate any significant impact of the noise generated by such equipment. • Well-tuned vehicles will be used.
	Noise Level	The activities such as foundation & infrastructure construction, plant erection will produce periodic noise during construction phase. However, possible noise control measures will be adopted and hence the impact of generated noise on the equipment is likely to be temporary and insignificant.	• D.G set to be used during construction phase shall be provided with acoustic enclosures. • Noise protection PPEs shall be provided to the workers and their use by workers shall be enforced by contractors as well as site management.
C	**Water Environment**		
C.1	Water quality	During the construction phase, site preparation (leveling, excavations etc.) and erection of structures may have temporary effect on the water quality of receiving water body. Flow of loose materials (soil and construction material) into the drains, especially during monsoons may result in higher turbidity and suspended solids content. Stagnation of water may create unhygienic condition.	Construction management will ensure the following: • The wash off will be directed to a sedimentation basin before discharge. As the site and drainage network is already developed, the impacts shall be controlled effectively. • Fuel oil, lubricants and grease etc. shall be stored in closed containers in dykes in storage areas with impermeable floors. • Adequate arrangements would be made to ensure proper drainage and disposal of the wastewater; so that water does not stagnate promoting the breeding of

Sl. No.	Aspects	Impact identified	Mitigation Measures
			mosquitoes and creating unhygienic conditions.
D	Ecology	As the land is already under possession of Anuppur TPP and is under industrial use, the direct impact on terrestrial ecology (loss of flora and fauna) during construction phase is likely to be insignificant. Construction activities may result in fugitive dust emission. The dust deposition on pubescent leaves of the surrounding vegetation may lead to temporary reduction of photosynthesis. The runoff from construction area may lead to a short-term increase in suspended solids and decrease in dissolved oxygen near the discharge point in receiving water body. This may lead to a temporary decrease in the photosynthetic activity of phyto-planktons, rise in anaerobic conditions and food chain modification.	• As the site infrastructure facilities are already developed, construction activities will be confined to the proposed project site and the impact will be marginal for a short time period. • Fugitive dust emission shall be minimized through regular water sprinkling in dust-generating areas and green belt development. • All the stormwater runoff shall be channelized through sedimentation basins to control suspended solids.
E	Demography & Socio-economics	The social impact during the construction stage will be beneficial in nature. During construction phase, people from neighborhood will be engaged by contractors on daily wage basis as most of the construction work is labour intensive. Local people would be preferred for secondary employment with contracting agencies, depending upon their skill and experience.	Positive impacts • Generation of employment both direct and indirect to the local people. • Improvements in local infrastructure, such as roads, transportation, and utilities. • Increased employment and small business opportunities near construction site that can increase economic growth, leading to improved living standards.

Sl. No.	Aspects	Impact identified	Mitigation Measures
		During construction, due to influx of labour, economic activities in surrounding areas will be increased. The construction material like stone chips and sand may be procured locally. Thus, there is possibility of generation of local trading opportunities for a limited period of time.	
F	Local Infrastructure	The influx of labour will result in increased load on drinking water facilities, health facilities and sewerage system.	• Basic facilities for labours hired from outside such as shelters, and adequate drinking and sanitation facilities shall be provided.
G	Site Development & Construction of Main Plant & Ash Pond	The site development and construction activity will generate dust, which generally settles down on the adjacent areas within a short period due to its larger particulate size. This temporary dust generation and deposition on vegetation from the construction activity have adverse impact on visual and aesthetic quality in and around the proposed activity. The proposed main plant site is located within the existing power plant site. The potential impact on Visual and aesthetics due to fugitive emission without mitigation major is considered to be Moderate significance.	• Dust nuisance from the construction site will be suppressed through periodical water spraying at disturbance area; • Construction material will be transported through covered truck/trailors.

Hence negative impact is considered to be insignificant due to the construction of the proposed expansion project as proper mitigation measures are taken in account. However, there will be positive impacts on social conditions.

B. Impacts due to Operation of the project:

Table 4-6: Identification of Impacts & Mitigation Measures-Operation Phase

Sl. No.	Aspects	Impact identified	Mitigation Measures
A	**Land Environment**		
A.1	Soil Quality	During the operation stage, the project will generate fugitive dust and gas emissions. The transportation of ash and coal will also have some spillage which will have limited impact on localized soils. The soils within the deposition zone of pollutants may undergo physico-chemical changes due to deposition of PM (ash particles) and washout of gases (SO_2 and NOx) during the rains. The soil microbial environment undergoes changes as a result of accumulation of pollutants. Fugitive dust (including ash particles) induced alterations in soil properties ultimately affects plant growth. Spillage of fly ash while transportation may lead to change in soil characteristics.	Transportation vehicles will have tarpaulin to avoid dust emission. The impacts on soil due to operation of the power plant and gaseous emission are likely to be under control as the incremental concentration of particulate matter PM_{10}, $PM_{2.5}$, SO_2 & NO_2 levels are observed within NAAQS in the surrounding areas. PM from boilers will be controlled by the installation of ESP Dust suppression and bag filters for the coal handling systems will control PM emissions. FGD and De-NOx systems shall be provided to effectively control SO_2 and NOx emission levels. Ash silos will be provided for collection of fly ash in dry form for further transportation to utilities.
A.2	Solid and Hazardous Wastes	**Solid Waste:** During the operation stage, the project will generate fly ash and bottom ash. About 2.25 MTPA total ash to be generated from the proposed 2x800 MW unit. Approximately 80% (1.80 MTPA) of it will be fly ash and balance 20% (0.45 MTPA) will be in the form of bottom ash. **Hazardous Waste:** During the operation stage, the project will generate Hazardous	**Solid Waste:** Ash utilization shall be made as per MoEF&CC notification. Dry ash will be handled by pneumatic conveying systems and will be supplied to ash brick/ash product manufacturers. In case of exigencies, fly ash from the silos shall be disposed to ash dyke through len slurry disposal system. **Hazardous Waste:** The used oil will be collected in drums and sent

Sl. No.	Aspects	Impact identified	Mitigation Measures
		Wastes which will be managed according to the applicable regulation.	to authorized re-processor. All other waste will be co processed/ reuse/ recycled through authorized agencies as per the authorization from SPCB.
		The hazardous materials used during the construction may include diesel and paints. Construction sites handle small quantities of lube oils and diesel for running the construction equipments. In case of spill of these materials, the soil quality can get deteriorated.	• In order to avoid soil contamination due to accidental spills, it has been recommended to provide spill absorbing material at the construction site and the contaminated soil should be excavated and these materials shall be stored and disposed of to hazardous waste disposal sites according to the guidelines. • Hazardous waste such as used oil generated during construction activities shall be stored at designated paved area in leak proof containers at site and shall be sent for disposal to an authorized recycler. • Other solid waste generated during construction phase such as packaging waste i.e. paper, plastic etc., shall be collected in dedicated area and shall be disposed off to an approved scrap dealer. • Care will be taken to avoid spillage of painting waste containing heavy metals during painting job. It is recommended to cover ground with protecting sheets to avoid damage to soil.
B	**Air Environment**		
B.1	Air Quality	The proposed expansion of coal based thermal power station along with the existing unit will have pollutant emission in form of SO_2,	To control PM emissions from TPP Stacks, high efficiency Electrostatic Precipitator (ESP) is proposed. For control of SO_2 emissions, Flu Gas

Sl. No.	Aspects	Impact identified	Mitigation Measures
		NO_x and PM from flue gas of the stacks. The air borne fugitive dust from the plant is likely to be generated from coal handling plants, which will be deposited on the topsoil and leaves of flora in the immediate vicinity of the plant boundary. Fugitive dust nuisances are the aspects of concern for people residing nearby, trees in vicinity whose leaves will accumulate these depositions and local fauna which will inhale the Respirable component of those dust particles. Predictions have been carried out for stack emissions & emissions from crusher houses considering worst coal characteristics.	Desulphurization (FGD) with lime scrubbing is proposed. To control NOx emission low NOx burner is proposed. Necessary dust suppression arrangement will be used in railway siding and coal handling plant. The top surface of coal wagons will be adequately sprinkled to reduce fugitive emissions during unloading. Belt conveyors will be covered to minimize the fugitive dust emissions. Auxiliary fuel (LDO) transportation will be occasional; hence its impact will be for limited time period. The ash handling system will be provided with sprinkler and bag filter to control emission. Regular housekeeping will be done at plant roads, platforms and storage area.
B.2	Noise Level	During operation, the maximum expected noise level will be from turbine generator and other sources like cooling tower, boiler, mills, transformer, compressors, etc. Exposure to prolonged or excessive noise has been shown to cause a range of health problems ranging from stress, poor concentration, productivity losses in the workplace, and communication difficulties and fatigue from lack of sleep to other more serious issues.	Noise pressure level from equipment will be kept low by proper design and enclosures, wherever possible. Dense green belt all around will attenuate noise to acceptable limits at boundary and beyond. In addition, protective measures (ear muff & ear plug etc.) will be provided to the operators and workers working near high noise generating machineries. As per Occupational Safety and Health Administration (OSHA) Standards, the maximum allowable noise level for the workers is 90 dB (A) for 8 hours exposure a day which will be taken care.

Sl. No.	Aspects	Impact identified	Mitigation Measures
			In case of higher noise level at work places, rotation of employees will be done as per OSHA Limits.
C	**Water Environment**		
C.1	Water resource	A thermal power plant requires huge quantity of water for its continuous operation. Water requirement for the existing unit is 68,400 KLD while additional water requirement for the proposed unit is 95,808 KLD with AWRS system. The entire water shall be sourced from Narmada River allocated by Water Resources Department, Anuppur, MP.	Ultra super critical technology, ETP, STP, ZLD, rainwater harvesting etc., provisions have been made to conserve fresh water. Further waste water will be treated, recycled & re-used to reduce fresh water consumption and make it more sustainable & efficient.
C.2	Surface water quality	Sources of waste water include: • Regeneration waste from DM plant • Boiler blow down • Boiler & ESP area wash water • CHP-DS system effluent & CHP run off • Effluent from floor washing run-off and oil handling areas. • Domestic sewage These effluents, if discharged outside, may degrade the quality of the water body. The effluent system may also pose a risk to surface water bodies if allowed to mix up with the storm water drainage system.	Regeneration waste from DM (De-mineralized Water) Plant and CPU (Condensate Polishing Unit) will be collected in Neutralizing pit. After Neutralizing; the water will be pumped to CMB (Central Monitoring Basin). Boiler blow down collected in separate sump will be pumped to CMB. Boiler & ESP area wash water will be collected in pre settling pit. Water collected in CMB will be monitored and after pH correction water will be treated in UF & RO to make it suitable for reuse in DM Plant makeup / Aux. CT (Cooling Water) make-up. The sewage from plant shall be treated in a sewage treatment plant. The treated sewage conforming to prescribed standards shall be utilized for plantation & horticulture to the extent possible.

Sl. No.	Aspects	Impact identified	Mitigation Measures
			The proposed plant will be designed for zero discharge.
C.3	Groundwater resource and quality	Groundwater issues typically arise from leachate from ash disposal area.	No groundwater extraction is proposed. The ash dyke is already existing and properly lined so as to prevent any spillage of ash water to the ground. Stormwater will be collected in RWH system to the extent possible and reused.
		Ground water pollution can take place due to leachate from ash pond. Ground water pollution can take place due to leachate from storage of toxic waste.	• Ash pond bottom will be lined by compacting clay making an impervious layer. Though possibility of leaching of metals from ash water is very low, the impervious lining will eliminate possibility of ground water pollution. • There is also no storage of toxic waste and thus there is also no scope of polluting ground water sources by seepage or leaching.
D	Ecology	Quantitative and qualitative changes in solar radiation impinging on the leaf surface and alterations in the energy exchange process of leaf due to dust deposition. Particulate emission and Sulphur dioxide emissions from the proposed TPP are the major pollutant that may affect the ecology of the area. Dust particles deposited on stigmatic surfaces of flowers reduce effective pollinations and hence fruit yields. Noise generated from various activities of the plant may disrupt	Emission of particulate matter, SO_2 and NO_x from the proposed plant. CPCB adopted the injury symptoms and pollution dose thresholds of tolerance by sensitive species of plants developed by W.H. Smith (1981) which stipulates that SO_2 at 0.70 ppm (1820 µg/m^3) after 1 hour exposure or 0.18 ppm (468 µg/m^3) after 8 hours' exposure gives rise to visible injury symptoms in vegetation. Similarly, NOx at 20 ppm (38x103 µg/m^3) after 1 hour exposure or 1.6-2.6 ppm (3000-5000 µg/m^3) after 48 hours' exposure or 1 ppm (1900 µg/m^3) after 100 hours' exposure is

Sl. No.	Aspects	Impact identified	Mitigation Measures
		breeding behaviors, resulting in shifts in population dynamics. As the water required shall be drawn from Son River, fish may tend to get entrapped and impinged in the intake system; and smaller organism as phytoplanktons & zooplanktons may get entrained in the intake system. The entrained organism may be subjected to a combination of physico-chemical and mechanical stresses, leading to their destruction.	likely to bring about injury symptoms in vegetation. However, such high ambient air concentration of SO_2 and NO_X is not likely to occur in the area. As per modeling studies done, the maximum resultant concentration of SO_2 and NO_x in the ambient air even after the power plant comes into operation will be 11.72 µg/m^3 & 4.53 µg/m^3 respectively. The details of the incremental concentration of the pollutants at existing forest blocks, along with distance and direction from project site as given in **Table 4.8** shows that the values are too less to induce any significant impact on vegetation. Suitable screens are provided at the intake point of water to prevent entrapment of organisms.
E	Demography & Socio-economics	The proposed project will improve the basic infrastructure & the people of nearby villages will be able to use these amenities. During operational phase, manpower of 150 (direct) & 500 (indirect) are anticipated for operation, maintenance and general requirements of the power station. The skilled manpower will be in general sourced from the present pool, while the semi-skilled and unskilled workers will be sourced locally as per qualification and skill.	Positive impact
F	Physical Presence of Plant, Ash	The physical presence of main plant, especially the elevated structures like Boiler & turbine	Greenbelt development proposed in the plan need to be implemented along with the construction phase

Sl. No.	Aspects	Impact identified	Mitigation Measures
	Pond and Associate Facility	house, stack, coal silos, elevated coal conveyor, etc. will lead to adverse visual impact for residents of the area.	depending upon the availability of the area for sapling plantation. It is proposed to develop a greenbelt around the main plant, and ash pond on available area. Periodic monitoring of greenbelt survival as well as plantation of new plants shall be carried out. Plantation shall be carried out in 2 to 3 tier.
G	Coal Handling Plant	Unloading of coal from coal rakes, transport of coal-to-coal crushing plant, crushing of coal and stacking of coal will generate coal dust, which lead to dust nuisance in the immediate vicinity of coal handling plant. The deposition of coal dust on vegetation and property would have some adverse impact. However, dust suppression measures in coal unloading site, crushing plant, storage of coal in silos, greenbelt along the main plant will minimize dust emission. This limited dust generation in coal handling plant will settle down on the adjacent areas within a short period due to its larger particulate size.	Dust suppression measures through sprinklers; Greenbelt plantation around the CHP
H	Coal Combustion and Stack Emission	The major visual impact from the power plant will be deposition of fly ash from the stack emission on the adjacent land and property. The Project will be having advanced air pollution control systems like ESP, FGD, NOx control etc., will be in place in order to comply with the air quality standards, which include	• Installation and operation of high efficiency pollution control equipment to ensure maximum removal of flue gas air pollutants. Continuous emissions monitoring of flue gas.

Sl. No.	Aspects	Impact identified	Mitigation Measures
		taller stacks for better dispersion of pollutants. Stack emissions will also be monitored by Continuous Emission Monitoring System.	

4.4 IMPACT ON AIR QUALITY

4.4.1 AIR POLLUTION MODELLING

4.4.1.1 FUGITIVE EMISSION

The air borne fugitive dust from the plant is likely to be generated from coal handling plants, stock piles and traffic movement which will be deposited on the topsoil in the immediate vicinity of the plant boundary. However, the fugitive emission is likely to be controlled to a great extent through control measure like dust suppression system at coal transfer point, dedusting system at Crusher House by bag filter limiting emission of PM to less than 30mg/Nm^3, greenbelt etc. The impact of fugitive emissions from all sources is likely to be restricted over a limited area (up to a maximum distance of 500 m from the source).

4.4.1.2 PROCESS STACK EMISSION

Other than the fugitive emission, the flue gas emission from the chimney of the existing and proposed units of the power plant as a result of coal burning is anticipated to be the major contributor to increase in pollution level in the ambient air quality of the project vicinity. For the proposed units, PM will be limited below 30 mg/Nm^3 and 100 mg/Nm^3 for SO_2 & NO_2 as per standards vide S.O.3305E dated 7th December, 2015. Hg emissions will be insignificant and below TPP emission standards of 0.03 mg/Nm^3 for Indian coals. The emissions from the existing Unit are within the applicable norms.

In order to quantify the maximum likely impact within a 10km buffer area around the project site, the contribution of the existing as well as proposed units of the power plant on the ambient concentration level is assessed using suitable approved dispersion model.

4.4.1.3 AIR MODELLING AIR POLLUTION IMPACT PREDICTION THROUGH MODELLING FOR OPERATING PHASE

The impact on air quality is assessed based on combined emissions of the proposed power plant along with the present baseline data. Suspended Particulate Matter (SPM), Sulphur dioxide (SO_2) and Oxides of Nitrogen (NO_x) will be the important pollutants emitting from the power plant. Prediction of impacts on air environment has been carried out employing mathematical model based on a steady state Gaussian plume dispersion model designed for multiple point sources for short term. In the present case, AERMOD dispersion model based on steady state Gaussian plume dispersion, designed for multiple point sources for short term and developed by United States Environmental Protection Agency [USEPA] has been used for simulations from point sources.

Air Dispersion Modelling Studies

Prediction of impacts on air environment has been carried out by air dispersion modelling employing mathematical model based on a steady state Gaussian plume dispersion model designed for multiple point sources.

The assessment methodology for the air dispersion modelling is done based on document "Assessment of Impact to Air Environment: Guidelines for Conducting Air Modelling" by Central Pollution Control Board.

The detailed model recommended is AMS/EPA Regulatory Model (AERMOD). The model of selection was the commercially available AERMOD Ver 9.9.1 View dispersion model, developed by Lakes Environmental. This model is used extensively to assess pollution concentration and deposition from a wide variety of sources. AERMOD View is a true, native Microsoft Windows application and runs in Windows applications. The AMS/EPA Regulatory Model (AERMOD) was specially designed to support the EPA's regulatory modelling programs.

AERMOD is a regulatory steady-state plume modelling system with three separate components:

- AERMOD (AERMIC Dispersion Model)
- AERMAP (AERMOD Terrain Preprocessor), and
- AERMET (AERMOD Meteorological Preprocessor).

The AERMOD model includes a wide range of options for modelling air quality impacts of pollution sources, making it a popular choice among the modelling community for a variety of applications.

Modelling capabilities of AERMOD include the following:

- The model can be used to analyze primary pollutants and continuous releases of toxic and hazardous waste pollutants.
- Source emission rates can be treated as constant or may be varied by month, season, hour-of-day, or other optional periods of variation. These variable emission rate factors may be specified for a single source or for a group of sources. For this project all emission rates were treated as constant.
- The model can account for the effects of aerodynamic downwash due to buildings that are nearby point source emissions.
- Receptor locations can be specified as gridded and/or discrete receptors in a Cartesian or polar coordinate system.
- For applications involving elevated terrain, the U.S. EPA AERMAP terrain preprocessing program can be incorporated into the model to generate hill height scales as well as terrain elevations for all receptor locations.
- The model contains algorithms for modelling the effects of settling and removal (through dry and wet deposition) of large particulates and for modelling the effects of precipitation scavenging for gases or particulates.

AERMOD requires two types of meteorological data files, a file containing surface scalar parameters and a file containing vertical profiles. These two files are provided by the U.S. EPA AERMET meteorological preprocessor program.

- **For Proposed Units:**
  - Chimney height 100 m as per MoEF&CC's guidelines.
  - Electrostatic Precipitators to limit the particulate emission (PM) within 30 mg/Nm^3
  - Wet FGD system will be provided to bring down SO_2emission within 100 mg/Nm^3.
  - Low NO_X burners (LNB)/Low NOx System, which reduces the air available to the fuel stream during the devolatilization process, and thus reduces NO_X production to bring down NO_2 emission within stipulated norms.

- **For Existing Units:**
  - Chimney height 100 m as per MoEF&CC's guidelines.
  - Electrostatic Precipitators to limit the particulate emission (PM) within 30 mg/Nm^3
  - Wet FGD system will be provided to bring down SO_2 emission within 100 mg/Nm^3.
  - Low NO_X burners (LNB)/Low NOx System, which reduces the air available to the fuel stream during the devolatilization process, and thus reduces NO_X production to bring down NO_2 emission within stipulated norms.

4.4.1.4 STACK DETAILS

The emission data in the model has been calculated using the Sulphur content and emission factors of various components. Emission Rates (Maximum) has been calculated considering the MoEF&CC emission standards of pollutants dated 16.10.2017. Modelling has been done with 1 stack height scenarios for existing and proposed units as given as below.

Scenario 1: Emissions from existing units of Anuppur TPP with 100-m stack height & with FGD and proposed units 100-m stack height & with FGD within 10 km radius.

The stack details are given in table below:

Table 4-7: Details of Stack Emissions of expanded plant

Description	**Proposed 2x800 MW**		**Proposed 2x800 MW**		**Proposed 2x800 MW**	
Scenario	**With FGD & SCR**		**With FGD and without SCR**		**Without FGD & SCR**	
Units	**(Unit – 1)**	**(Unit – 2)**	**(Unit – 1)**	**(Unit – 2)**	**(Unit – 1)**	**(Unit – 2)**
No. of Stack(s)	**01 (Single Flue)**	**01 (Single Flue)**	**01 (With Twin Flue)**		**01 (With Twin Flue)**	
Stack height (m)	100	100	275	275	275	275
Internal diameter at Stack Top (m)	9.05	9.05	9.05	9.05	8.22	8.22

Exit velocity of flue gas (m/s)	16.5 (Max.)	16.5 (Max.)	16.5 (Max.)	16.5 (Max.)	22 (min)	22 (min)
Temp. of flue gas degree ºC	60	60	60	60	125	125
Flue gas flow rate (m^3/Hr)	2939700	2939700	2939700	2939700	3200000	3200000
Flue gas flow rate (Nm^3/Hr)	3263067	3263067	3263067	3263067	4245333.333	4245333.333
Flue gas flow rate (Nm^3/sec)	906.41	906.41	906.41	906.41	1179.26	1179.26
Rate of coal consumption, TPH (BMCR Worst Coal)	557.67	557.67	557.67	557.67	557.67	557.67
GCV of Coal (kcal/kg)	3350	3350	3350	3350	3350	3350
Ash Content (max.), %	39%	39%	39%	39%	39%	39%
Sulphur in coal(max.), %	0.40%	0.40%	0.40%	0.40%	0.40%	0.40%
SO_2 emission rate (g/s)	90.641	90.641	90.641	90.641	1239.3	1239.3
NOx emission rate (g/s)	117.926	117.926	271.922	271.922	353.7	353.7
PM emission rate (g/s)	18.128	18.128	18.128	18.128	35.378	35.378

**Phase-I commissioned during 2015-16. The design measures were as per the standards*

4.4.1.5 PREDICTED GROUND LEVEL CONCENTRATION

Short-term simulations, for 24-hourly average as applicable is carried to predict the concentrations at the various receptors to quantify the likely impact on the ambient concentration level over an area covering 10-km radius from the point of emission source. The maximum incremental ground level concentrations (GLCs) are predicted taking the worst-case scenario of emission from the project. The maximum incremental GLCs due to the proposed expansion project for PM_{10}, SO_2 and NO_x are superimposed on the ambient baseline concentration of PM_{10}, SO_2 and NO_x recorded at all the monitoring locations during the field monitoring period of pre monsoon season i.e., March to May, 2024.

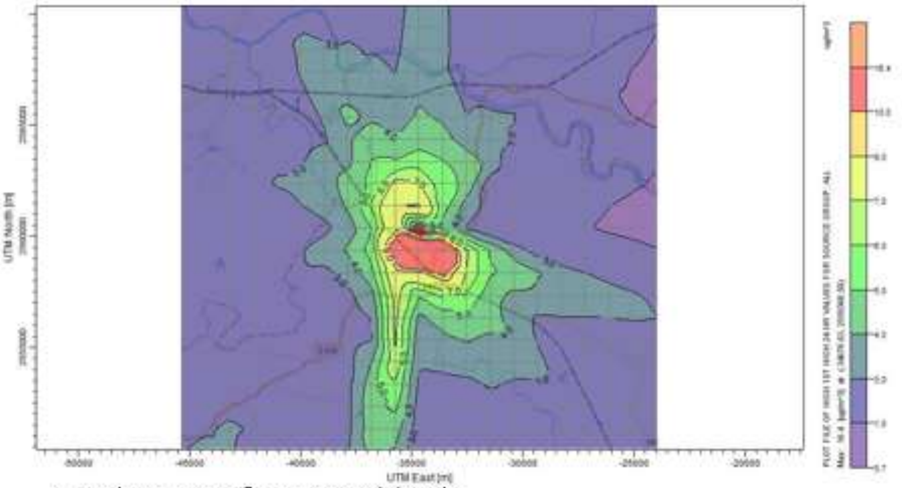
The ground level concentrations (baseline + incremental) after implementation of worst-case scenario are tabulated in **Table 4-8.**

Table 4-8: Summary of Predicted 24-Hourly Short-Term incremental GLCs in µg/m3

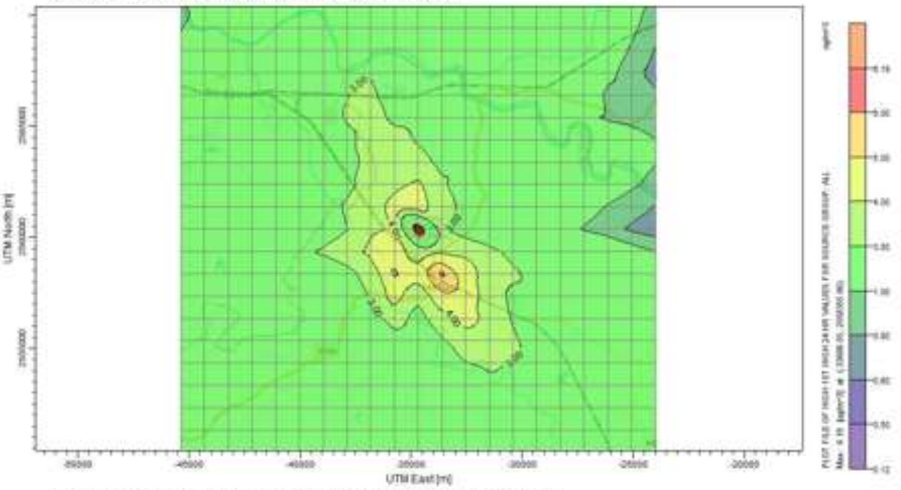
Sl No	Particulars	With FGD, SCR & 100m stack Hight		With FGD, without SCR & 275m stack Hight		Without FGD, with SCR & 275m stack Hight	
1	Stack ht, m	100	100	275	275	275	275
2	Flue gas temp, oC	60	60	60	60	125	125
3	Stack ID,m	9.05	9.05	9.05	9.05	8.22	8.22
4	Flue Gas Velocity, m/s	16.5	16.5	16.5	16.5	22	22
5	PM, g/s	18.13	18.13	18.3	18.3	35.38	35.38
	SO2, g/s	90.64	90.64	90.64	90.64	1239.3	1239.3
7	NOx, g/s	117.93	117.93	271.92	271.92	353.7	353.7
8	GLCs						
A	PM. Ug/m3	3.27		1.24		1.65	
B	So2, ug/m3	16.37		6.19		57.89	
C	Nox, ug/m3	21.14		16.6		16.52	
D	Distance, Direction	0.3km, SSE		0.8km, SSE		1.2 km, SSE	

Pollutant	**Baseline Conc. (µg/m3)**	**Max Incremental GLCs (µg/m3)**			**Resultant Conc. (µg/m3)**			**Distance (km) & Direction**
		With FGD, SCR & 100m stack Height	With FGD, without SCR & 275m stack Height	Without FGD, with SCR & 275m stack Height	With FGD, SCR & 100m stack Height	With FGD, without SCR & 275m stack Height	Without FGD, with SCR & 275m stack Height	
PM	62.28	3.27	1.24	1.65	65.55	63.52	63.93	0.85, S
SO2	11.4	16.37	6.19	57.89	27.77	17.59	69.29	0.85, S
NO2	15.99	21.14	16.6	16.52	32.51	32.59	32.51	0.85, S

Observation:
It can be observed that the resultant GLCs of all pollutants are well within the NAAQS.



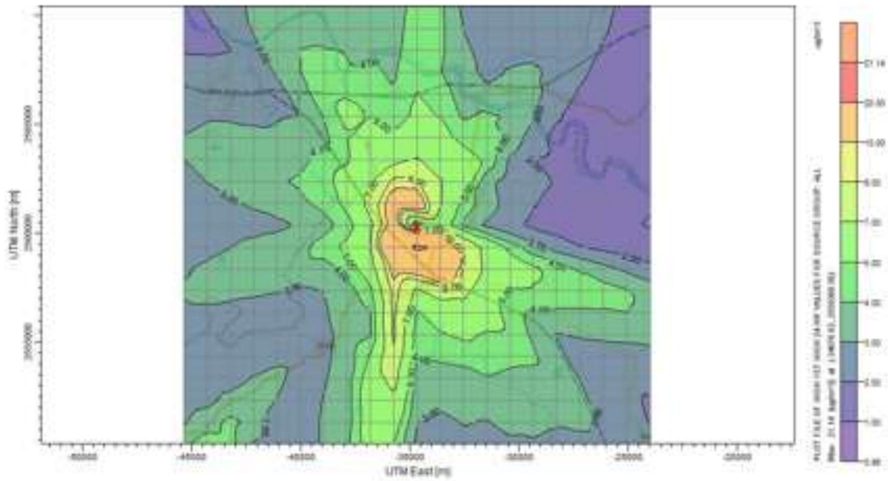
A. With FGD, SCR & 100m Stack height



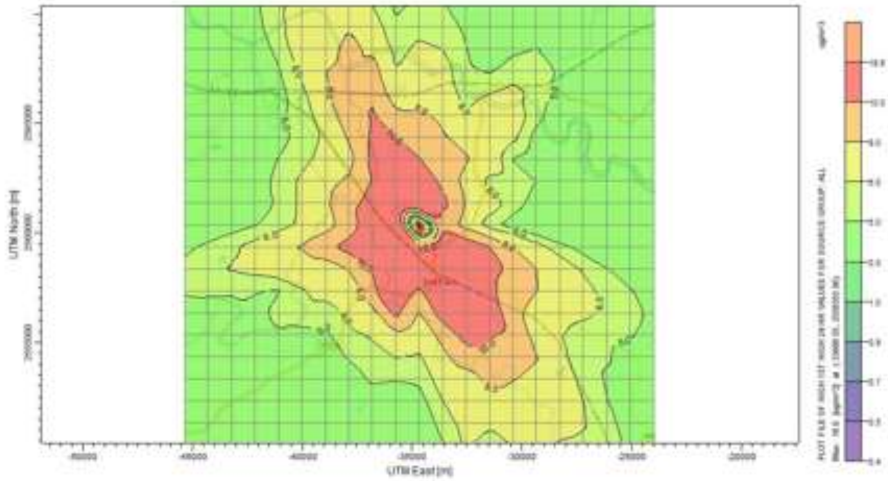
B. With FGD, without SCR & 275m Stack height

C. Without FGD, with SCR & 275m Stack height

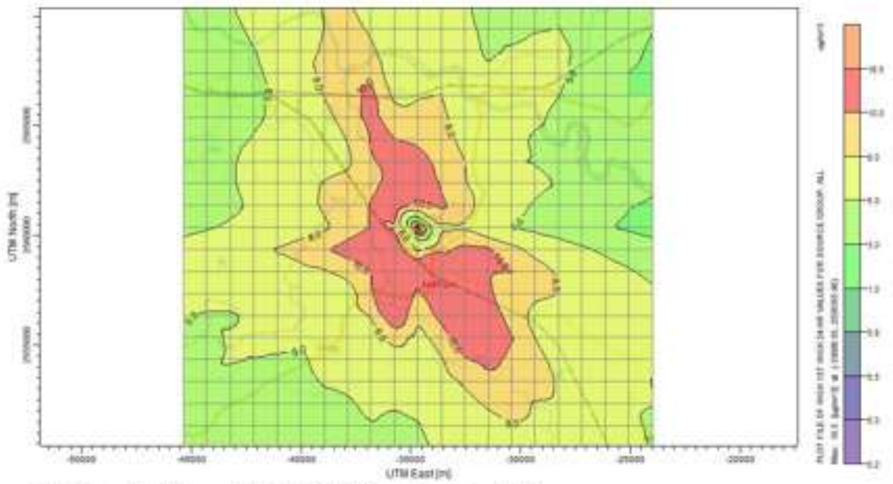
Figure 4-1: SO_2 Incremental Ground Level Concentration (µg/m^3)



A. With FGD, SCR & 100m Stack height

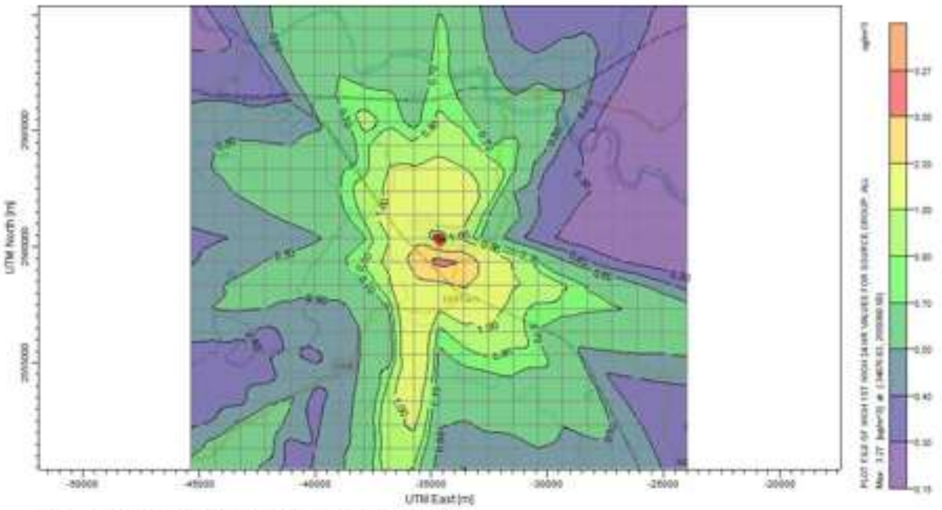


B. With FGD, without SCR & 275m Stack height

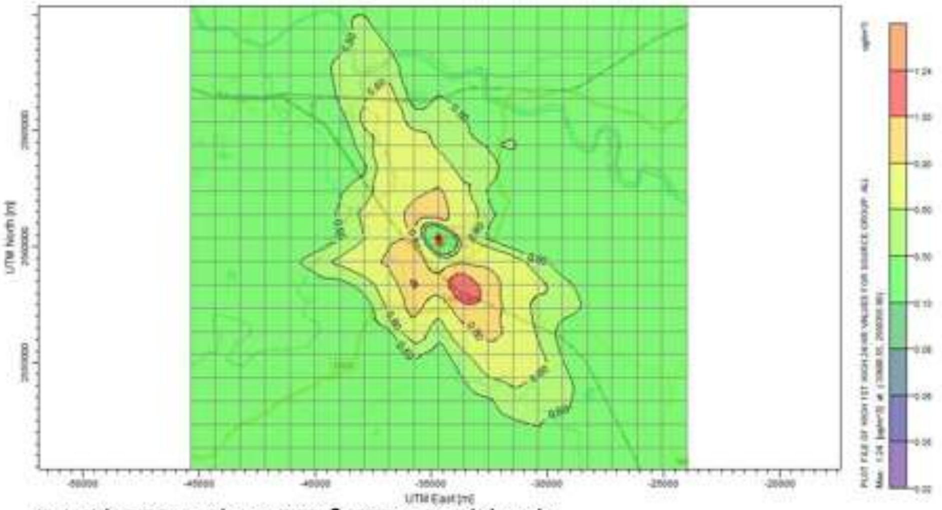


C. Without FGD, with SCR & 275m Stack height

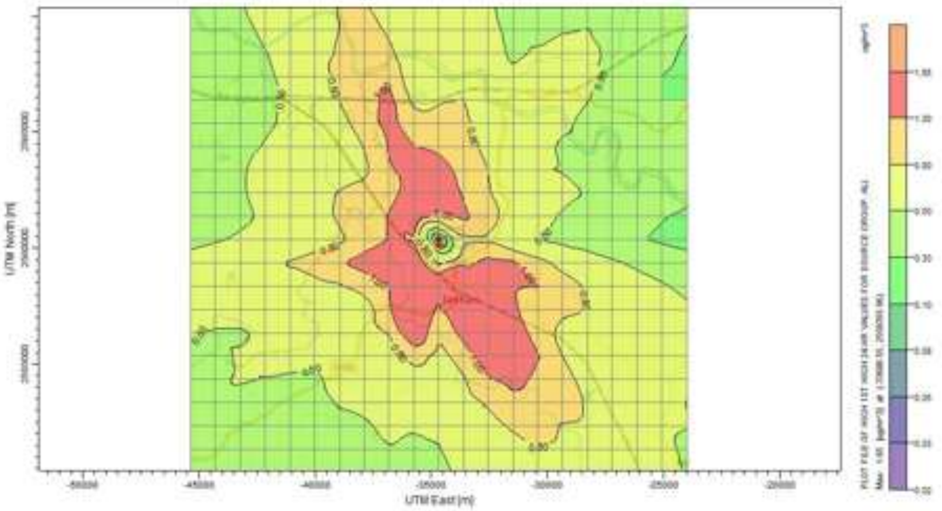
Figure 4-2: NO_2 Incremental Ground Level Concentration (µg/m^3)



A. With FGD, SCR & 100m Stack height



B. With FGD, without SCR & 275m Stack height



C. Without FGD, with SCR & 275m Stack height

Figure 4-3: PM Incremental Ground Level Concentration (µg/m^3)

Thus, from the prediction of the proposed project, it is clear that even the highest contribution on the ground level concentrations of PM10, NO_2 and SO_2 are very low. The resultant concentrations at all locations are found to be within the permissible limits of NAAQS. Therefore, after implementation of the units of project, the maximum GLCs for PM, SO_2 and NOx are predicted to be within the prescribed 24 hours NAAQS for Industrial, Residential, Rural and Other areas hence impact on air quality is considered to be insignificant due to the proposed project.

4.5 IMPACT ON WATER RESOURCES-SURFACE & GROUND WATER

Waste water generation in the existing 2x630 MW plant is 4,176 KLD and the estimated waste water from the proposed 2x800 MW plant will be 4,632 KLD. Most of the wastewater generated will be recycled and reused. The effluent recycling/ reuse system will be designed for maximum reuse of all the plant effluents. This system will not include storm water/ rainwater reuse in the plant during monsoon seasons. The sources of plant effluent are mainly: (i) CW blow down; (ii) Effluent from WT plant; (iii) Coal pile area run off water and (iv) Plant drains

Table 4-9: Waste water generation and treatment details.

Particulars	Present	Expansion
Quantity of waste water generation per day	4,176 KLD	4,632 KLD
Quantity of treated water proposed to use per day	4,176 KLD	4,632 KLD
Purpose for which treated water is proposed to use	CW makeup, Ash Handling, Horticulture, Fugitive dust suppression	Aux. Cooling makeup, Service water system, Ash handling system, Coal dust suppression
Treatment plant, STP	261 KLD (2x120,1x15, 1x5, 1x1)	130 KLD (1x120, 2x5), MBBR
Treatment plant, ETP	4,200 KLD	4,800 KLD
Technology	STP, Settling, Neutralization, Oil Removal	ETP, Lamella clarifier/Tube settler with chemical dosing

ACW blow down will be utilized for meeting the requirement of ash handling.

Water treatment plant effluent comprises mainly of WT plant regeneration waste and filter backwash. These effluents will be pumped to the Ash Handling system.

Provision for suitable treatment will be made to control the effluent constituents within the limits stipulated by the concerned authorities. The clarifier sludge from the CW clarifier and DM plant clarifier which is intermittent will be pumped to the sludge handling system with thickener and centrifuge.

The domestic sewage will be treated in the STP and treated sewage will be used for Horticulture. Provision is made for rainwater harvesting to collect stormwater from roof top, road/ paved areas, greenbelt and open areas. Refer **Table 4.10** for Rainwater available for harvesting.

Table 4-10: Rainwater available for harvesting

Sr. No.	Description	Total Area (m^2)	Effective area considered for rainwater harvesting (m^2)	Average Annual Rainfall (m)	Coefficient as per annexure IV of revised guidelines for NOC, CGWA, 2017	Water available for Rainwater Harvesting (m^3)
1	Roof top/shed area – BTG etc.	17,92,230	16,13,000	1.2	0.7	13,54,920
2	Road/paved area (Switchyard, weigh bridge, road, tank etc)	80,970	73,000	1.2	0.6	52,560
3	Green belt	15,27,670	13,75,000	1.2	0.2	3,30,000
Total						17,37,480

The impact on water resources shall be insignificant as wastewater generating within the project site is getting treated in the ETP & STP and is being recycled & reused following the zero liquid discharge concept.

4.6 IMPACT ON NOISE LEVELS

The main source of noise and vibration during operations will be:

- Delivery of equipment and raw materials by trucks.
- Transfer of coal through railway line;
- Operation of generators and turbine inside the power house; and
- Operation of various pumps, fans and motors.

Turbines, cooling towers, transformers, compressors, pumps, vehicles and miscellaneous equipment during plant operation, will generate noise.

Also, the adoption of modern building design and the use of sound absorbing materials will minimize noise and vibration from the power house.

The noise levels at the source for these units will be in the range of 80-90 dB(A). The noise dispersion from the plant units has been computed based on the mathematical model.

The major noise generating sources from the proposed expansion plant are turbine, DG sets, cooling towers, CHP and compressors etc. These are considered as in put to the noise model. The following are the noise levels expected from the proposed plant where as the noise levels of operating plant are covered in baseline noise levels.

Table 4-11: Source of Noise Levels from Proposed Plant.

Sl. No.	Particulars	Source Noise Levels, dB(A)
1	TG Building	91.0
2	ID Fans	86
3	Boiler House	83
4	Coal Handling Area	86
5	Ash Handling Area	78
6	Outside Cooling Tower	70
7	DG sets	85
8	Outside WTP	60

Noise Modelling for Plant Machinery

The impact from a continuous stationary noise source at observer's place, considering the hemispherical propagation of sound waves is represented by the following equation:

LR = LS + DI – 20 Log(r) – Ae – 8

Where:

LR: Sound pressure level at a receptor located at radial 'r', dB (A)

LS: Sound pressure level at the source, dB (A)

DI: Directivity index of the source (for hemispherical radiation DI = 3dB(A)

R: Radial distance of the receptor from the source, m

Ae: represents excess attenuation of sound caused by the environmental conditions such as:

- Absorption in air;
- Effect of rain, snow and fog;
- Reflections and refractions at barriers and buildings;
- Effect of the terrain, grass, shrubs, trees etc.; and
- Effect of wind and temperature gradient.

The absorption of the sound is generally a complex phenomenon. In general, for homogeneous loss free atmosphere Ae = 0.

The cumulative impact of multiple stationary noise sources (through hemispherical wave propagation) at a particular place can be calculated by:

Lp (Total) = 10 Log [10(Lpi/10)] i=1

Lp (Total) is the resultant cumulative sound pressure level due to separate sources. The cumulative impact from different stationary noise sources at proposed project site has been predicted at 1m distance using the above model.

Presentation of Results

The noise levels at the plant boundaries are given below in **Table-4.10**.

Table 4-12: Predicted Incremental Noise Levels at the Plant Boundaries.

Sr. No.	Direction	Noise Level in dB(A)
1	N	28
2	NE	26
3	E	30
4	SE	28
5	S	30
6	SW	28
7	W	30
8	NW	26

The predicted noise levels at the boundary due to various plant activities do not exceed 30 dB(A). There will not be any adverse impact due to the noise generation on the habitations falling on the boundary of the proposed expansion project. It is seen from the simulation results that the noise levels are well within the CPCB standards. The noise contours are presented in **Figure 4-4.**

Presentation of Results

Ambient Noise Levels

The noise levels have been predicted with proposed values of different equipment for Anuppur TPP, Stage-II (2x800 MW). The ambient noise level recorded during field study in the area varies between 51.4 dB(A) to 62.4 dB(A) during day time, whereas 42.2 dB(A) to 53.1 dB(A) during night time. The nearest village noise level varies from 43.2 dB(A) to 52.6 dB(A) located at a distance of 360 m. Hence, there will not be any significant impact on the village due to masking effect.

Scheduling deliveries to daytime as much as possible would minimize noise generation by truck movement. In addition, proper acoustic enclosures would be provided to control the noise level within 80dB(A), as per the requirement of Occupational Safety and Health Administration Standard (OSHAS).

Impact on Work Zone and Community

Boilers and cooling towers are the high noise generating equipment in the power plant. However, impacts on the working personnel are not expected to be significant on account of the high level of automation of the plant, which means that lesser man power near the equipment will be exposed for short duration only and that too intermittently with suitable protection equipment for working in noisy area. The noise generation during operational phase would be at source itself through different measures such as inspection, operation and maintenance at regular intervals. The noise control measures as described in EMP will be fully followed. The occupational noise exposure to the workers in the form of 8 hourly time weighted average will be maintained well within the prescribed OSHA standards (<90 dB(A)). Hence, the impact on occupational health of workers would be less significant.

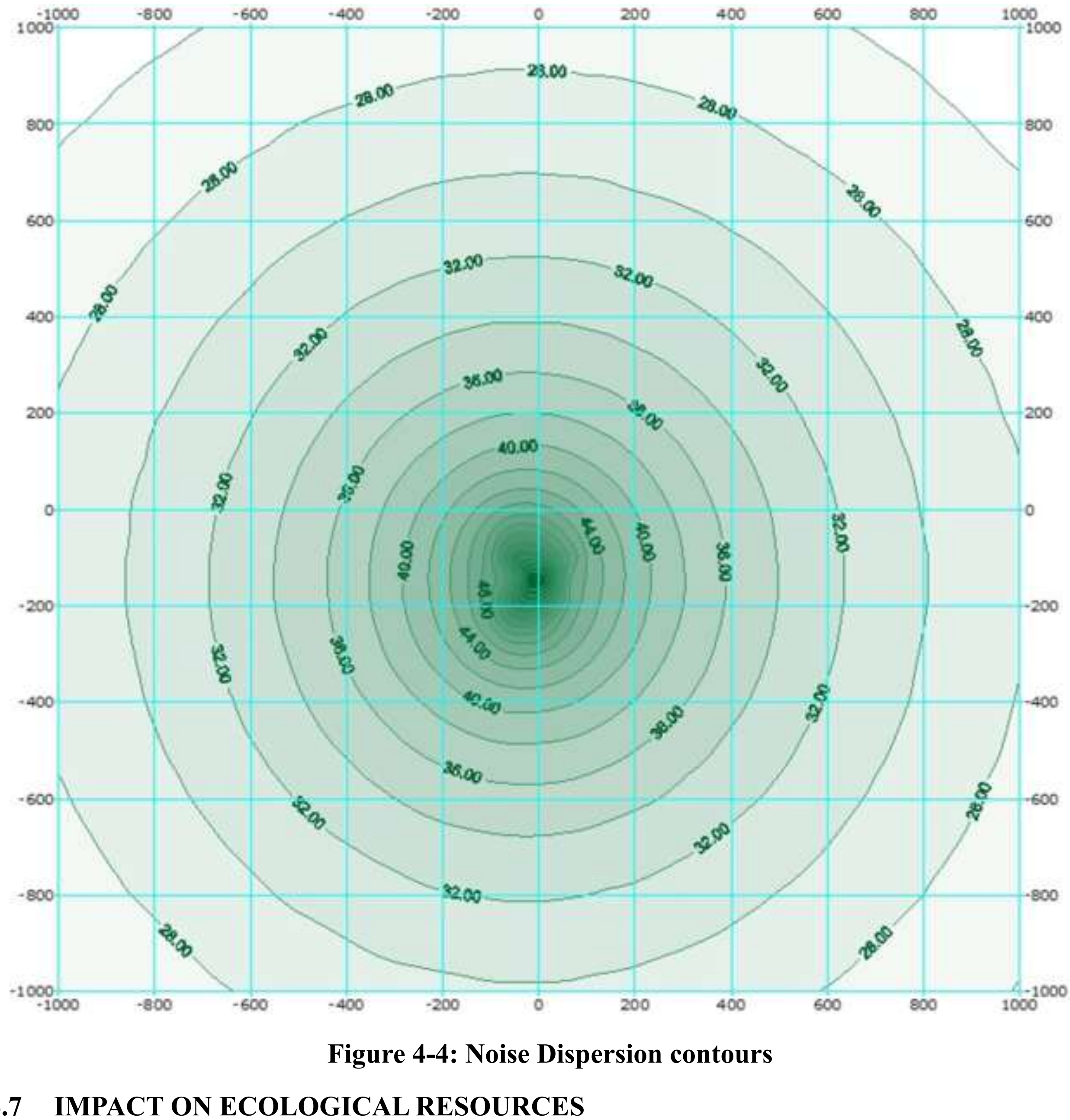


Figure 4-4: Noise Dispersion contours

4.7 IMPACT ON ECOLOGICAL RESOURCES

The air pollutant which may generate from the plant activities are likely to affect the flora in surrounding area specifically in downward wind direction. The proposed new stacks are equipped with FGD which may reduce the quantum of pollutant in the air ensuring no adverse impact on ecology.

The impact on water resources shall be insignificant as wastewater generating within the project site is getting treated in the ETP & STP and is being recycled & reused following the zero liquid discharge concept. Since, the impact on water quality is insignificant, it will not have any adverse impact on ecology.

Particulates and sulphur dioxide are major air pollutants of a coal based thermal power plant. The impact on the terrestrial ecosystem due to operation of a thermal power project may occur from deposition and absorption of air pollutants on flora and soil surfaces.

Provision of ESP, FGD Dust Suppression, NOx control have been envisaged to control the air emissions.

Deposition of fly ash on leaves may interrupt gaseous exchange through stomata clogging, thereby affecting plant growth. However, the impact of Anuppur TPP, Stage-II is envisaged to be as maximum incremental ground level concentration of PM due to emissions from Anuppur TPP, Stage-II is predicted to be in the range of 0.52 $\mu g/m^3$ only. The predicted maximum incremental ground level concentrations of SO_2 of Anuppur TPP, Stage-II is 34.22 $\mu g/m^3$. This is within the National Ambient Air Quality Standards. Since most of the tree species occurring in the area are deciduous forest type, they have high Air Pollution Tolerance Index (APTI), and therefore, impact of SO2 will not be significant. The greenbelt shall have 3-tier plantation as per the CPCB guidelines with re-densification of existing greenbelt.

Total green belt/ plantation area developed inside the existing 2x630MW Anuppur Thermal Power Plant premises is 110.33 Ha which is 26.4% of the total project area of 417.996 Ha. 38.31Ha. of additional land area has been identified inside and outside plant premises for development of Greenbelt/Plantation under Stage-II.

Total greenbelt/plantation area including existing (110.33 Ha.) and proposed (38.31 Ha.) is 148.6 Ha. which shall be 33% of the total project area 451.202Ha.

Existing plantation is physically verified every year to ascertain survival rate of >85%. The plantation details for the previous years are given in **Table 4-10.**

Table 4-13: Year-wise plantation details

Financial Year	Plantation inside plant premises	Plantation outside plant premises	Total trees planted
2015-16	128952	250	129202
2016-17	25893	0	25893
2017-18	21905	100	21005
2018-19	17413	0	17413
2019-20	13748	0	13748
2020-21	14944	1200	16144
2021-22	16290	0	16290
2022-23	20014	2000	22014
2023-24	10402	1500	11902
2024-25	8700	600	9300
Township area (2015-23)	3439	0	3439
Total	**281700**	**5650**	**287350**

Impacts on Aquatic Ecology

The project will draw water from intake point on Son River. Therefore, there is a likelihood of entrapment or impingement of phytoplankton/ zooplankton in the water intake system. However, as the water system of the project has been designed with maximum recycle/ reuse of water, and a small quantity shall be drawn as a make-up to the system, this impact shall be negligible.

Further, as the project will have an Air-cooled condenser system with Aux cooling towers and clarified water as make-up to the cooling system, there will be no thermal impact on aquatic ecosystem due to operation of the project. Also, the water balance scheme for the project is designed to achieve zero discharge.

It may, therefore, be concluded that there would be no impact on aquatic life of the river.

4.8 IMPACT ON SOCIO-ECONOMIC ENVIRONMENT

Most of the people around the site have an income directly or indirectly from agriculture and other service-related work. Since, proposed brown field project will create employment opportunities for locals during both construction and operation phase, the socio-economic impact of proposed plant will be positive. Secondary employment will also be generated due to this project which will enhance the income of the surrounding population and raise the living standards in the region.

4.9 IMPACT ON TRAFFFIC

The study has been done as per Indian Road Congress (IRC) Standards and based on the existing traffic scenario. This includes the traffic due to the existing plant for bringing raw materials and taking out solid waste. To & fro movement of vehicles are considered for carrying men & materials to plant. The Passenger Carrying Unit (PCU) due to existing expansion of plant traffic has then been deducted from existing PCU as surveyed to project PCU. This will be considered as a theoretical baseline PCU without expansion of Anuppur TPP. On this baseline, PCU due to expansion plant will be added to obtain PCU due to expansion plant when the number of trucks increases further.

(i) Change in Road Scenario: The traffic volume as surveyed during study has been projected till 2026-27 considering 7% growth each year. The projected figure and Level of Service (LoS) with and without GTPP are mentioned in **Table 4-14**.

Relation between V/C ratio & LoS		
V/C Ratio	**LoS**	**Performance**
0.0-0.2	A	Represents a condition of free flow
0.2-0.4	B	Represents a zone of stable flow
0.4-0.6	C	The general level of comfort and convenience declines noticeably at this level
0.6-0.8	D	Represents the limit of stable flow
0.8-1.0	E	Represents operating condition when traffic volumes are at or close to the capacity level

Table 4-14: Existing Level of Service

Sl No	Traffic Survey Point	V (Volume in PCU/day)	C (Capacity in PCU/ day)	Existing V/C Ratio	LOS
1	Pendra Road	2,803	15,000	0.1868	A

(ii) Post-expansion changes in road scenario: After expansion, the increase in traffic due to the project will be very minimal as most of the transportation of material will be done through railway siding. So, the increase in traffic will be due to the transportation of construction material during construction period and the general growth of population. The estimated increase in traffic as well the predicted Level of Services is given in **Table 4-12.**

Table 4-15: Level of Service after Project Expansion

Parameters	Pendra Road
Existing PCU/day	2,803
Projected PCU/ day during 2026-27 with 7% annual growth	3209
Additional PCU/Day due to project expansion	75
Total PCU/day in 2026-27	3,284
Design capacity (C) PCU/day	15,000
V/C	0.218
LOS in 2026-27 due to project expansion	**A**

From the survey, it is clear that the LoS of the road will not change i.e. remains A, during 2026-27 even if the project comes into operation.

(iii) Prediction of Incremental Air Pollution due to increase in Traffic

The emission factors reported in this study are based on BS-IV certified diesel trucks for which the predicted Ground level concentrations of Sulphur dioxide, CO, and HC+NOx have been estimated on 24 hours basis. The model has been run on the basis of the number of trucks on which a survey has been done during the monitoring period from October to December 2024. For the expansion project, wind speed of 1.6 km/hr and stability class C has been considered. The predicted ground level concentration of gases is given in **Table 4.16**.

Table 4-16: Comparison between Pollution Load before and after Project Scenario

Pollutant	Distance (m)	GLC 24hr (µg/m^3) BS IV	
		T1:	
		Existing	After expansion
NOx+HC	100	109	136
	200	55	69
	300	37	46
	400	32	39
	500	28	34
	600	25	31

Pollutant	Distance (m)	GLC 24hr (µg/m³) BS IV	
		T1:	
		Existing	After expansion
	700	20	25
	800	18	23
	900	17	21
SO_2	100	0.1	0.2
	200	0.1	0.1
	300	0.0	0.1
	400	0.0	0.0
	500	0.0	0.0
	600	0.0	0.0
	700	0.0	0.0
	800	0.0	0.0
	900	0.0	0.0
CO	100	62	77
	200	31	39
	300	21	26
	400	18	22
	500	16	19
	600	14	17
	700	11	14
	800	10	13
	900	10	12

Due to the use of ultra-low sulfur diesel oil, the incremental GLC due to SO_2 emission (GLC – 24 Hrs) will be insignificant. The contribution of CO (GLC – 1 Hrs) is well within prescribed NAAQS and HC+NOx (GLC – 24 Hrs) is almost insignificant.

5. Analysis of Alternative Technologies

5.1 INTRODUCTION

The consideration of alternatives is a proactive approach of an environmental assessment by enhancing the project design by examining alternates instead of only having a defensive approach to reduce adverse impacts from the project. This calls for the systematic comparison of feasible alternatives for the proposed expansion site and technology.

5.2 SITE ALTERNATIVES

The proposed project is an expansion of MBPMPL's Anuppur Thermal Power Project by adding 1600 (2x800) MW Ultra Super Critical TPP to the existing 1260 (2x 630) MW Power plant at village Laharpur, Murra, Guwari, Belia & Jethari in Anuppur district of Madhya Pradesh. A total of 451.202 hectares of land has been acquired at project site. In which approximately 417.996 hectares of land was utilized to accommodate Anuppur TPP Stage-I (2x630 MW) project components i.e. Main Plant, Ancillary Facilities, Ash Disposal Area, Green Belt, Township and unused area for Stage II TPP. The Stage II (2x800 MW) project including main plant equipment, ancillary facilities and ash disposal facility will be developed within the existing plant boundary. While additional 33.206 hectares of land will be used for development incoming railway line for coal transportation and green belt development of Anuppur TPP Stage-II (2x800 MW) project. The project will benefit from the available infrastructure, logistic, water source etc. It also provides all other necessary infrastructure to cater to the requirement of the enhanced capacity which will be developed while also using the facilities of the existing plant. Hence, no alternative site is explored for the expansion.

5.3 TECHNOLOGY ALTERNATIVE

5.3.1 DESCRIPTION OF EACH ALTERNATIVE

5.3.1.1 SUB-CRITICAL BOILER

Subcritical boilers are boilers that work at temperatures up to 374°C and at a pressure of 221 bar (the critical point of water). These boilers compose a system with constant evaporation endpoint. A typical example for a subcritical boiler is the drum-type steam generator.

Inside the boiler, the natural circulation of the fluid is generated by heating the risers. The water and steam mixture that is leaving this riser is then separated into water and steam in the drum. Water is circulated, water returns to the evaporator inlet through down corners while steam flows into the super-heater chamber.

If the fluid is allowed to undergo natural circulation, the application range is limited to about 190 bar as the maximum drum pressure. But if the circulation is done using a circulating pump, (known as forced circulation), this range can be extended. This extension happens because of the fixing of the endpoint of evaporation in the drum. And also, it sets the size of the heating surface in the evaporator and in the super-heater. A major drawback of the subcritical boiler is, in these boilers, bubble formation can occur which leads to more water consumption.

5.3.1.2 SUPER CRITICAL BOILER

A supercritical boiler burns pulverized coal and is a once-through boiler, meaning that it doesn't require a drum to separate steam from water. Rather than boiling water to produce steam and then using that steam to turn a plant's turbine, a supercritical boiler operates at such high pressure i.e. above critical point of water.

This supercritical fluid turns the turbine that generates electricity. As it does so, it drops below the critical pressure point and becomes a mix of steam and water, passing into a condenser. In the process, less fuel is consumed than in a traditional drum boiler, making supercritical boilers more efficient than their subcritical counterparts.

Supercritical boilers offer benefits in the three interrelated areas that mean the most to plant owners and operators today: efficiency, emissions, and cost. While supercritical boilers cost more than comparably sized subcritical boilers, the larger initial capital investment can be offset by the lifecycle savings yielded by the technology's improved efficiency, reduced emissions, and lower operating costs—all due to its higher steam temperature and pressure parameter.

Improved Efficiency	Reduced Emissions	Lower Operating Costs
• Supercritical and ultra-supercritical boilers' ability to operate at much higher pressures and temperatures than subcritical boilers translate into noticeably better efficiency ratings. • Ultra-supercritical units reach pressures and temperatures as high as 279kg/cm^2, 603-613°C.	• Improved plant efficiency also translates into reduced emissions. The general rule of thumb is that each percentage point of efficiency improvement yields 2–3% less CO.	• For all fossil fuel–fired plants, fuel represents the largest operating cost. By reducing the amount of fuel needed to yield the requisite energy, cost of the power generation reduces considerably.

5.3.1.3 ULTRA-SUPER CRITICAL BOILER

Ultra-supercritical boiler is essentially "once-through type". The volume of the evaporator system of once-through boiler is much smaller compared to a natural circulation boiler. This leads to smaller amount of water in the evaporator. Due to smaller inventory of stored water and steam, theoretical rate of response of supercritical and ultra-supercritical units are much faster than drum type unit.

With ultra-supercritical parameters, there is an improvement of cycle efficiency attributable to elevated pressure and temperatures. However, for smaller units the improvement in heat rate is marginal.

5.3.2 SUMMARY OF ADVERSE IMPACTS OF ALTERNATIVES

The adverse impact of the sub-critical and super critical technology is mentioned in **Table 5.1**.

Table 5.1: Adverse impacts of each alternative

Option-1: Sub-Critical Technology	Option-2: Super-critical Technology
High coal consumption	Material limitation, due to high thermal stress
Low efficiency	Water chemistry is more stringent
Emission of high pollutant	High levels of corrosion
Large boiler size	Increased supervision and maintenance cost
High start-up time required.	Limited scope for retrofitting opportunities
	Tube leakages are very frequent due to localized heating

5.3.3 SELECTED TECHNOLOGY - ULTRA-SUPER CRITICAL TECHNOLOGY

The ultra-super critical technology has been proposed for expansion. The ultra-supercritical units have low thermal inertia resulting in a shorter start-up time, faster rates of load change and shorter time of forced cooling operation during emergency shutdown. Pressure changes could be achieved more easily and a true sliding pressure operation mode with reasonable load change capabilities becomes possible. In ultra-supercritical units, main steam temperature is controlled by water-fuel ratio control with back up spray at attemperation. As a result, rated steam outlet temperature could be achieved at all loads with all types of fuel.

Using ultra-supercritical parameters is more advantageous for larger units where thermal efficiency improvement is more pronounced. An approximate efficiency gains of 3 - 5% points compared to conventional supercritical technology can be obtained by selecting ultra-supercritical steam parameters.

In addition to faster response times, ultra-supercritical technology, increase in overall plant thermal efficiency results in reduction of fuel consumption per unit of electricity generated, which in turn also reduces CO_2 emissions in coal fired power plant. Ultra-supercritical units also emit less SOx and NOx. Improvement in thermal efficiency also causes substantial reduction in emission of suspended particulate matter to the environment. Lastly, better efficiency is associated with lower fuel costs.

5.3.3.1 SUMMARY OF ADVANTAGES OF ULTRA SUPER CRITICAL THERMAL POWER PLANT

The benefits of ultra-supercritical technology, may be summarized as:

- Improved thermal efficiency attainable.
- Reduced fuel cost.
- Reduction of CO_2 emission by as much as 15% per unit of electricity generated compared to typical sub-critical units. This may help in meeting country’s GHG Reduction target.
- Very good part load efficiency.
- Very low emissions of NOx, SO_2 and PM achievable using modern flue gas clean-up equipment.
- Initial investment requirement marginally higher than super critical technology and less than other clean coal technology. This, however, depends on the unit size considered.

6. Environment Monitoring Programme

6.1 NEED FOR ENVIRONMENT MONITORING

The monitoring program is designed to verify the implementation of environmental measures and confirm their effectiveness in delivering the intended benefits to the target population. To ensure proper implementation of the Environment Monitoring Programme, it is essential that an effective monitoring program is designed and carried out.

The primary aims of the environmental monitoring initiative include:

- To monitor impacts on the surrounding environment and the effectiveness of mitigation measures during the construction and operation phases.
- To ensure that the environmental control systems are installed and operating satisfactorily.
- To suggest ongoing improvements in mitigation measures, if required, for subsequent effective monitoring.

In the sections below the proposed environment cell, its functions and financial implications are described. The monitoring program will be implemented in consultation with MPPCB before the start of operation of plant.

The construction and operation of the thermal power station will be overseen by a dedicated Environmental Management Group (EMG), which will handle key functions related to environmental performance monitoring and regulatory compliances.

Regularly periodic environmental monitoring is being done for existing power plant as per the Environmental Clearance & its amendments and reports are being submitted to MoEF&CC & MPPCB/CPCB along with EC compliance reports. The Latest EC compliance report was submitted for the period of April24 to Sept’24 vide letter no. MBPMPL/EHS/Env/2024-25/1489 dated 30-11-2024. for existing 2x630 MW Anuppur Super Thermal Power Plant **(copy enclosed as Annexure-1.4)**.

IRO, MoEF&CC official conducted site visit on 24.01.2024 - 25.01.2024. Certified EC compliance report dated 03.02.2024 and Action taken report has been issued for Anuppur TPP Stage-I (2x630 MW) on IRO observation has been submitted by Anuppur TTP (**copy enclosed as Annexure 6.1)**.

6.2 ENVIRONMENT MONITORING PROGRAMME

The monitoring program has been formulated to take care of impact of proposed expansion project. The monitoring program for different parameters of environment, outlined in the following sections, is based on the findings of the impact assessment. Environment Monitoring Plan during Construction Phase is given in **Table 6.1**. The final post-study environmental monitoring program including number and location of monitoring stations, frequency of sampling and parameters to be covered have been summarized and presented in **Table 6.2**.

Table 6.1: Environment Monitoring Program during Construction Phase

Sl. No.	Aspect	Parameters	Frequency	Location
1	Meteorological aspects	Wind speed & direction, temperature, rainfall, and humidity	Continuous hourly monitoring	At plant site
2	Ambient Air quality	PM10, PM2.5, SO2 and NOx and other parameters as per CPCB notification 2009	Twice in a week / As per CTE Condition.	Project Premises
3	Noise	Equivalent noise pressure level	Quarterly	Project Premises
4	Ground water quality	Physical, chemical and biological parameters including heavy metals as per IS 10500	Quarterly	Five locations
5	Surface water quality	Physical, chemical and biological parameters including heavy metals as per IS 2296, CPCB criteria.	Quarterly	Two locations.

Table 6.2: Environment Monitoring Program during Operation Phase

Sl. No.	Aspect	Parameter	Location	Monitoring & Frequency	Responsible Person/ Organization
1	Meteorology	Wind speed & direction, temperature, rainfall and Humidity	Permanent station in plant premises. The wind sensor is preferably at 10m height above the ground without any surrounding hindrances that may affect the free flow of wind.	Continuous data logging micro-metrological station.	MBPMPL
2	Ambient Air Quality	PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO & other parameters as per AAQ Standard	3 within plant and 1 at collector office (Anuppur) area by installing continuous Ambient Air Quality Monitoring Station	Continuous on-line monitoring connected to SPCB & CPCB websites	MBPMPL
			4 nearby locations (offline) within 10-km radoius	Twice a week, for 52 weeks	MBPMPL / NABL Accredited laboratory

Sl. No.	Aspect	Parameter	Location	Monitoring & Frequency	Responsible Person/ Organization
3	Process Stack	PM_{10}, SO_2, NO_2 The project proponent shall install a 24x7 continuous emission monitoring system at main process stacks to monitor stack emission concerning standards prescribed in Environment (Protection) Rules 1986 and connected to MPPCB and CPCB online servers and calibrate these systems from time to time according to equipment supplier specification. Hg (offline) emission Monitoring	All Process Stacks.	Continuous on-line monitoring. Hg offline monitoring, connected to SPCB & CPCB web sites	MBPMPL/ NABL Accredited laboratory.
4	Noise	Noise	30 locations source noise levels within the plant 05 locations around project boundary and 05 locations outside in a nearby residential area, township etc.	Monthly	MoEF&CC / NABL Accredited laboratory
5	Surface Water Quality	Physical, chemical, and biological parameters	Surface Water quality to be assessed at 5 location-	Monthly	MoEF&CC / NABL Accredited laboratory

Sl. No.	Aspect	Parameter	Location	Monitoring & Frequency	Responsible Person/ Organization
		including heavy metals.	• Son River (Upstream) Son River (Downstream) • Tipan River (Upstream), Tipan River (Down Stream) • Water Reservoir		
6	Ground Water Quality & Level	Physical, chemical, and biological parameters including heavy metals	4 locations near to project site	Monthly	MoEF&CC / NABL Accredited laboratory
		Piezometer/ Dug/ Tube well to be included for long-term monitoring of groundwater table.	8 locations around Ash Dyke.	Monthly	NABL Accredited laboratory
7	Soil	Physical and chemical parameters with organic content	5 locations.	Quarterly	MoEF&CC / NABL Accredited laboratory
8	Ecology	Visible damage to crops, density and diversity of local fauna	Buffer zone within 10 km radius of the project site	1 in every two years. As and when required.	Through Reputed Institute.
9	Coal	Heavy Metals & Radio activity Parameters	Plant-2 samples	Yearly	Through Reputed Institute
10	Fly Ash & Bottom ash	Heavy Metals & Radio activity Parameters	Plant- 2 samples	Yearly	Through Reputed Institute
11	Medical check-up of employees		Nearby hospitals/ Health Centre/ On-site Occupational health Centre	Yearly	MBPMPL

6.3 WASTEWATER QUALITY MONITORING

The wastewater quality monitoring programme consists of treated wastewater parameters monitoring prior to reuse, recycle & recirculation. Surface water and groundwater quality monitoring will also be covered. The monitoring schedule for treated water generated from various sources and the parameters to be analysed are shown in **Table 6.3.**

Table 6.3: Wastewater monitoring schedule

Waste water source	Frequency of analysis	Parameter of examination	Responsible Person
Boiler blow down	Monthly	pH, Temperature, suspended soils, oil & grease, dissolved solids, copper, iron etc.	MoEF&CC / NABL Accredited laboratory.
Waste Water treatment plant effluent	Monthly	Physical, chemical, and biological parameters including heavy metals	MoEF&CC / NABL Accredited laboratory.
Ash pond effluent	Monthly	Physical, chemical, and biological parameters including heavy metals	MoEF&CC / NABL Accredited laboratory.
STP Effluent	Monthly	Physical, chemical, and biological parameters including heavy metals	MoEF&CC / NABL Accredited laboratory.

The assessment of surface and groundwater quality (e.g.) drinking and irrigation wells, ponds, tube wells etc.) of surrounding areas will be carried out at 10 different locations, within a 10 km radius of the proposed power plant once in a month. The parameters to be monitored encompass dissolved solids, oxygen levels, bacterial contamination, and heavy metals etc as per IS 10500 Standards.

6.4 DATA ANALYSIS

Data generated from monitoring and analysis of the samples will be compared with the prescribed/stipulated limits. If any parameter is not found within the prescribed/stipulated limit appropriate control measures will be taken.

6.5 REPORTING SCHEDULE

Regular monitoring and data analysis shall be followed through proper documentation and reporting system. Provision will be made for online monitoring of emission and effluent data is already available for the existing unit and same arrangements shall be made for the upcoming expansion units and the data shall be uploaded to MPPCB/CPCB server to make them available on real-time basis as public disclosure.

6.6 EMERGENCY PROCEDURES

Well planned emergency procedures, drills shall be employed viz, Emergency Evacuation Plan, Disaster Management Plan and Industrial Safety plan to meet the requirement in case of failure of any pollution control equipment. In case it is not possible to take appropriate corrective measures immediately, the unit will be shut down.

6.7 INFRASTRUCTURE

Anuppur TPP has established online and offline monitoring system for stack emissions, waste water, noise and ambient air quality monitoring.

The list of equipment's required for environment monitoring is given in **Table 6.4**.

Table 6.4: General Equipment's Required for Environment Monitoring Laboratory.

Sl. No.	Equipment	Quantity
I	**Meteorology**	
1	Automatic Weather Station with data logger	1 set
II	**Stack & Ambient Air**	
1	Respirable Dust Sampler/Fine Particulate Sampler	5 sets
2	Vacuum Pump with Electric Motor	2 sets
3	Ammeter and Voltmeter	1 set
4	Online Stack monitoring Kit with necessary Accessories	2 sets
III	**Noise**	
1	Integrated Noise Level Meter with Frequency Analyzer and data logger	1 set
IV	**Water**	
1	BOD Incubator	1 set
2	Bacteriological Incubator	1 set
3	Oven	1 set
4	Muffle Furnace	1 set
5	Analytical Balance (Single Pan Digital)	1 set
6	Spectrophotometer (Spectronic 20)	1 set
7	pH Meter	1 set
8	Turbidity Meter	1 set
9	Conductivity Meter	1 set
10	Thermometer	1 set
11	Flame Photometer	1 set
12	Atomic Absorption Spectrophotometer	1 set
13	Distillation Apparatus	2 sets
14	Hot Plate	4 sets
15	Regents and Chemicals	As required
16	COD Assembly	1 set

Figure 6-1: Existing Monitoring Stations (AAQMS).

6.8 ENVIRONMENT MONITORING COST

The estimated capital costs to be incurred by the Project Proponent for undertaking pollution prevention measures at the plant are provided in **Table 6.4**.

During the construction phase of the project, the recurring cost for environment monitoring amounts to Rs. 3,68,000. This expense covers the ongoing monitoring activities that are necessary to assess and ensure environmental compliance and impact during the construction period.

Once the project enters the operational phase, the recurring environment monitoring cost increases to Rs. 17,18,000. As the facilities for continuous monitoring stations for Air and Piezometer are already installed for the existing power plants, there is no additional capital investment. This higher amount reflects the continued need for environmental monitoring and maintenance during the operational lifespan of the project.

Table 6.5: Environment Monitoring Cost

Component	Locations	Frequency	Total no. of samples annually	Cost per Sample (Rs)	Recurring cost (Rs)	Capital Cost (Rs)
	Construction Phase					
Air	2	Once in two weeks	52	5000	2,60,000	0.00
Water	2 surface water samples	Twice in 6 months	8	6000	48,000	0.00
	2 ground water samples	Twice in 6 months	8	5500	44,000	0.00
Noise	2	Once in three months	8	2000	16,000	0.00
Total Environment Monitoring Cost during Construction Phase				--	**3,68,000**	**0.00**
	Operation Phase					
Air	Continuous online monitoring station	Continuous	0	0.00	0.00	0.00
	4	Monthly	48	5000	2,40,000	0.00
Water	5 surface water samples	Monthly	60	6000	3,60,000	0.00
	4 groundwater	Monthly	48	6000	2,88,000	0.00
	4 Wastewater/ ETP	Monthly	48	4000	1,92,000	0.00
	Piezometer	Long term assessment	8	-	-	0.00
Noise	10	Monthly	120	2000	2,40,000	0.00
Soil	2	Quarterly	8	6000	48,000	0.00
Ecology	Study Area	Once a year	1	-	3,50,000	0.00
Total Environment Monitoring Cost during Operation Phase				--	**17,18,000**	**0.00**

Overall, the environmental monitoring costs during both the construction and operation phases are significant, with the operational phase bearing a higher recurring expense due to ongoing monitoring and compliance requirements. The capital cost represents the upfront investment necessary to initiate the environmental monitoring activities essential for the project's environmental sustainability and compliance throughout its lifecycle.

7. Additional Studies

7.1 Introduction

The additional studies as suggested in Para 7 & Appendix-III of EIA Notification 2006 amended to date are (i) Public Consultation; (ii) Risk Assessment; (iii) Social Impact Assessment and (iv) Rehabilitation & Resettlement (R&R) Action Plan. As the expansion will take place within the area of existing plant, there will be no applicability of R&R.

Based on the TOR specified by the Ministry of Environment, Forest, and Climate Change (MoEF&CC) issued vide letter no. J-13012/99/2008-IA.II(T) Dated 28.12.2024 for preparation of EIA report for the proposed expansion project for Anuppur TTP, MBPMPL is carrying out several additional studies regarding hydrogeology study, Watershed Management Plan, Carbon Emission and allied carbon sequestration plan, Need based social Impact Assessment, etc. which will help in the understanding the environmental impact of the expansion project in better ways. Summary of all the additional studies is presented in this chapter with the detailed report during the Final EIA & EMP report.

7.2 Public Hearing & Consultation

As per the conditions of the granted ToR and the EIA Notification 2006 & its subsequent amendments, public consultation will be held for the project based on this draft EIA&EMP report. "Public Consultation" refers to the process by which the concerns of local affected persons and others who have plausible stake in the environmental impacts of the project or activity are ascertained with a view to considering all the material concerns in the project or activity design as appropriate. The Draft EIA-EMP report will be submitted to MPPCB, Madhya Pradesh along with other relevant documents. The Authority is expected to process the application for Public Hearing and conduct the same within 45 days of receiving the application as per EIA notification 2006 and its subsequent amendments.

The regulatory authority shall, however, make available on a written request from any concerned person the Draft EIA&EMP report for inspection at a notified place during normal office hours till the date of the Public Hearing. All the responses received as part of this public consultation process will be forwarded to the applicant through the quickest available means.

After completion of the Public Hearing, the project proponent shall address all the environmental concerns expressed during this process and make appropriate changes in the EIA&EMP report. The final EIA&EMP report, so prepared, will be submitted by the PP MOEF&CC for appraisal by respective EAC for the grant of EC.

7.3 Risk Assessment

A hazard is something that can potentially cause harm, and a risk is the chance, high or low, that any hazard will actually cause somebody harm. Industrial disaster may arise when a major accident occurs and becomes uncontrollable resulting in the consequences spreading out of the project boundary. Hazards are inherent to all industrial operations since they involve handling of hazardous materials (flammable, explosive, corrosive and toxic materials), heavy machineries & technical units. Thus, risk assessment becomes an important part of the EIA-EMP study. Risk Assessment is a methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods, and the environment on which they depend.
Risks are inherent in thermal power plant operations since they involve working with many Hazards such as (i) High pressure super-heaters, re-heaters, economizer units exchanging heat with the hot flue gases; (ii) Turbines that utilize the HP steam to generate power; (iii) Fuel oil storage and handling units; (iv) Coal handling units; (v) Hydrogen as a coolant in turbo generators drawn from hydrogen cylinders; (vi) Chlorine dioxide as water treatment chemical and (vii) Switchyard including transformers, isolators etc. (viii) Hydrogen Storage as coolant

Nevertheless, a properly designed and operated potentially hazardous unit of a thermal power plant will have a very low probability (to a level of acceptable risk) of a threat. Subsequently, a properly designed and executed management plan can further reduce the probability of a threat turning into an on-site emergency and /or an off-site emergency.

The four major steps in risk assessment are:

- Hazard identification
- Dose response assessment
- Exposure assessment
- Risk characterization

Hazard identification is a process that determines the probable risk on human health or properties that could result from exposure to a potential hazard. This process requires a review of the scientific literature. The literature could include information published by the national and international organizations like US Environmental Protection Agency (EPA), state agencies, and health organizations. Identification of causes and types of potential hazards is the primary task for planning for consequential risk assessment.

Dose-response or toxicity assessment is the determination of how different levels of exposure to a hazard or pollutant affect the likelihood or severity of health effects. Responses/effects can vary widely since all chemicals and contaminants vary in their capacity to cause adverse effects. The dose-response relationship can be evaluated for either carcinogenic or non-carcinogenic substances.
Exposure assessment is the determination of the magnitude of exposure, frequency of exposure, duration of exposure, and routes of exposure by contaminants to human populations and ecosystems.

There are three components to this step: **Component-1:** Identification of contaminants being released which are hazardous; **Component-2:** Estimation of the amounts of contaminants released from all sources or the source of concern and **Component-3:** Estimation of the concentration of contaminants.

7.3.1 Component-1 Identification of Contaminants/Hazards

A classical definition of hazard states that it is the characteristic of system/process that presents potential for an accident. Hence, all the components of a system/process need to be thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident.

Estimation of probability of an unexpected event and its consequences form the basis of quantification of risk in terms of damage to property, environment, or personnel. Therefore, the type, quantity, location, and conditions of release of a toxic or flammable substance have to be identified in order to estimate its damaging effects, the area involved, and the possible precautionary measures required to be taken. Based on the areas and unit operations involved in generation of power from a coal fired thermal power plant, various hazards are identified which are given in **Table 7.1**.

Table 7-1 Potential Hazards

Sl. No.	Blocks/Areas	Hazards Identified
1	Coal storage in open yard	Fire, Spontaneous Combustion
2	Coal handling plant	Fire and/or Dust Explosions
3	Boilers	Fire (mainly near oil burners), steam; Explosions, Fuel Explosions
4	Turbo-generator buildings	1. Fires in a) Lube Oil systems; b) Cable galleries c) Short circuits in (i) Control rooms(ii) Switchgears 2. Explosion due to leakage of hydrogen and fire following it. 3. Fire in oil drum storage
5	Power transformer	Explosion and fire
6	Switch yard control room	Fire in cable galleries and Switchgear/ Control Room
7	Hydrogen Plant	Explosion and/or fire, Physical dangers
8	LDO	Fire
9	FGD	FGD effluent –Corrosive

7.3.2 Component-2 Estimation of Amount of Contaminants

In a coal based TPP, fuel oils are needed for start-up operations. Hazardous substances in fuel oil storage may be classified into three main classes namely flammable substances, unstable substances and toxic substances. The fuel storage details of the project and properties are LDO which falls under Class B Flammable Liquids **(Table 7.2).**

Table 7-2: Flammability Classification Criteria

Sl. No.	Flammability Class	Flash point (°C)
1	Class A Flammable Liquid	FP < 23
2	Class B Flammable Liquid	23 > FP <65

Fuel oils (LDO) will be used in small quantity for initial start-up. Acid, alkalis and other chemicals are used in the makeup water treatment & DM Plant. The hazards associated with the use of these materials would be taken careful consideration and due precaution would be taken for its safe handling at various stages of usage.

Coal dust when dispersed in air and ignited would explode. Crusher house and conveyor systems are most susceptible to this hazard. To be explosive, the dust mixture should have: (i) Particles dispersed in the air with minimum size (typical figure is 400 microns); (ii) Dust concentrations must be reasonably uniform; and (iii) Minimum explosive concentration for coal dust (33% volatiles) is 50g/Nm^3. Failure of dust extraction and suppression systems may lead to abnormal conditions and may increase the concentration of coal dust to the explosive limits. However, uncontrolled emission of coal dust from coal handling plant do no exceed 5 g/Nm^3.

Sources of ignition present are electric equipment and cables, friction, spontaneous combustion in accumulated dust. Dust explosions may occur without any warnings with Maximum Explosion Pressure up to 6.4 bar. Another dangerous characteristic of dust explosions is that it sets off secondary explosions after the occurrence of the initial dust explosion. Many a times the secondary explosions are more damaging than primary ones. The dust explosions are powerful enough to destroy structures, kill or injure people and set dangerous fires likely to damage a large portion of the Coal Handling Plant including collapse of its steel structure which may cripple the life line of the power plant.

Thus, storage of coal would be designed in such a way that the air content in the coal pile is minimized. Dimension of the coal stack, particularly the height, is a very important parameter for making storage of coal safe and adequate care would be taken while designing the same. Regular watering of stock pile will be done to keep temperature within limits.

7.3.3 Component-3: Estimation of The Concentration of Contaminants

Preliminary Hazard Analysis: Two scenarios are considered for the **Preliminary Hazard Assessment (PHA)**: (i) Spillage of chemicals while handling.

Table 7-3: Preliminary Hazard Assessment for Power Plant: Environmental Factors

PHA Category	Description of Plausible Hazard	Recommendation
Environmental factors	Spillage of chemicals from tanks and while handling	• Any unintentional spills must be handled in accordance with the MSDS for each chemical. • All chemical storage tanks must be housed inside a ditch with dike wall according to volume of tank to prevent spills from occurring from ruptures or leaks in joints. • A copy of the MSDS must be maintained in the warehouses and chemical laboratory.
	Spillage of chemicals or baths into trench	• All tanks storing chemicals shall be kept within Dyke with wall so that spillage due to rupture or leakages in joints does not take place. • The source of the spillage shall be immediately identified and plugged. • The spilled chemical shall be washed with water and the washed water shall be collected and treated.

7.3.4 Hazards From LDO Handling & Storage

7.3.4.1 Pool Fire of LDO Storage

One tank of 500 m^3 is provided to store LDO. Due to the proposed expansion, there will be 2 additional tank of storage capacity 2000 m^3 are envisaged for LDO. The tanks will be kept within Dyke. In the event of spilling its contents through a small leakage or due to rupture of the pipeline connecting the tank and on ignition, fire will eventuate. As a worst case it is assumed that the entire contents are leaked out from the storage tank into the tank bund.

7.3.5 Hazard from Coal Handling

Unwanted non-coal materials like shale and stones are generally present with occasional presence of iron pieces like shovel teeth etc. Some of the common problems of power plants due to poor and inconsistent raw coal quality are listed below-

- Damage to conveyor belts, crusher elements and frequent choking of chutes and feeders;
- Reduced pulverizing capacity of the mills, higher erosion of grinding elements and reduced availability of mills due to higher outages;
- Reduced flame stability requiring additional oil support;
- Slagging and fouling of the water walls;
- Faster erosion at the coal burners and flue gas path;
- Increased requirement of land for dumping of ash, and ash handling equipment;
- Reduced Plant Load Factor (PLF) as well as reduced station thermal efficiency;
- Higher emissions and related environmental impacts.

Several other operational problems may also arise due to poor and inconsistent quality of coal

Table 7-4: Risk Associated with Coal Handling Unit.

Component	Type of defect	Affecting Factor	Reasons
Transfer Chute Liners, Grinding jib of crushers	Reduction in thickness due to wearing o surface Development of crack holes, pitting	Continuous coal flow	Friction between Coal and Component, crack generated from holes of fixing of bolts
		Impact of corrosive nature of coal	Wet coal when flows through then chances of pitting are more.
Conveyor Structures	Reduction in thickness due to wearing of surface and pitting	Corrosive component of coal	The accumulation of coal on structures
	Catastrophic structure failure	Cyclic loading	A result of manufacturing fabrication defects or localized damage in service.
Crusher Rotor, Motor shafts, Suspension bars, Arms Bearings	Development of cracks	Impact of coal & improper loading	Internal flaw
Conveyor pulleys	End disc failure, failure of locking assembly	Cyclic loading	Failure of the weld between the hub and the end disc in welded-in hub designs
Drive foundations	Bolt failure, frame failure	Cyclic loading	A result of manufacturing fabrication defects or localized damage in service
Wire ropes of Aerial Ropeway	Due damage in strut	Cyclic loading	Weak area of strut

7.3.6 Mitigation Measures of Fire & Explosion Hazards

7.3.6.1 General Mitigation Measures

- Fire is one of the major hazards, which can result from auxiliary fuel (LDO) storage Tanks. Fire prevention and relevant code enforcement is one of the major responsibilities of project proponent. The fire service facility shall be equipped with:
  - Smoke and fire detection alarm system
  - Hydrant system
  - Medium velocity water spray system
  - High velocity water spray system
  - Low expansion foam system
  - Fire tenders

- Mobile & portable fire extinguishing equipment

- Smoke and fire detection, fire hydrant & nozzle installation etc. as indicated above shall be included as part of all major units.
- Periodic maintenance of all protective and safety equipment shall be done.
- Windsocks/wind cock should be operational at suitable height and with proper visibility to check the prevailing wind direction at the time of accident.
- Periodical training/awareness shall be given to work force at the project to as refresh courses in order to handle any emergency situation.
- Periodic mock drills shall be conducted so as to check the alertness and efficiency of the DMP and EMP and corresponding records should be maintained.
- Signboards including emergency phone numbers and no smoking signs shall be installed at all appropriate locations.
- Plant shall have adequate communication system.
- All major units/equipment shall be provided with smoke/fire detection and alarm system.
- All electrical equipment shall be provided with proper earthing. Earthed electrode shall periodically tested and maintained
- Emergency lighting shall be available at all critical locations including the operator's room to carry out safe shut down of the plant and for ready identification of firefighting facilities such as fire water pumps, fire alarm stations, etc.
- In addition to normal lighting, each installation shall be equipped with emergency (AC) and critical (DC) lighting.
- All electrical equipment shall be free from carbon dust, oil deposits, grease etc.
- Cable routing shall be planned away from heat sources, gas, water, oil, drain piping, air conditioning ducts etc.

7.3.7 Project Specific Mitigation Measures

- The LDO storage shall be located at least 100 m away from coal storage area in view the predicted heat radiation contour distance.
- Protective systems with high reliability and availability should be designed to ensure that these physical conditions are maintained.
- Dyke shall be provided for LDO Storage Tanks
- Co-ordination with local authorities such as fire, police, ambulance, district administration and nearby industries would be ensured to manage / control meet any eventuality.
- To prevent the hazard of static electricity, the fill and recirculation lines to the Storage Tanks shall be located below the liquid level.
- The following arrangements are suggested for LDO Storage Tanks:
    - One independent high-level alarm and trip off liquid inlet-line.
    - One low level alarm with trip off device.

  - Provision of auto deluge Water Sprinkler system for each bulk Storage Tank. The auto deluge Water Sprinkler would be set to start working at a temperature of 66ºC.
- In case of any Tank on fire or fire in the vicinity, the cooling of adjoining tank shall be resorted promptly in addition to Tank on fire so that the affected tanks well as the neighbouring Tanks does not give away.
- The night vision wind stocking be mounted on top of administrative building, main plant building and storage tanks is preferred so that people can move in upwind directions in the event of massive spillage from tank on fire.
- No machinery of vital importance like firefighting pump house, Hydrant and Fuel oil pump house shall be placed at radiation contours of 37.5 kW/m2 heat intensity having a distance of concentration of 13.5 m.
- **Chlorine Tonners**
  - Chlorine from pressure relief devices should go to an expansion tank or to gas absorption system
  - To prevent the large release of chlorine to atmosphere, monitoring and feedback facilities for early detection leaks and emergency shut down shall be provided
  - There should be facilities in the form of water curtain for absorption of chlorine released during an emergency as chlorine is highly soluble in water
  - Flow control valves at key points should be installed to prevent excess Cl_2 flow from the tonner with multiple level safety per line
  - Immediate actions needs to be taken for evacuation of all personnel in case of accidental release of chlorine
  - Eye wash stations and emergency shower stations should be provided at appropriate locations especially in the vicinity of Chlorine storage and dosing facilities
  - The stand by Cl_2 tonners shall be kept / stored at isolated covered warehouse at safe distance. It shall be provided with sufficient high (about 6 m) roof ventilation, Cl_2 detection and water spray system inside storage facility
  - Conduct awareness programmes on regular basis in order to educate villagers around the project about the consequences of possible health hazards and their precautionary measures during accidental conditions.

It is recommended that strict adherence to standards and accepted maintenance and operation of the plant plays a vital role in proper up-keep of the plant. Regular checking and monitoring of the health of equipment, pipeline and machines, thickness survey etc. will improve plant performance and safety.

Coal Storage & Handling System Precautions

Special precautions will be taken for pollution control by providing dust extraction and or spray type dust suppression arrangements at different transfer points and stockpile areas to contain dust under adverse wind condition.

Ventilation system should be provided for the underground tunnels, transfer points and at bunker level. Water spray (FOG) or CO2 is best extinguisher for small fires. The only media not to be used inadvertently is water. Fire hydrant ring main encompassing the coal stock should be considered to combat incidence of fire due to self-ignition. Handling and storage precautions are envisaged as follows:

- Exposure to high temperatures and flames are being and will be avoided
- High dust concentrations are being and will be avoided
- Exposure to strong oxidizers is being and will be avoided
- Coal would be stored in clean area and water is being and will be sprayed at appropriate intervals

Dust Mitigation Measures

- Coal dust fugitive emissions from transfer points shall be controlled by pneumatic suction into cyclone or bag filters as per design feasibility.
- Dust containment should be accomplished by enclosing the coal conveying equipment and related installations.
- Water spraying should be done to suppress the dust in outdoor areas. Permanently mounded water sprinklers should be located in the dust generating area.

The personal precautions envisaged include wearing of appropriate protection for the dust inhalation as per various regulatory limits as enforced by agencies. The spill clean-up measures include removing spills by vacuuming or by lightly spraying with water and sweeping mixture into a suitable container and will be rejected. However, Dry sweeping would be avoided.

7.4 Disaster Management Plan

7.4.1 Industrial Disasters

Industrial hazards are threats to people and life-support systems that arise from the mass production of goods and services. When these threats exceed human coping capabilities or the absorptive capacities of environmental systems, they give rise to industrial disasters.

Anuppur STPP has already implemented a Disaster Management Plan for existing unit. New units shall also be included in the same plan. Disaster Management Plan has been approved by Chief factory Inspector.

Events like explosion pool fire, toxic release and fireball are such calamities, which had never been foreseen, and for the persons working in the plant doing routine type of operations, the procedure becomes so monotonous that they forget that such type of events could occur any moment. Under these circumstances, as the people are unaware, they flee in all directions by vehicles or on foot. Although the traffic is halted, it leads to a massive jam making access to the site impossible for the rescue team. Due to explosions and smoke leading to confusion of common people, coordination becomes difficult and without the cooperation of these persons, the situation becomes uncontrollable. Emergency preparedness planning can be divided in two subsections: **(i) Onsite Disaster Management Plan and (ii) Off-site Disaster Management Plan**

Scope

The aim of hazard control and disaster management is concerned with preventing incidents through good design, operation, maintenance and inspection, by which it is possible to reduce the risk of an incident, but it is not possible to eliminate it. Since, absolute safety is not achievable; an essential part of major hazard control must also include mitigating the effects of a major incident.

An important aspect of mitigation is emergency planning, i.e., identifying accidents as soon as possible, evaluating the consequences of such accidents and deciding on the emergency procedures, both on-site and off-site, that would need to be adapted in the event of an emergency.

Objective

- The objective of this Plan is to describe the plant's emergency response organization, the resource available (internal as well external) and response actions applicable to deal with various types of emergencies that could occur at the facility with the response organization structure being emergency response actions.
- Effective notification and communication facilities.
- Regular review and updating of the Onsite & Offsite Emergency Plan.
- Proper training of the concerned personnel.

Scope of the Plan

An important element of mitigation is emergency planning i.e., recognizing that accidents are possible, assessing the consequences of such accidents and deciding on the emergency procedures, both on site and off site that would need to be implemented in the event of an emergency. Emergency planning is just one aspect of safety and cannot be considered in isolation.

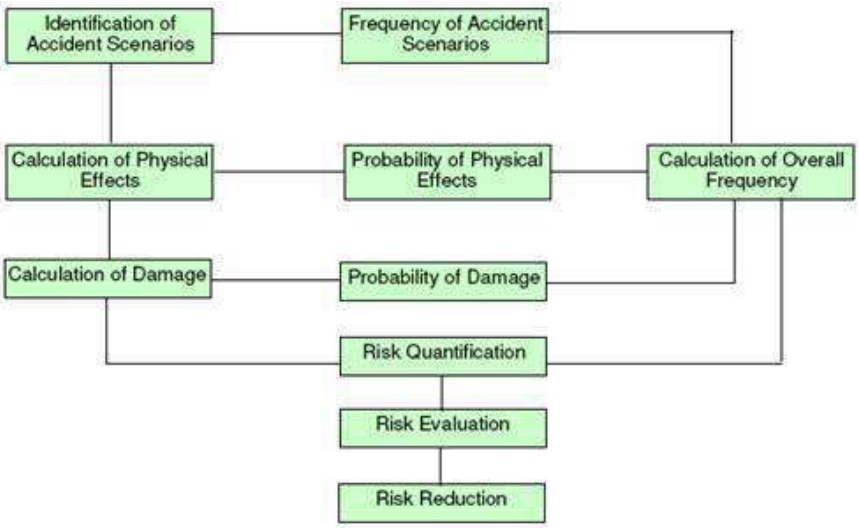


Figure 7-1: Risk Analysis Strategy.

Methodologies for Risk Analysis

The objective of risk analysis is to produce outputs that can be used to evaluate the nature and distribution of risk and to develop appropriate strategies to manage risk. Events or issues with more significant consequences and likelihood are identified as higher risk and are selected for higher priority mitigation actions to lower the likelihood of the event happening and reduce the consequences if the event occur. Qualitative methods use descriptive terms to identify and record consequences and likelihoods of the events and resultant risk. Quantitative methods identify likelihoods as frequencies or probabilities. They identify consequences in terms of relative scale (orders of magnitude) or in terms of specific values (for example estimate of cost, number of fatalities or number of individuals lost from a rare species). For both qualitative and quantitative methods, it is important to invest time in developing appropriate rating scales for likelihood, consequence and resultant risk. The full range of risk situations likely to be encountered within the scope of the exercise should be considered when developing rating scales.

Semi Quantitative Methods.

Semi-quantitative approaches to risk assessment are currently widely used to overcome some of the shortcomings associated with qualitative approaches. Semi-quantitative risk assessments provide a more detailed prioritized ranking of risks than the outcomes of qualitative risk assessments. Semiquantitative risk assessment takes the qualitative approach a step further by attributing values or multipliers to the likelihood and consequence groupings. Semi-quantitative risk assessment methods may involve multiplication of frequency levels with a numerical ranking of consequence. Several combinations of scale are possible.

		LIKELIHOOD				
SEVERITY		1	2	3	4	5
		Rare	Unlikely	Possible	Likely	Almost Certain
Catastrophic	5	5	10	15	20	25
Serious	4	4	8	12	16	20
Moderate	3	3	6	9	12	15
Minor	2	2	4	6	8	10
Negligible	1	1	2	4	4	5

Risk Factor 20 to 25 - Very High – A risk factor in this range would indicate an "unacceptable" level of risk. It would be appropriate to prohibit the activity until suitable improvements have been implemented to reduce the level of risk to an acceptable level;

Risk Factor 17-19 – Moderate High- Risk in this range are very severe and “borderline unacceptable”. They are just below the threshold of being prohibited but still require immediate and significant action to mitigate.

Risk Factor 10 to 16 - High – Hazards within this range should be proactively managed to reduce the risk to a level as low as reasonably practicable;

Risk Factor 5 to 9 - Medium – Risk factors within this range may be regarded as "tolerable" and identified hazards within this range should be actively managed; and

Risk Factor 1 to 4 - Low - Risk factors within this range would indicate that the level of risk is "acceptable" and therefore no further action would be necessary. However, it would still be important to ensure that any existing controls are maintained.

Onsite Disaster Management Plan:

The Onsite Disaster Management Plan is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operation in this same order of priorities. Considering the process and the material used at Anuppur STPP, the following hazards are identified along with the probable areas of occurrence as summarized in **Table 7.7.**

Table 7-5: Identification of Hazards and Potential/Probable Locations of Occurrence

Nature of Hazard	**Potential Areas / Locations of Occurrence**
Fire Hazards	• In coal handling plant, conveyors. • Cables in galleries, switchgear rooms, MOT in TG area. • Fuel oil handling areas and oil tanks. • Transformer oil storage and handling area. • Fire in generator transformers, transformers generation building, UTA, interconnecting transformer in switchyard. • Control Rooms. • Storage area of combustible / flammable goods. • Record rooms of documents.
Explosion Hazard	• Turbo generators where hydrogen is used for cooling of TG. • Boiler (coal/oil fired) • Coal dust in mills and boilers. • Critical Equipment / vessels under Pressure. • Battery Rooms
Bursting of Pipe Lines& Vessels	• Gas line due to high pressure • Steam pipes due to high pressure. • Water pipes due to high pressure. • Air receiver tanks and other pressure vessels. • Gas cylinders
Release of Gases / Dust	• Hydrogen in turbo generator area of main plant. • Pulverized coal dust from mills and associated piping.

Nature of Hazard	Potential Areas / Locations of Occurrence
	• Fly ash from chimneys and ash ponds, ESP hoppers and bottom ash system. • Coal dust in transfer points, CHP, Crusher, Bunker & Mill areas.
Release of Liquid	• Chemical tanks in water treatment plant. • Fuel oil tank in fuel oil handling section.

Important Response function during Emergency:

The emergency control majors can broadly be categorized in three phases i.e. pre-emergency, during emergency and post emergency majors. Figure given below explains different functions to be performed under these categories:

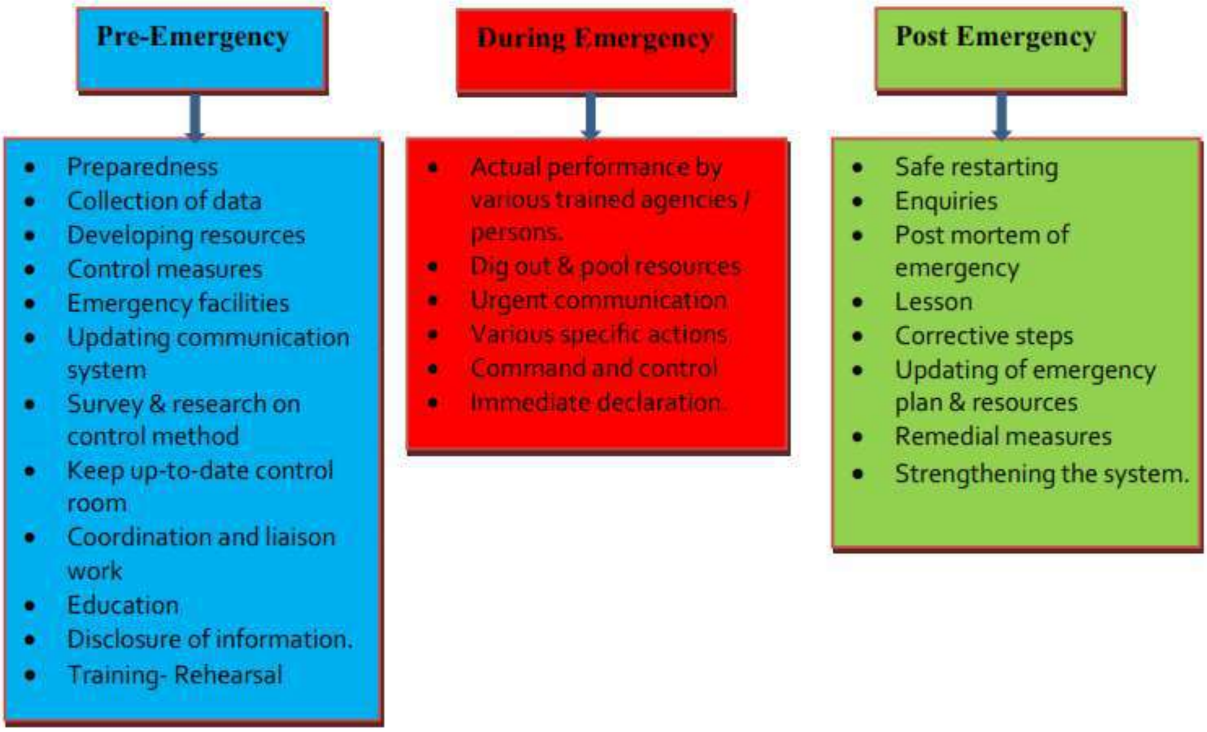


Figure 7-2: Response function during emergency

The Emergency Management Plan (EMP) envisages the need for providing appropriate action so as to minimize loss of life/property and for restoration of normalcy within the minimum time. Adequate manpower, training and infrastructure shall achieve this. An appropriate fire protection system is also developed to meet any emergency.

The emergencies are classified as construction hazard, natural hazard and operational hazard. During the construction time good construction practice and safety requirement should be enforced by the contractor at site. The construction manager can be the co-ordinator for the emergency management. Depending on the severity of the injury/ disaster outside medical help can be obtained. Before commencement of the work the hospital facilities should be identified and the address and phone numbers to be available to the contractor as well as the construction manager. During natural hazard the emergency plan to be implemented with the help and guidance from the district collector, who is the co-ordinator for such activity. During operation, the plant manager become the co-ordinator for the emergency activity and the emergency cell will be acting in accordance with the disaster management plan (DMP).

During construction phase proper measures should be taken to ensure safety at heights. Fencing/railing should be provided at construction openings to prevent physical injuries and fall of construction workers.

Emergency at MB Power (Madhya Pradesh) Limited:

S. No.	Particular	Details
1	Level I: Plant Level Crisis	The type of emergency, which can be handled and controlled by the plant management with own resources as per On-site emergency plan, is called as On-site Control or Level-I. This type of Emergency may arise due to – ▪ Small spot of fire in plant premises. ▪ Small leakage of hazardous or flammable material (gas / liquid) for short duration in plant premises. ▪ Collapse of small equipment in plant premises.
2	Level II: Mutual Aided/ Local Level Crisis	If the Level-I, is uncontrollable by the management, further help is needed, the neighbouring units or mutual aided local units will provide their resources to tackle the situation. The emergency of the Unit which is handled and controlled by the outside resources is called as Level-ll Mutual Aided or further if this type of emergency is governed by Local Crisis Group then it is called as Level-ll Local Crisis. This type of Emergency may arise due to: ▪ Huge Fire in plant premises ▪ Electrical flashover, power transformer oil fire and explosion in plant premises ▪ Heavy leakage of hazardous or flammable material (gas / liquid) for short duration in plant premises
3	Level III: District Level Crises	Even after putting efforts as explained in Level-ll, the situation becomes uncontrollable and beyond the control of Local Crisis Management, than the District Crisis Group will take over the charge & handle the emergency situation. This is termed as Level-III or District Crisis. This level of emergency, assume Off-Site Implications having possible impact on the neighbouring population outside the plant boundary as well as nearby outside general public places. It is beyond the control of plant's internal resources and outside mutual aid members and local crisis group and the help of more outside

		agencies (District Crisis) is required. This type of Emergency may arise due to- ▪ Explosion of high-pressure Vessel in plant premises. ▪ Explosion of vessel containing hazardous material (gas/liquid) ▪ Heavy leakage of hazardous material (gas/liquid) for long duration. ▪ Collapse of plant, building or structures.
4	Level IV: State/ National Level Crises	If gravity and situation of the emergency is beyond control of Local or District Crisis Group, The State / National Crisis Group has to command and control such crisis by utilizing all resources from the State or Nation, as prevailing circumstances, and then it is called as State Crisis or National Crisis. This level of emergency, assume Off Site Implications beyond control of Local or District Crisis Group. This type of Emergency may arise due to – ▪ Forced entry by External group of people. (Terrorist Attack , Act of War – Bombing) ▪ Sabotage (Bomb threat - Bomb Explosion)

Depending upon the process in different plant sections of the MB Power Plant, the types of hazards are listed in following table along with the existing protection measures:

S. No	Type of Hazards	Control Measures
1	**Fire in Coal Storage Area:** The coal is the main raw material for the power generation. The raw coal is stored in coal storage at MBPMPL having sufficient storage space.	• Fire hydrant system; • Fixed water monitors and sprays system conforming to Tariff advisory committee guidelines. • Apart from this fixed installation there are two no of fire tenders equipped with all necessary equipment to handle any fire incident effectively. • Proper compaction of coal stock by dozers to be done to eliminate auto ignition.
2	**Fire in Coal Conveyor Belt and Coal Mill:** Sub bituminous coal from coal storage is conveyed to the coal crusher and fed to the boiler using conveyor belts. For the purpose of risk analysis, fire in sub bituminous coal conveyor belt is envisaged. Fire may be caused by friction, hot work in the area, contact with hot materials; electrical fault etc. or due to coal conveyor belt operations. Any fire in conveyor would result in shutting down of plant operation. It applies to coal mill fire also. Hence such an emergency would be category III and the probability of occurrence would be frequent.	• Water monitor provided to fight fires at higher elevation. • Linear heat sensing cable and sprinkler system for entire coal conveyor system. • Conveyor belt made of fire-retardant material. • Walk ways have been provided to the entire length of the conveyor belt for regular physical monitoring. • Wet riser points have been provided for bunker floor and surrounding of conveyor system. • Chute blocks alarm system. • Water atomization system at all transfer

		points in CHP • Area is made free from combustible/flammable material. • Proper ventilation system in underground area and provision of smoke detection. Welding work forbidden in the area.
3	**Catastrophic Rupture of LDO Tank:** MBPMPL uses LDO in vertical storage tank for the start-up of the boiler. For the purpose of risk analysis, catastrophic rupture of entire LDO storage tank and subsequent pool fire ignited by heat sources is envisaged. Pool fire subsequent to catastrophic rupture of LDO tank and subsequent spread of fire	• Self-contained breathing apparatus (SCBA) in the fire station and fire tender. • Adequate training on usages of emergency repair and rescue equipment. • Installation of wind shock to know the direction of blowing air. • Hazard communication and Caution notice at various locations. • Restricted entry at handling area. • Medium pressure tank cooling system. • Fixed foam monitors and tank foam drenching system
4	**Loss of Containment of sulfuric Acid Tank:** MBMPPL has installed a 30mt sulfuric acid tank (concentration of acid is above 98%) in the cooling water treatment area. Catastrophic rupture of the sulfuric acid tank may lead to emission of corrosive fumes and traces of hydrogen gas i.e., category II emergency. However, considering the failure of such tanks in similar industries, the probability of the failure of sulfuric acid tank is considered remote.	• Dyke wall with adequate capacity to contain the leak with wall with acid resistant (tiles). • Neutralization Pit.
5	**Explosion of Air receivers Tanks:** MBMPPL has installed air receivers of 25 cum capacity for utility purpose. Explosion of air receiver tank is envisaged for the purpose of risk analysis. Due to the missile effect of the fragments, people up to the distance of 29 mtr from the location of air receiver would be affected. In this case, the emergency would be of category II. The probability of occurrence is remote.	• Pressure Switches and Safety valves provided on each air receiver tanks. • Continuous monitoring by the operator. • Auto tripping of compressors.
6	**Fire in Generator Transformers, Transformers Generation Building, UTA, Inter Connecting Transformer in Switchyard:** Appreciable quantity of transformers oil is used for cooling in the transformer. Barriers (baffle wall) are provided to segregate the transformers from rest of the transformers. US statistics reveal that about 1200 transformers out of 50 million transformers used for the non-residential purpose are affected by fires. Winding faults, bushing failure etc. were some of the causes. Though transformer in MBPMPL is built as per Indian electricity rules and tariff advisory committee regulations; remote probability of fire exists with the transformers, which may lead to category III emergency scenario.	• High velocity water spray system actuated by the automatic deluge valve system is provided for protecting the transformer against the fire. • External hydrant protection is also available. • Portable fire extinguishers have been installed as per fire load.

7	Fire in cable gallery in TG building: In MBPMPL, cable cellar is located in the TG building at the 0mtr,3 & 7 mtr level. Considering the fire experience in the similar area of other occupancies and damage potential of any fire scenario in the area, cable fires due to accumulation of combustible dusts and presence of ignition sources like insulation deteriorative cables are visualised. Considering the risk control measures employed, the probability has been visualised to be occasional and possible emergency scenario to be category III.	• Smoke detection system coupled with medium velocity water spray system is provided. • Linear heat sensing cable. • Fire barrier have been planned between the wall partitions. • Fire stop chemical coating shall be done for the cables. • Cable gallery is designed as per the TAC guidelines.
8	**Fire in Switchgear Room:** The main switch gear panel room is located at the 10mtr level in the TG building. Fire in the main switch gear panel may be due to accumulation of combustible waste or due to overheating of cable terminations in the cable alleys of the electrical panel. Such an emergency occurring in the switchgear room would lead to category III type of emergency. The probability of occurrence of such fire is remote.	• Pressurized deluge system for the switchgear room. • Heat and smoke sensors has been provided in all control rooms.
9	**Fire in Plant Control Room**: Plant control room is located at 14mtr level of TG building. Entire control of the plant is through. Distributed control system and the plant is operated through the controls available in the control room. Fire and smoke spread to control room in case of fire in the false ceiling is visualized. Though it is a remote possibility as the false ceiling has automatic detection system, the emergency arising out of such possibility can be of class III category.	• Smoke detection system is provided for the control room. • It is manned and under continuous monitoring round the clock.
10	**Fire / Explosion in Battery Room:** Battery room is located at 7 mtr level in the Central Control building. Lead Acid Batteries are installed in battery room 7.3 mtrs; fire/explosion due to evolution of hydrogen during the changing process is envisaged for the purpose of risk analysis. While such an emergency would of category III, the probability of occurrence is remote.	• Adequate ventilation is provided. (Exhaust fans planned.). • Daily inspection schedule for battery rooms shall be maintained.
11	Fire in Main Turbine Oil Tank: Main turbine oil tank of 53KL capacity and is located at 0 meter level. Though similar occupancies have experienced a number of fires due to oil leak. Probability of occurrence is envisaged as occasional at MBPMPL and can result in an emergency of category III.	• Pressurized hydrant system with booster pumps.
12	Catastrophic Rupture of Ash Silo (1000 cum capacity each): Fly ash silo made of concrete has a capacity of 5000 cum. The structure is designed as per IS 1893 to have adequate earthquake resistance. Failure of concrete silos has been experienced in some other occupancy like cement industry in the past. However considering the design and age of the silo at	• Design of silo by expert consultant. Barricading road by security.

	MBPMPL, the probability of the failure of silo appears to be remote. However in case of failure, the emergency that is visualized may be category IV.	
13	Structural Collapse of Electro Static Precipitator (ESP): MBPMPL has installed two pass ESP. For the purpose of risk analysis, structural collapse of the ESP is envisaged, resulting in the fly ash spreading to the other plant areas. Such as emergency would be of category III.	• Design by expert consultants following all relevant standards.
14	**Pool Fire due to Catastrophic Rupture of 990 ltr Diesel Day Tank in DG room:** MBPMPL has provided a diesel day tank of capacity 990-litre in the diesel generator room. Catastrophic rupture of the diesel tank and subsequent pool fire is considered for the purpose of risk analysis. The quantity of the diesel involved in fire such an emergency would be of category II and the probability of occurrence is remote.	• Dyke wall around the diesel to check the spread of fire. • Hydrant network in entire plant.
15	**Boiler Explosion:** Boilers are operated under high pressure (205kg/cm sqr) and temp. Boilers are installed at MBPMPL are designed as per statues and standards. The safe guards like pressure and temperature indicators and automatic controls, redundant safety relief valves are provided. However failure of safe guards may result in uncontrolled explosion of boiler. Such occurrence is expected to be remote. However, the consequences may result in category III type emergency.	• FSSS logic incorporated in boiler design. • Fire hydrant are fixed at zero mtr, 17 mtrs, 26 mtrs,29 mtrs,33 mtrs,36 mtrs and 72 mtrs. • Yearly inspection by competent authority.
16	**Clinker Formation:** Clinker formation if not cleared in time can lead to a serious operational problem, which may occur in a Boiler due to various reason like sudden change in coal properties and improper operating condition etc. The removal of clinker from boiler bottom ash hopper is a critical process and hence shall be done under supervision. If ash accumulation in bottom ash hopper is allowed to pile up / not dislodged at regular interval, water level in this hopper will rise. Sudden dislodging/falling of slag into Bottom ash hopper, while the same is being cleared, may cause furnace draft fluctuations and in extreme case may cause serious burn injury. Hence such an emergency would be termed as 'category III' and the probability of occurrence would be lowest, if all the safety measures are properly taken.	• Opening of Man-Hole is not allowed. • Use of fire suit, face shield and PPE during clinker clearing operation through peephole. • Soot blowing system operation, on a regular basis. • Clinker grinder operation is never bypassed.
17	**Fire Due to Lightning Strike**: Lightning strike may cause damages to the structures by means of fire and harm people working under or near the structures by means of fire and shock injuries. Considering the location of the plant, the probability of lightning strike in damage to property/harm to people is envisaged to be remote. Major damage due to	• MBPMPL has installed lighting protection system for the entire plant area as per IS 2309.

	lightning can cause emergencies of category III	
18	**Catastrophic Ruptures of Steam line at 167 bars:** Pipelines carrying high-pressure steam are exposed to high pressure and temperature. Improper design and material failure can result in explosion and /or release of high temperature steam. The pipe lines are designed as per the specification of IBR and relevant standards. Therefore, the probability of occurrence of pipe line failure is envisaged to be remote and major damage can cause category II type emergency.	• Steam lines are designed as per standards so as to take care of design pressure. • Continuous monitoring of all governing parameters with adequate control systems.
19	**Collapse of Chimney:** MBPMPL has installed a concrete chimney with two insulated flue cans adequately safety measures. However, for the purpose of risk analysis, defect in chimney is considered, which may lead to collapse of part of chimney resulting in category III type emergency. However, the probability of occurrence of such incident is remote.	• It is designed by the expert agency in accordance with relevant standards and codes with safety factors. • Adequate quality control was ensured during construction process.
20	Fire in Turbine Hall: Fire in turbine hall is considered for the purpose of risk analysis. Given the presence of turbine oil, lube oil, control oil and governing oil and possibility of ignition sources, fire in turbine hall may be critical to the operation of the power plant. Such an emergency would fall under category III and the probability of occurrence is occasional.	• Fire detection and protection systems are installed at all appropriate locations.

7.4.2 Hazard from LDO Handling & Storage

ALOHA® is the hazard modelling program for the CAMEO® software suite, which is used widely to plan for and respond to chemical emergencies and approved by USEPA. The same is used here.

7.4.2.1 Ammonia Leakage from Storage Tank

CHEMICAL DATA:

Chemical Name: AMMONIA
CAS Number: 7664-41-7 Molecular Weight: 17.03 g/mol
AEGL-1 (60 min): 30 ppm AEGL-2 (60 min): 160 ppm AEGL-3 (60 min): 1100 ppm
IDLH: 300 ppm LEL: 150000 ppm UEL: 280000 ppm
Ambient Boiling Point: -30.3° F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

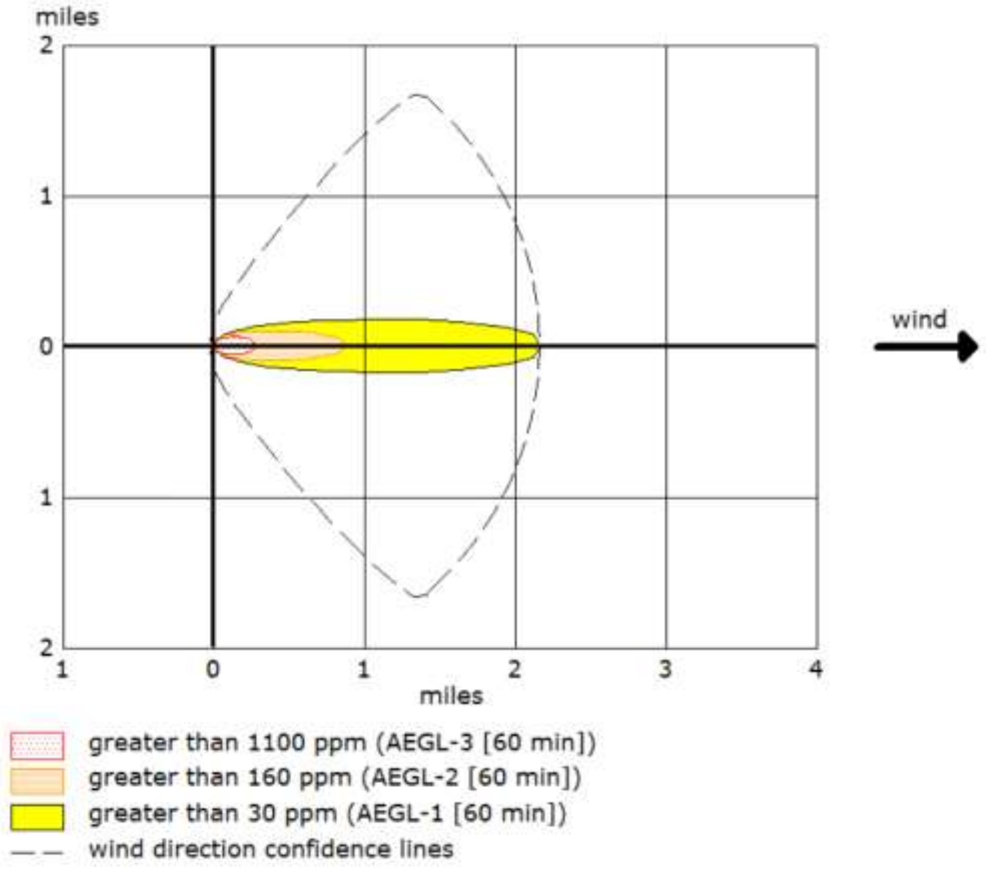
Wind: 2.1 meters/second from N at 10 meters
Ground Roughness: open country Cloud Cover: 5 tenths
Air Temperature: 31.6° C Stability Class: C
No Inversion Height Relative Humidity: 80%

SOURCE STRENGTH:

Leak from hole in horizontal cylindrical tank
Flammable chemical escaping from tank (not burning)

Tank Diameter: 11.64 meters Tank Length: 18.79 meters
Tank Volume: 2,000 cubic meters
Tank contains liquid Internal Temperature: 31.6° C
Chemical Mass in Tank: 919 tons Tank is 70% full
Circular Opening Diameter: 0.5 inches
Opening is 5 meters from tank bottom
Release Duration: ALOHA limited the duration to 1 hour
Max Average Sustained Release Rate: 375 pounds/min (averaged over a minute or more)
Total Amount Released: 22,519 pounds
Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
Model Run: Heavy Gas
Red : 483 yards --- (1100 ppm = AEGL-3 [60 min])
Orange: 1567 yards --- (160 ppm = AEGL-2 [60 min])
Yellow: 2.2 miles --- (30 ppm = AEGL-1 [60 min])



7.4.2.2 Chlorine Leakage from Storage Tank

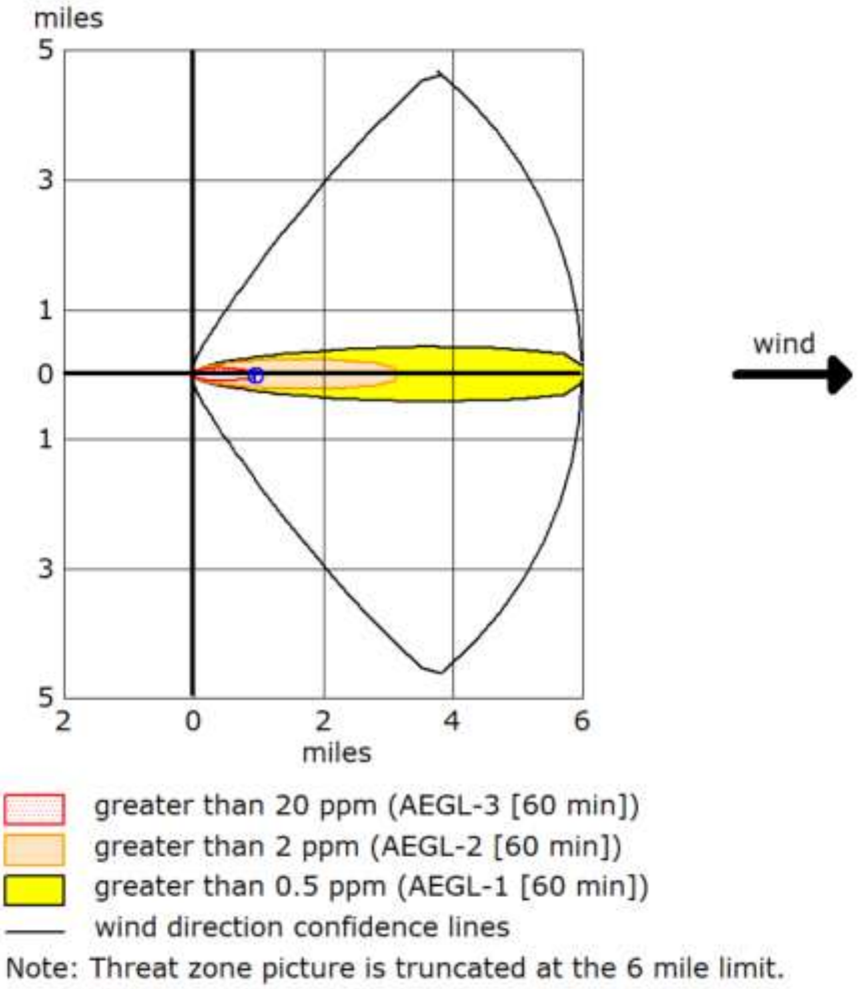
CHEMICAL DATA:
Chemical Name: CHLORINE
CAS Number: 7782-50-5 Molecular Weight: 70.91 g/mol
AEGL-1 (60 min): 0.5 ppm AEGL-2 (60 min): 2 ppm AEGL-3 (60 min): 20 ppm
IDLH: 10 ppm

Ambient Boiling Point: -31.6° F
Vapor Pressure at Ambient Temperature: greater than 1 atm
Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
Wind: 2.1 meters/second from N at 10 meters
Ground Roughness: open country Cloud Cover: 5 tenths
Air Temperature: 31.6° C Stability Class: C
No Inversion Height Relative Humidity: 80%

SOURCE STRENGTH:
Leak from hole in horizontal cylindrical tank
Non-flammable chemical is escaping from tank
Tank Diameter: 11.64 meters Tank Length: 18.79 meters
Tank Volume: 2,000 cubic meters
Tank contains liquid Internal Temperature: 31.6° C
Chemical Mass in Tank: 2,138 tons Tank is 70% full
Circular Opening Diameter: 0.5 inches
Opening is 5 meters from tank bottom
Note: RAILCAR predicts a stationary cloud or 'mist pool' will form.
Model Run: traditional ALOHA tank
Release Duration: ALOHA limited the duration to 1 hour
Max Average Sustained Release Rate: 500 pounds/min (averaged over a minute or more)
Total Amount Released: 30,006 pounds
Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
Model Run: Heavy Gas
Red : 1.4 miles --- (20 ppm = AEGL-3 [60 min])
Orange: 4.8 miles --- (2 ppm = AEGL-2 [60 min])
Yellow: greater than 6 miles --- (0.5 ppm = AEGL-1 [60 min])



Emergency Command Structure

During the normal operation most of the key persons and the different team members are available within the plant and hence can assume the responsibilities assigned to them in case of emergency.

Silent hour refers to the time during the period, only Station Engineer will take the initial whole-sole responsibility and communicate to WIC/ECC/ Incident Controller through the available landline or mobile phones. On arrival at the accident site, Incident Controller or his alternate assumes the charge and activates the same command structure.

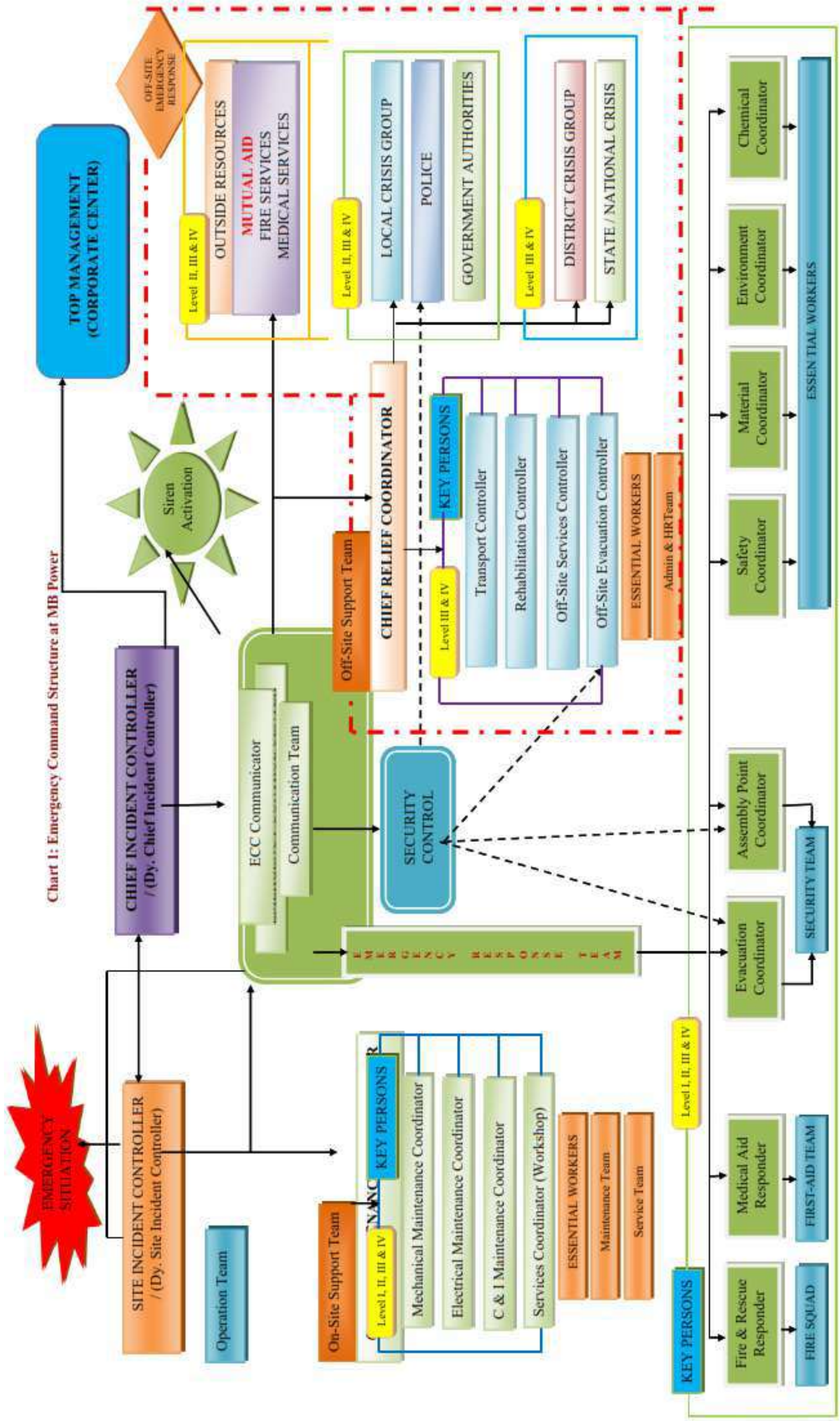


Figure 7-3: Emergency Command Structure at MBPMPL.

Responsibilities of Designated Key Personnel during Emergency:

S. No	Designated roles of Emergency Command Structure	Responsibilities
1	Chief Incident Controller (CIC) / Chief Adviser – Thermal	• Declaration of "Major Emergency" if he is certain that the incident cannot be controlled with routine operations. If he decides that a major emergency exists is likely, he should ensure that the emergency services have been called on and the on-site plan activated. • Ensure that key personnel are called in; • Exercise direct operational control of those parts of the works • outside the affected area; • Continually review and assess possible developments to determine the most probable course of events; • Direct the shutting down of plants and their evacuation in consultation with the Incident Controller and key personnel; • Ensure that casualties are receiving adequate attention. Arrange for additional help if required. Ensure that relatives are informed; • In the case of emergencies which involve risk to outside areas from wind-blown materials, contact the local meteorological office to receive early notification of impending changes in weather conditions; • Liaise with chief officers of the fire and police service and with the Health and Safety executive; provide advice on possible effects on areas outside the works; ensure that personnel are accounted for; • Control traffic movement within the works; • Arrange for a log book of the emergency to be maintained; • Where the emergency is prolonged, arrange for the relief of site personnel and the provision of catering facilities; • Assessment of the magnitude of the situation and to decide whether the employees are to be evacuated from the assembly points to identified shelter place. • To undertake a continuous review of possible developments and assess in consultation with various teams as to whether shutting down of the plant or any section of the plant is required. • To consult and liaise with senior officials of the government like Fire Brigade, Police, Medical and the Factories Inspector through appropriate IC/Team Leaders. On the basis of the recommendation of Team Leaders, provide advice to authorities on possible harmful effects to neighbouring population staying outside the factory premises. • To look after rehabilitation of affected persons on discontinuation

		of emergency. • To issue authorised statements to news media, and ensure that evidence is preserved for enquiry to be conducted by the Statutory Authorities. • The corporate office assistance shall be sought as and when required depending upon the severity of the situation.
2	Works Incident Controller (WIC)	• As soon as he has been made aware of an incident the Works • Incident Controller should assess its scale against predetermined criteria or emergency reference levels, and decide whether a major emergency exists or is likely. If so, he should immediately activate the on-site plan and if necessary, the off-site emergency plan. He will also inform the CIC. • He should assume the duty on the Chief Incident Controller • pending the latter's arrival, in particular to: Ensure the emergency services have been called on & key personnel have been summoned; Direct the shutting down and evacuation of the other plant areas, etc., likely to be affected. • Direct all operations at the scene of the incident, e.g. Rescue and firefighting operations in close association with fire brigade, search for casualties & ensure necessary medical assistance with help of OHC personnel; Evacuation of non-essential workers to assembly areas. • Set up communication points and establish continuous contact with Emergency Control Centre relating to failure of electric supply and thereby Public Address System (PAS) and internal telephones. • Give advice and information as requested to the emergency • services; • Brief the Chief Incident Controller and keep him informed of developments. • Issue instructions to shut down all operations within the affected area taking into consideration priorities for safety of personnel, minimise damage to the plant, property and the environment. • Provide advice and information to the fire and security personnel in consultation with concerned officials. • Ensure that all non-essential workers/staff of the affected area have been evacuated to the safer places. • Report all significant and developments to CIC. • He will take action to preserve the evidence for the further enquiry into the cause and circumstances which caused or escalated the emergency.
3	Incident Controller (IC)	Immediately after hearing the emergency siren, the Incident Controller will wear PPE and will rush to the scene of the emergency and take following actions: • Decide complete course of action as per situation, viz., shutting

		down, sealing, isolation, evacuation, barricading of the area, etc. • Direct all operations within the affected area with the priorities – ensure the safety of personnel, minimize damage to plant, property and environment. • Guide fire-fighting operation/all possible steps to control emergency. • Ensure that all non-essential workers in the affected area are evacuated to the appropriate assembly points. • Will keep record of the incident and progress of operation to fight emergency, and then intimate all significant developments to the WIC and Emergency Officer. • In case of power failure/telephone services disruption, he will arrange communication to all concerned through messengers.
4	Emergency Officer (EO)	• Provide strategic advice to WIC and CIC. • Will have close association with fire and rescue team and advise for control of the emergency. • Ensure the availability of all safety equipment and PPE. • Ensure the preservations of evidences for the investigation of the incident. • Investigate the accident to find out the causes. • Ensure that the on-site emergency operations are carried out safely. • Guide the fire officer/firefighting team to control the spread of fire. • Arrange for further equipment /assistance for firefighting, if necessary. • Arrange for containment /diversion of spills and chemicals, draining of effluent generation during firefighting, emergency operations etc. • Guide the rescue team members. • Any other work in consultation with IC.
Onsite Support Team		
5	Chief maintenance Coordinator	• He will evaluate emergency requirements with “Site Incident Controller” and arrange necessary logistics through staff. • He will conform that all communication facilities in good order. • He will ensure continuous availability of Fire pumps and uninterrupted water supply for controlling emergency conditions. • He will arrange for establishing Emergency Control Centre in event Control Room is being rendered non-operational. (Directly affected) • He will ensure availability / restoration / isolation of power supply in the affecting areas as required. • He will arrange for additional personnel as required for carrying out Mechanical Electrical, C&I and Civil, Jobs at site. • He will arrange to provide necessary tools, tackles & operators for

		the same. • He will arrange emergency repairs and maintenance to keep the station operational during the emergency. • He will make arrangement for temporary / permanent connection for Emergency lights / Flood lights / Streetlights / other equipment, Shelters, Relief areas etc. • He will extend any other helps required.
6	Mechanical Maintenance Coordinator	• He will keep the Mechanical Maintenance section office manned (operational) with effective communication link with ECC to execute all emergency jobs. • He will ensure that the personnel carried out their section jobs (including contractors) in "Trouble Spot" areas are safely evacuated. • He will arrange to mobilise necessary equipment along with personnel skilled in their use and make them available at the "Trouble Spot", area. (Equipment: Welding and Cutting set, Chain Pulley Block, Water pump, Personnel Protective Equipment, etc. Personnel Skill: Skilled manpower to attend any leakage of toxic materials Gas or liquid (Acid / Alkaline), etc.
7	Electrical Maintenance Coordinator	• He will keep the Electrical Maintenance section office manned (operational) with effective communication link with ECC to execute all emergency jobs. • He will ensure that the personnel carried out their section jobs (including contractors) in "Trouble Spot" areas are safely evacuated. • He will arrange for all necessary Isolations and / or Restoration of power supply in the "Trouble Spot" areas, as required. • He will arrange to mobilise Diesel Generator sets in the affected areas. If required. • He will arrange to mobilise necessary equipment along with personnel skilled in their use and make them available at the "Trouble Spot", area (Equipment: Electrical tools, Emergency Lighting arrangement, Temporary connections for equipment, Welding m/c, pump sets etc, and Personnel Protective Equipment o Personnel Skill: Skilled manpower to provide, power connection, as required and for testing, relay setting work etc.) • He will advise for relay setting or set relays for safe operations of the plant during emergency conditions. • He will arrange testing of the affected equipment and give clearance for putting back in service / availability of equipment for service. • He will extend any other helps required.
8	C&I Maintenance Coordinator	• He will keep the C&I Maintenance section office manned (operational) with effective communication link with ECC to execute all emergency jobs.

		• He will ensure that the personnel carried out their section jobs (including contractors) in "Trouble Spot" areas are safely evacuated. • He will organise repairs, adjust instrument setting & control for effective Emergency operation. If required • He will arrange to restore the function / resetting of controls and alarms indicators etc. for operational stability. If required • He will arrange to mobilise necessary equipment along with • personnel skilled in their use and make them available at the "Trouble Spot", area. (Equipment: Instrument, Calibration tools, and Personnel Protective Equipment o Personnel Skill: Skilled manpower to provide, C&I connection, as required and for testing, setting work etc.) • He will extend any other helps required.
9	Service Coordinator	• He will keep the Workshop and Services section office manned (operational) with effective communication link with ECC to execute all emergency jobs. • He will ensure that the personnel carried out their section jobs (including contractors) in "Trouble Spot" areas are safely evacuated. • He will arrange for diversion of water supply to emergency area. • He will extend any other helps required
Responsibilities of Emergency Response Team		
10	Fire & Rescue Responder	• On receiving "Message or Call", he will Rush to the place of Occurrence Scene and assume responsibility of directing Fire or Emergency and Rescue operations. • In case of Fire, he will enquire about the Isolation of electrical supply, Dangerous liquids / gases / materials under the Fire and start firefighting operations (If permitted - under the guidance of Incident Controller in case of electrical fire) • Keep liaison with the utilities and arrange for external Water supply / Diesel for Diesel operated Hydrant Pumps, etc. Maintaining adequate supplies for Firefighting Equipment as well as Personal Protective Equipment. • Ensure that firefighting team members do not endanger their lives during firefighting due to anxiety. Ensure that they take necessary precautions. • He will arrange the firefighting materials available in the fire station and put at the disposal of firefighting crew for firefighting operations. • In case of dangerous chemicals leakage, he will enquire about the Isolation of chemicals, start emergency operations (If permitted - under the guidance of Site Incident Controller) • He will ensure the wind direction and conduct plant evacuation. • Ensure availability of adequate numbers of Self Containing

		Breathing Apparatus sets and other emergency kits for handling toxic gas release incidents • He will ensure that no one is left behind as a casualty or trapped. In case of trapped person he will start rescue operations • He will take assistance of SIC and call the other Fire Squad Members from their residences for assisting the crew already fighting the fire or emergency. • If the fire or emergency (leakage) is serious, he will request help from mutual aider, fire brigade, Local Crisis Group with the help of Site Incident Controller • If the Crisis is grave, which may endanger the neighbouring residences and highway road traffic, He will request for Outside Evacuation and inform Police Control (Telephone- 100) with the help of Site Incident Controller • He will extend any other helps required.
11	Safety Coordinator	• On receiving "Message or Call", he will Rush to the place of Occurrence Scene, assess the situation and guide the Emergency Operations. • He will ensure safety of all personnel engaged in "Emergency Specific Operations" • He will arrange for isolate and cordon off all hazardous equipment / zones in affected areas with help of Security and Main Plant Operation sections. • If any unsafe conditions prevailing in the affected area for • immediate rectification, he will bring to the notice of Chief Incident Controller (CIC), Site Incident Controller (SIC), Shift-Charge-Engineer • He will ensure Rescue and Evacuation operations are performed in a safe manner. • He will remove affected personnel to OHC - First-aid room for medical attention He will extend any other helps required.
12	Medical-Aid Responder	• He will establish Medical Centre or First Aid Post at site during the emergency conditions, in addition to the existing facilities, if required. • He will organise Ambulance service, Treatment, Hospitalisation and Medical supplies of affected personnel. He will organise help of other professionals, if required. • He will contact Blood Bank for blood supply, if required. • He will organise Blood Donation, if required. • He will update Chief Incident Controller (CIC), information of personnel treated, hospitalised, discharged from hospital and condition of affected personnel under treatment.
13	Evacuation Coordinator	• He will Depute Security Personnel to assist the Site Incident controller for Firefighting and Rescue operations along with "Firefighting staff" and "Fire squad"

		• Restricts Unauthorized Entry at the Scene of Fire or Emergency areas, and If required arrange for the cordon off the areas. Control & records entry / exit. • He will arrange for necessary aid to outside affected areas and assist to Police force for Outside Evacuation of Surrounding places depending upon the prevailing conditions. • He will assist for Plant Evacuation and ensure that Emergency Exists is clearly available for evacuation purpose. • He will extend any other helps required.
14	Environment Coordinator	• He will keep the Environment section manned (operational) with effective communication link with ECC to execute all emergency jobs. • He will continuously monitored and update Meteorological data – Weather conditions - Wind direction, Wind Velocity etc. to the ECC (If Gas Release). • He will extend any other helps required.
15	Assembly Point Coordinator	• He will deploy Security persons as a Assembly Point In-Charges for all Safe Assembly Points to guide crowd assembled. He will arrange for Head Count of persons assembled in all the Safe Assembly Points with the help of Assembly Point In-Charges, Counting shall be done department wise and report to ECC / Chief Incident Controller (CIC) (Number of Present persons & Absent persons) • He will ensure that all the trainees and Visitors in the “Trouble Spot” areas are safely evacuated. • He will extend any other helps required.
16	Chemical Coordinator	• He will take Charge of the situation in area Storing Hazardous Chemicals and assist Firefighting / Toxic Gas Release in such areas. • He will decide on the Method of Neutralizing and Disposal of Chemicals, / Gases releases to safe guard personnel, property against Toxic Chemical Releases. • Maintain the inventory of the chemicals for neutralizing the hazardous chemical in case of accidental leakage. • Arrangement the removal of spilled chemical to the safer area. • Provide chemical protection suits / cartridge fitted respirators/ spill kits as required • Maintain the water level in the fire water tank • He will extend any other helps required.
17	Material Coordinator	• He will keep the Stores section manned (operational) with effective communication link with ECC to provide all material and equipment necessary for controlling all emergency jobs. He will keep updated on available supplies and equipment needed for an emergency. A list of emergency materials and equipment is as follows:

		▪ Fire extinguishers and firefighting agents. ▪ Fire hoses and nozzles. ▪ Personal Protective Equipment including, Self-Contained ▪ Breathing Apparatus, full protective clothing and Respirators ▪ etc. ▪ Emergency lights ▪ Spill control agents ▪ Plastic containers and lining material for containment. ▪ Cranes, Earth Moving Machinery for the same purpose. ▪ Fuel and Gasoline for the operation of emergency vehicles and machinery. • He will arrange for emergency procurement of materials from all available sources at short notice, and ensure that sufficient supply is available as required by ECC. • He will extend any other helps required.
18	Security Coordinator	• He will ensure manning of all the gates. • He will ensure cordoning off the area during emergency. • He will restrict entry of unauthorised persons and non-essential staff. • Divert traffic as per the requirement of the situation or directed by CIC/WIC. • He will permit with minimum delay the entry of all authorised personnel and outside agencies, vehicles, etc. • He will allow the ambulance/ evacuation vehicles through • without normal checks. • Any other responsibility as entrusted by CIC, looking into the circumstances at the time of disaster.
19	Transportation & Temporary Accommodation Coordinator	• In consultation with Assembly Point Coordinator, He will ▪ Keep the up-to-date list of persons (employees/contract workers /contractors/suppliers/visitors) as available in various areas in the plant. ▪ Will compare the list of persons available at each assembly point with the up-to date list of persons. • He will arrange: ▪ Transport for injured persons. ▪ Vehicles to bring the key personnel from their residences ▪ Transport for shifting of necessary equipment and ▪ materials to the emergency location ▪ Additional transport if required o For temporary shelter as ▪ required. ▪ For rehabilitations of persons ▪ Any other work in consultation with CIC/IC
20	Public Relation and Liasonning Officer	• He will disclose all the necessary information as required so as to avoid rumor and confusion, in consultation with CIC/WIC. • He will maintain liaison with the press and the community regarding the emergency under instruction from CIC.

		• He will liaise with District Collector, Superintendent of Police regarding law and order and other matters. • He will liaise with other stakeholders, Government Departments, private organizations etc., if needed.

Sequence Of Action

In order to handle disaster/emergency situations, an organizational chart entrusting responsibility to various plant personnel has been prepared along with their specific roles during an emergency. The possible composition of the management team is given in **Figure 7.2.**

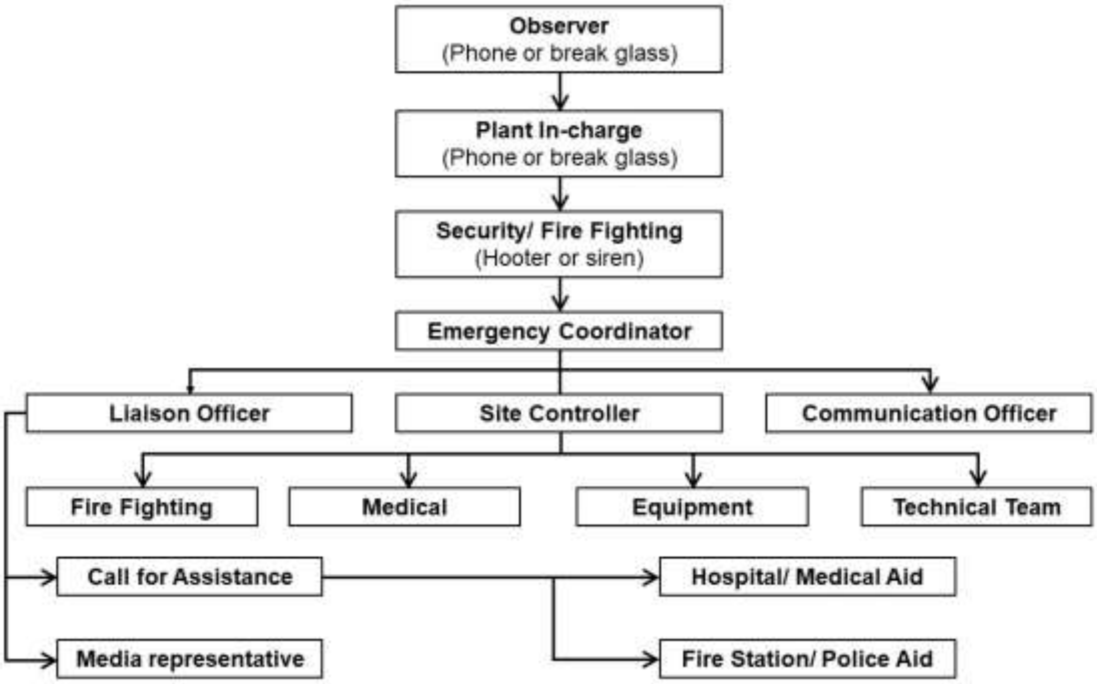


Figure 7-4: Sequence of Action during Emergency.

Infrastructure

Following infrastructure & operational systems should be provided to meet emergencies:

- First aid boxes
- Gas masks
- Telephone line with STD facility
- Loud hailers
- Emergency lighting system
- Stretchers
- Transport facility
- Appropriate Fire-fighting equipment
- Fire-tenders
- Ambulance

ASSEMBLY POINTS

Assembly points are to be set up farthest from the location of likely hazardous events, where pre-designated persons would assemble in case of emergency. The location near to the entrance gate is one of the safest places. This can be the assembly point.

EVACUATION PATH

The road straight to the entrance gate is quite wide and no hazardous installation besides the road. This road can be taken as the evacuation path.

COMMUNICATION SYSTEM

Different types of alarms to differentiate types of emergencies should be provided. In case of failure of siren, placards of various colours should be used to indicate the situations. If everything fails, a messenger should be used for sending the information and the various placards mentioned would also be used.
Alarms should be followed by announcement over Public Address System. In case of failure of alarm system, communication should be by telephone operator who will make announcement in plant through Public Address System, which should be installed. Walkie-talkie and paging systems using predetermined codes of communication are very useful during emergency.

WARNING SYSTEM AND CONTROL

The control centres shall be located at an area of minimum risk or vulnerability in premises concerned, taking into account the wind direction, areas which might be affected by fire/explosion, toxic releases etc.

EMERGENCY SERVICES

This includes fire-fighting system, first aid centre, hospital etc. Alternate sources of power supply for operating fire-pumps, communication with local bodies, fire-brigade etc. should also be clearly identified. Adequate number of external and internal telephone connections should be installed.

S No	Particular	Mobile No.
1	Fire Station	8435105093
2	Medical	9669091234
3	Security Main Gate	8435105135
4	Control Room	7773011721

Table 7-6: Designated Personnel in Case of Emergency.

S. No	Key Personnel	Position	Contact Number	Standby Officer	Position	Contact Numbers
1	Mr. Anand Deshpande COO & Plant Head	Chief Incident Controller (CIC)	9325033301	TM Pai	Dy. Chief Incident Controller (DCIC)	9349388616
2	Mr. TM Pai	Works Incident Controller (WIC)	9349388616	Neeraj Agarwal	Dy. Works Incident Controller (DWIC)	7089909919

3	Mr. Yash Mishra	Incident Controller (IC)	9839090994	Mr. Arun Mall	Dy. Incident Controller (DIC)	9644009825

Table 7-7: On-site Support Team.

S. No	Key Personnel	Position	Contact Number	Standby Officer	Position	Contact Numbers
1	Mr. Anil Mishra	Chief Maintenance Coordinator	7773011359	S.Routrey	Dy. Chief Maintenance Coordinator	7049923894
2	Mr. Terun Chauhan	Mechanical Maintenance Coordinator	7499183230	Keshav Chandra	Dy. Mechanical Maintenance Coordinator	7773011380
3	Mr. Suresh Behra	Electrical Maintenance Coordinator	7049914384	Neeraj Tiwari	Dy. Electrical Maintenance Coordinator	9669696576
4	Mr. Jeetesh Singh	C&I Maintenance Coordinator	7773011726	Mr Sharad Agarwal	Dy. C&I Maintenance Coordinator	8435002687
5	Mr R K Khatana	Services Maintenance Coordinator	8435003317	Vijay Soni	Dy. Services Maintenance Coordinator	9826169936

Table 7-8: Key Personnel: Emergency Response Team.

S. No	Key Personnel	Position	Contact Number	Standby Officer	Position	Contact Numbers
1	Mr. RS Kushwaha	Fire, Rescue & Evacuation Responder	9644047101	Mr Dhirendra Pratap Singh	Dy. Fire, Rescue & Evacuation Responder	7905499891
2	Mr Ankit Jain	Safety Coordinator	9669696578	Mr Imran Ahmad	Dy. Safety Coordinator	7773011384
3	Dr. Sonal raj	Medical Responder	9738550949	Dr. Tanveer Ahmad Janwai	Dy. Medical Responder	8825050641
4	Mr R K Khatana	Roll Call Coordinator	8435003317	Shrikrishna Pandey	Dy. Assembly Point coordinator	7999932940
5	Dr. BP Kushwaha	Environment Coordinator	77733011351	Mukesh kumar	Dy. Environment Coordinator	9718013658
6	Mr. Vinay Mishra	Chemical Coordinator	8966905336	Sanjay Patel	Dy. Chemical Coordinator	9644407558
7	Mr. Bhupendra pal Singh	Material Coordinator	9350171826	Durgesh Dwivedi	Dy Material Coordinator	7049914398
8	Mr Arvind Kumar Singh	Security Coordinator	7773011350	Mr Sidhartha Dutta	Dy Security Coordinator	7089909948
9	Mr. Ashwani patkar	Transportation & Temporary Accommodation Coordinator	7089909922	Mr Gaurav Pathak	Dy. Transportation & Temporary Accommodation Coordinator	8435002675
	Mr Atish Upadhaya		7089909907			
10	Mr. R K Khatana	Public Relation & Liaison Coordinator	8435003317	Vijay Soni	Dy Public Relation & Liaison Coordinator	9826169936
				Gaurav Pathak		8435002675

Off-site Disaster Management Plan:

The off-site emergency plan is vital part of any hazard control system. It is based on those incidents identified by the work management, which could affect people and the environment outside the works. Thus, the off-site plan follows logically from the analysis that took place to provide the basis for the on-site plan and the two plans therefore complement each other. The roles of the various. parties that may be involved in the implementation of an off-site plan is very important. The responsibility for the off-site plan will be with the local authority.

The plan should identify an emergency coordinating officer who would take command of the off-site activities. Consideration of evacuation may include the following factors:

- In the case of a major fire but without explosion risk (e.g., an oil storage tank), houses close to the fire are likely to need evacuation.
- If fire is escalating very fast it is necessary to evacuate people nearby as soon as possible.
- In acute emergency people are advised to stay indoors and shiel themselves from the fire.
- He District Collector is responsible to prepare, implement and manage the Off-site Emergency Plan.

Different aspects of offsite emergency preparedness include:

Emergency Control Organization:

The numbers of functions are to be performed on the occurrence of any emergency situation and for better and effective operations during emergency it is very important to organise the event / activities in a very smooth and systematic manner. After declaration of emergency, the designated personnel & key persons along with response teams would keep the command with and execute emergency operations in a coordinated way.

Communications

Identification of personnel involved, communication centre, call signs, network, list of telephone numbers.

Special Emergency Equipment

Details of availability and location of heavy lifting gear, specified fire-fighting equipment, fireboats etc.

Voluntary Organizations

Details of Voluntary organizations, telephone numbers of nearby hospitals, Emergency helpline, resources etc. are to be available with chief authorities

Non-government Organizations (NGO)

NGOs could provide a valuable source of expertise and information to support emergency response efforts. Members of NGO's could assist response personnel by performing specified tasks, as planned during the emergency planning process.

- Evacuation of personnel from the affected area
- Arrangements at rallying posts and parking yards
- Rehabilitation of evacuated persons.

Hazardous substance information

Details of the hazardous substances (MSDS information) and a summary of the risks associated with them are to be made available at respective storage site.

Meteorological information

There is to be arrangements for obtaining details of weather conditions prevailing at the time of incident and weather forecasts updates.

Humanitarian Arrangements

Transport, evacuation centres, emergency feeding, treatment of injured, first aid, ambulances, temporary mortuaries.

Public Information

Dealing with the media-press office, Informing relatives, etc.

Assessment

Collecting information on the causes of the emergency.

Reviewing the efficiency and effectiveness of all aspects of the emergency plan.

Role of the Emergency Co-ordinating Officer

The emergency services will be coordinated by an emergency coordinating officer (ECO) appointed by district collector. The ECO will be the main coordinator to handle the emergency situation. Again, depending on the local arrangements, the external control will be passed to senior level local authority administrator or even an administrator appointed by the central or the state government in case of very severe incidents with major or prolonged off-site consequences.

Role of local authority

Local Authorities like Panchayat, Sabha, Samity, municipalities can help in combating emergency situation after assessing the impact scenario in rescue phase.

Role of police

The police are to assist in controlling of the incident site, organizing evacuation and removing of any seriously injured people to hospitals.

Co-ordination with the transport authorities, civil defence and home guards.

Co-ordination with army, navy, air force and state fire services.

Arrange for post-mortem of dead bodies.

Establish communication centre.

Role of Fire Brigade

The fire brigade is to be organized to put out fires and provide assistance as required during emergency.

Media

The media is to have ready and continuous access to designated officials with relevant information, as well as to other sources in order to provide essential and accurate information to public throughout the emergency and to avoid commotion and confusion. Efforts are made to check the clarity and reliability of information as it becomes available, and before it is communicated to public. Public health authorities are consulted when issuing statements to the media concerning health aspects of incidents. Members of the media are to facilitate response efforts by providing means for informing the public with credible information about incidents.

7.4.3 NATURAL DISASTERS

A natural disaster is the result of a natural phenomenon (e.g. flood, tornado, earthquake, Tsunami, Cyclone and land slide, epidemics, pandemics etc.). It leads to financial, environmental or human losses. The resulting loss depends on the vulnerability of the affected population to resist the hazard, also called their resilience. MP State Disaster Management Authority is a nodal agency for preparation of disaster management plan of natural disaster for MP.

Earthquake: As per the recent categorization, the country has been divided into four zones (II, III, IV and V) and the project site is coming under Moderate Earthquake Zone (i.e. Zone-III). The plant and surrounding area fall in a moderate damage risk zone as per the recent earthquake categorization zone.

Objectives

- Minimize the risk to human life and property.
- Ensure the continuous operation of critical plant functions.
- Facilitate a coordinated and efficient response to earthquake events.
- Promote rapid recovery and return to normal operations.

Before an Earthquake (Preparedness and Mitigation)

A. Risk Assessment and Planning

1. **Seismic Hazard Analysis:**
   - Conduct regular seismic hazard assessments to understand the potential impact of earthquakes.
   - Identify and map out high-risk areas within the plant.
2. **Structural Safety:**
   - Ensure all buildings and structures meet seismic design standards.
   - Retrofit vulnerable structures to enhance earthquake resistance.
3. **Emergency Planning:**
   - Develop and regularly update an Earthquake Emergency Response Plan.
   - Establish clear evacuation routes and assembly points.
   - Prepare an inventory of emergency supplies, including first aid kits, water, food, and communication devices.

B. Training and Drills

1. **Employee Training:**
    - Conduct regular training sessions for employees on earthquake preparedness, response, and evacuation procedures.
    - Train personnel in first aid and basic search and rescue techniques.

2. **Drills and Simulations:**
    - Organize periodic earthquake drills to test the effectiveness of the emergency response plan.
    - Evaluate and improve response strategies based on drill outcomes.

C. Infrastructure and Equipment

1. **Equipment Safety:**
    - Secure heavy machinery and equipment to prevent movement during an earthquake.
    - Install automatic shut-off systems for gas, electricity, and other critical utilities.
2. **Communication Systems:**
    - Ensure reliable communication systems are in place for internal and external coordination.
    - Maintain backup communication systems in case of primary system failure.

During an Earthquake (Immediate Response)

A. Initial Actions

1. **Drop, Cover, and Hold On:**
    - Instruct all personnel to drop to the ground, take cover under sturdy furniture, and hold on until the shaking stops.
2. **Emergency Shutdown:**
    - Implement automatic or manual shutdown procedures for critical operations to prevent accidents.

B. Evacuation and Safety

1. **Evacuation:**
    - Evacuate non-essential personnel to predetermined safe areas following established routes.
    - Ensure the safe evacuation of visitors and contractors on-site.
2. **Emergency Response Team:**
    - Activate the Emergency Response Team to assess damage and initiate immediate response actions.
    - Coordinate with local emergency services for additional support if necessary.

After an Earthquake (Recovery and Rehabilitation)

A. Damage Assessment and Repair

1. **Inspection:**

- Conduct a thorough inspection of all plant facilities and infrastructure to identify damage.
- Prioritize the assessment of critical systems and structures.

2. **Repairs and Restoration:**
   - Initiate repair work to restore essential services and operations.
   - Engage qualified engineers to ensure repairs meet safety standards.

B. Communication and Coordination

1. **Internal Communication:**
   - Keep all employees informed about the status of recovery efforts and any safety advisories.
   - Use multiple communication channels to ensure messages reach everyone.
2. **External Coordination:**
   - Liaise with local authorities, emergency services, and stakeholders to coordinate recovery efforts.
   - Provide regular updates to the community and regulatory bodies.

C. Support and Counselling

1. **Employee Support:**

   - Offer counselling and support services to employees affected by the earthquake.
   - Provide assistance for temporary housing and other essential needs if required.

2. **Community Support:**

   - Participate in community recovery initiatives and offer support to affected residents.

Review and Improvement

1. **Post-Event Analysis:**

   - Conduct a detailed analysis of the earthquake response to identify strengths and areas for improvement.
   - Document lessons learned and update the Disaster Management Plan accordingly.

2. **Continuous Improvement:**

   - Regularly review and revise the DMP based on new information, technological advancements, and feedback from drills and actual events.
   - Ensure ongoing training and awareness programs for all employees.

General precautions by people before the earthquake: Following safety measures has been suggested.

- Keep the following in a designated place: bottled drinking water, non-perishable food, first aid kit, torchlight, and battery-operated radio with extra batteries.
- Awareness to people about everybody how to turn off electricity, gas, etc.

- Identify places in the plant as well as house that can provide cover during an earthquake.
- It may be easier to make long distance calls during an earthquake. Identify an out of- town relative or friend as your family's emergency contact. If the family members/colleague get separated after the earthquake and are not able to contact each other, they should contact the designated relative/friend.
- The address and phone number of the contact person/relative should be with all the family members.

General precaution by people after the earthquake: Here are a few things to keep in mind after an earthquake. The caution by people should display in the aftermath can be essential for their personal safety.

- Wear shoes to protect their feet from debris.
- After the first tremor, be prepared for aftershocks.
- Though less intense, aftershocks cause additional damages and may bring down weakened structures.
- Aftershocks can occur in the first hours, days, weeks, or even months after the quake.
- Check for fire hazards and use torchlight instead of candles or lanterns.
- If the building is in a good shape after the earthquake, stay inside and listen for radio announcements.
- If one is not certain about the damage to his/her building, evacuate carefully. Do not touch downed power lines, if any.
- Help injured or trapped persons.
- Give first aid where appropriate. Do not move seriously injured persons unless they are in immediate danger of further injury. In such cases, call for help.
- Remember to help neighbours who may require special assistance-infants, the elderly, and people with disabilities.

7.5 OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT PLAN

Large industries, in general, and power plants in particular where multi-functional activities are involved during construction, erection, testing, commissioning, operation and maintenance, occupational health needs attention during all phases. However, the problem varies both in magnitude and variety in the above phases.

7.5.1 CONSTRUCTION & ERECTION PHASE

The problems envisaged at construction and erection stage can mainly be due to accident, fugitive dust emissions and noise. To overcome these hazards, the contractors in charge of construction and erection activities have to maintain noise levels within threshold limit values and the workers should be provided with personnel protective equipment. Mobile water sprinkler and wet drilling will be used to control dust emissions.

7.5.2 OPERATION & MAINTENANCE PHASE

The problems envisaged during the operation and maintenance phase are accident, exposure to heat, noise, chemicals etc. Suitable personnel protective equipments should be provided to all employees, likely to be exposed to these situations. The working personnel should be given the personnel protective equipment as listed in **Table 7.**. In addition, medical facilities should be made available round the clock for attending any medical emergency.

Table 7-9: Personnel protective Equipment

Protection For	Equipment	Protection Against
Head	Helmet	Fall of objects / hitting against objects during construction, maintenance, etc.
	Electrical resistance helmet	Electrical Shock
	Welder's leather cap	Splashing of liquid etc.
Eye	Panorama goggles with clear plastic vision	Oil and paint splashes, dust and chips
	Leather mask goggles	Foreign bodies entering the dyes and smoke.
	Spectacles type goggles with plain shatter proof lens	Foreign bodies entering the eyes and reflected arc rays
	Spectacle type goggles, with blue lens	High temperature flame during furnace work
	Panorama goggles with green plastic visor	Reflected arc rays during arc welding job.
Ear	Ear plugs or muffs	High noise level
Nose	Dust respirators	Fine dust particles
	Light fume mask	Acid fumes, vapours and gases (2.0%)
	Heavy fume mask	Toxic gases (0.1%)
	Canister gas mask	Acid fumes, vapours and gases (2.0%)
Face	Plastic face shield	Liquid chemicals, dust particles
	Welding helmet and shield	Welding fumes, sparks and UV rays
	Asbestos hood	Heat radiation during furnace work
Body	Leather apron	Falling of hot chips, slag's etc.
	Asbestos apron	Heat radiation
	PVC apron	Splashing of chemicals
	Safety Belt	Falling of persons from height
Hand	Leather gloves	Cuts due to handling
	Asbestos gloves	Heat radiation
	Acid and Alkali proof rubber gloves	Burns due to chemical handling
	Electrical resistance gloves	Electric shock
	Canvas gloves	Contact with oil, grease etc.
Leg	Leg guards	Welding sparks
	Leather safety boots	Striking by objects, fall of objects and stepping on sharp or hot objects.

Protection For	Equipment	Protection Against
	Asbestos safety boots	Eat radiation, stepping on hot or sharp objects, striking by stationary or moving objects
	Gum boots	Liquid splashing, in submerged and chemically hazardous area

Other Occupational Health Risks Envisaged

Common[1]

- **Electrical hazards:** Thermal power plants are used to generate electricity therefore they utilize various types of machines and electrical equipments that are used to process a large amount of electricity which poses a significant threat to the workers.
- **Heat stress and Fire hazards:** Workers are exposed to high temperatures, especially those working in boiler rooms and turbine sections. Fire safety in thermal power plants is another important focus. Various pieces of equipment use flames and sparks to do their jobs and that opens up the risk of a fire occurring in the plant.
- **Fall:** Many thermal power plants have large pieces of equipment spread across multiple stories. When employees work on these, they often do so on a ladder or some other type of elevation tool, which opens them up to the potential of falling and sustaining injury.
- **Exposure to chemicals:** Power plant workers are also routinely exposed to materials and chemicals that can be dangerous to come into contact with. Handling of chemicals used in water treatment and maintenance processes can lead to skin and respiratory issues.
- **Dust and particulate matters:** Coal dust and fly ash can cause respiratory problems like pneumoconiosis and chronic obstructive pulmonary disease (COPD). During maintenance and handling of ash, workers can be exposed to silica dust, increasing the risk of silicosis.
- **Noise exposure:** High noise levels from turbines, generators, and other machinery can lead to hearing loss.

Specific[2]

- Apart from the above mentioned occupational hazards, the following hazards also exist specifically for the power plant under discussion:
  - **Ergonomic Hazards:** For saving costs and due to availability of cheap labour the power plant employs manual labourers**.** Manual handling of heavy equipment can lead to musculoskeletal disorders.

[1] Safety, S., & Safety, S. (2022, May 3). *Safety 101: Power Plant Safety Measures*. Salvation Safety. https://salvationsafety.com/safety-101-power-plant-safety-measures/

[2] *Economy | Welcome to Aurangabad Madhya Pradesh | India*. (n.d.). https://aurangabad.bih.nic.in/economy/

- **Lack of expertise:** The power plant being located in an educationally backward region, the labourers tend to pay little heed to the safety standards and precautions thus exposing themselves to dangers.

7.5.3 OCCUPATIONAL HEALTH MONITORING, AWARENESS AND TRAINING

The work environment will be monitored for occupational accidents, diseases and dangerous occurrences. A proper record of the same will be maintained. The aspects will be adopted to ensure good health condition of employees are (i) Pre- employment check-up; (ii) Awareness programme; (iii) Routine check-up and (iv) Periodic vaccination programme etc.

Occupational Health Monitoring for Workers: Engagement of contractual workers will be done only after proper health check-up and fitness certificate by approved medical practitioner through contractor. Periodic medical examination (PME), as required under the Factories Act shall be undertaken. However, the investigations performed under the PME should be relevant to the job exposures. Since coal/ash handling workers are prone to dust exposure-related diseases, due attention is required to those workers. In case of need, the frequency of PME may be scheduled, based on observation of the health check-up information. Providing PPE and relocating of job for those workers may also be considered.

Awareness programmes and training: Periodic awareness programmes regarding the health and safety with active involvement of the workers will be organized, covering each individual with the minimum annual average duration of 8 hours per worker. Regular community level awareness programmes may be organized in the vicinity of the plant for the family members of the workers. First-aid training will be imparted to workers on regular basis to provide immediate relief to accident victim.

7.5.4 ASSESSMENT OF ENDEMIC DISEASES OF ENVIRONMENTAL ORIGIN

Endemic Diseases in the area: From data available, it is understood that malaria and dengue are endemic in the region which may be due to lack of hygiene and health facilities.

Diseases[3]

- As per the Rapid Appraisal of National Rural Health Mission Report for Anuppur district, the common diseases were reported as Malaria, Measles, gastroenteritis and Jaundice. It indirectly indicates that mosquito breeding is a major issue in the villages as outbreak of Malaria is reported by 42% of the respondents and incidences of gastroenteritis is also high, as per the survey report.
- **Other issues**[4]**:**
    - At the household and community level, women's status, household food security, hygiene and socio economic conditions further contribute to children's nutrition outcomes (underlying and basic determinants).

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[3] https://nhm.gov.in/images/pdf/nrhm-in-state/factsheet-district-report/district-report/anuppur.pdf

[4] https://ebrary.ifpri.org/digital/api/collection/p15738coll2/id/131997/download

Factors

- **Environmental**
  - **Pollution:** The major factor in this regard and the spread of different types of diseases is the pollution of air, water and land due to the mining activities thus weakening an already unstable environment.
  - **Global Warming and Climate Change:** An increase in the global warming due to ozone depletion has led to the melting of glaciers as well as excessive heatwaves and the unchecked and unregulated mining and power-generation activities is adding more to this heatwave. Also the melting of glaciers has led to an increase in the river-basins and the silting of riverbeds has led to an increase in the intensity of the flash floods.
- **Human (including social and political)**
  - The major human factors in this regard are the ones already discussed above such as –
    - **Lack of education**
    - **Lack of healthcare infrastructure**
    - **Lack of public infrastructure**
    - **Improper waste management**
    - **Improper Sanitation**
    - **Lack of Government vigilance**
    - **Social issues:** The issues of caste division have also lead to lack of access towards already limited public utilities for the oppressed classes and castes.
    - **Impact:** The local community, particularly those living near the plant, experience higher rates of respiratory and waterborne diseases. Surveys indicate a higher incidence of chronic respiratory conditions among residents compared to regions farther from the plant. Also they are in the crosshairs of impending natural hazards like floods and earthquakes and are also the victims of bad governance.

The District Health Department serves as the nodal agency responsible for preventing the occurrence of diseases originating from environmental factors. Recognizing the critical importance of maintaining public health, especially during construction projects, several proactive measures are being implemented to mitigate the risk of endemic diseases. These initiatives are part of a comprehensive strategy aimed at improving sanitation, hygiene, and overall health conditions in the affected areas. Below are the detailed actions being undertaken by MBPMPL to maintain and enhance sanitation and hygiene, with a commitment to strengthen these efforts during the proposed expansion.

1. **Maintaining Hygiene and Sanitation in Plant and Township**
   - Regular cleaning and disinfection of all plant and township areas.
   - Implementation of waste management systems to ensure proper disposal of waste materials.
   - Routine inspections and monitoring to ensure compliance with hygiene standards.

2. **Provision of Community Toilets and Sanitation Facilities**
   - Construction of community toilets in labour colonies to prevent wastewater stagnation.
   - Ensuring the availability of clean and functional sanitation facilities to all workers.
   - Regular maintenance and cleaning of these facilities to ensure a hygienic environment.
3. **Providing Mosquito Nets for Villagers**
   - Distribution of mosquito nets to households in nearby villages to prevent mosquito-borne diseases such as malaria and dengue.
   - Conducting awareness campaigns to educate villagers on the proper use and maintenance of mosquito nets.
4. **Supply of Bleaching Powder for Sanitation**
   - Regular supply of bleaching powder to neighbouring villages to assist in maintaining sanitation and hygiene.
   - Training and support for villagers on the effective use of bleaching powder for disinfection and cleaning purposes.
5. **Construction of Community and School Toilets**
   - Building new community toilets and repairing existing ones in nearby villages.
   - Constructing toilets in schools to ensure children have access to clean and safe sanitation facilities.
   - Promoting the importance of sanitation and hygiene practices among school children through educational programs.
6. **Medical Health Camps and Mobile Clinics**
   - Organizing regular medical health camps in villages to provide healthcare services to the community.
   - Deployment of mobile clinics to reach remote areas and offer medical consultations, treatment, and health check-ups.
   - Distribution of essential medicines and health supplies during these camps.
7. **Construction and Repair of Village Roads and Drains**
   - Building and repairing village roads to ensure proper access and mobility.
   - Constructing and maintaining drainage systems to prevent water stagnation and reduce the risk of water-borne diseases.
   - Regular monitoring and cleaning of drains to ensure they are free from blockages and function effectively.
8. **Enhanced Waste Management Practices**
   - Implementation of comprehensive waste management systems to handle solid and liquid waste generated during construction and operation.
   - Training workers and community members on proper waste segregation, recycling, and disposal practices.
   - Installation of waste collection points and bins to ensure proper waste handling and reduce environmental contamination.
9. **Awareness and Education Programs**

- Conducting awareness campaigns and educational programs to inform the community about the importance of hygiene and sanitation.
- Collaboration with local health departments and organizations to promote health education and disease prevention strategies.
- Distribution of informational materials such as pamphlets, posters, and flyers to raise awareness about endemic diseases and preventive measures.

By implementing these comprehensive measures, MBPMPL aims to create a healthier and safer environment for both workers and the surrounding communities. These efforts not only address immediate health concerns but also contribute to the long-term well-being and development of the region. The commitment to maintaining and enhancing sanitation and hygiene practices during the proposed expansion underscores MBPMPL's dedication to sustainable and responsible development.

7.6 Safety Training for Agency Workers: -

1. Induction training modules and 23 Job Specific Standard Training Module are developed in English and in Hindi. The standard modules of safety trainings include Induction Training, Caught In/ Caught By, Heavy Vehicle Safety, Working at Height, Electrical Safety, Working in Confined Spaces, Struck By, Safety in Using Hand Tools, Safety in Using Power Tools, Fire Prevention, Safety in Hot Works, Safety in Work On or Near Water, Work Permit System, Use of PPE, Manual Handling, Excavation Safety, Safety in Handling Hazardous Substances, Ergonomics, General Safety and Hygiene for Office, Safety in Demolition, Slips and Trips, Safety in Material Handling, Safety in Coal Handling Plant.

2. Language of Training modules are kept simple, personal and direct.

3. Guidance slides for trainers and prerequisite for training are available in training modules itself.

4. The identification of training needs (as per nature of work, potential exposure to hazards, working condition, personal capacity etc.) is to be done by EIC for each worker at the time of processing of gate pass. Thus, worker role competency matrix is to be prepared for all workers.

5. Safety Department of the station are required to conduct training on Induction, Fire and PPE Modules mandatorily for all workers.

6. Line managers (preferably trained trainers) are required to conduct training on other job specific safety training modules as identified during training need assessment.

7. The progress of training in form of identified Vis-a-vis Trained is to be captured on monthly basis by EIC to keep a track and completion of all identified trainings.

Safety in Overhauling Activity:

Overhauling of power plants is an specialised activity and many agencies involving high number of agency workers perform different works simultaneously. Safety provisions mentioned in 'Maintenance Management- Unit Overhauls' and 'Electrical & Mechanical- Safety Rules Handbook' are followed during unit overhauls.

From all the agencies involved in overhauling activities, nominations of Safety Officers/ Supervisors and qualified & trained electricians are obtained from each Agency. Safety Review Meeting with Contractors & Agencies' Safety Supervisors in presence of EICs and head of O&M before start of overhaul works shall be organized. In the meeting safety measures which are to be followed during overhauling works are discussed. Detailed guideline for maintaining safety in over hauling has been prepared and followed.

Safe Practices at Work:

For safety Practices at work MBPMPL has developed various guidance notes and directives on several topics like Hazard Identification and Risk Assessment, Implementation of Safety Rules (Electrical and Mechanical), Job Safety Analysis and Method Statements, First Aid Control and Monitoring, Safety Objectives and Plans, Safety Monitoring, Measurement & Improvement, Safety Awareness, Communication & Promotion, System for Reporting arrangements and Investigation of Accidents, Dangerous Occurrences and Major Incidents in a Power Station, Appointment of Key Safety Roles, Emergency Response Planning, Mitigating Occupational Health Risks - Stressors, Hygiene & Facilities, Periodic Safety Assessments (Internal to Station), Written Safe Work Procedures, General Safety Competencies and Training, Compliance with legal and other requirements, System for action on investigation reports etc.

Apart from above, various communications and circulars are issued from time to time by Corporate Safety regarding safe practices. Accident enquiry recommendations are also source of information regarding safe practice of work which circulated and made readily accessible.

Safety Audits:

Audits are conducted to asses whether any deviation is existing from laid out procedure. Every year, internal safety audits are conducted by inter station team of Safety Officers and External safety audits are carried out by reputed organizations as per statutory requirement for each Project/ Station. Every TC document as mentioned above has a section on procedures to conduct audit for that particular document. This also clearly specifies documents to be verified and site samples to be taken. This process is followed for all internal audit purpose.

Apart from that, special audits are conducted from time to time to asses adherence to laid out procedures and rules. MBPMPL has developed a pool of NOSA certified auditors, certified lead / internal auditors as per ISO 45001 for ensuring quality audit.

All audit observations are notified in SAP ERP system and compliance recorded along with evidence of compliance. Station safety department is required to monitor the progress of the closure of such notifications and present the status of the notifications to station management during review and other forums.

Incident Investigation:

There is a formal process for investigation of all accidents to examine each case in detail and in depth to find out the causes of accidents, the extent of losses caused, the circumstances / individuals responsible and to obtain considered recommendations for prevention of recurrences in similar or related nature of accidents.

There are specific guidelines and systems for handling the investigation report so that all recommendations of such investigations are taken up to a logical end and implemented. For all accident enquiry recommendations, action plan is prepared for compliance.

7.7 Hydrogeology Studies and Rainwater Harvesting Plan

As per the EIA Notification dated 14th Sept, 2006 and as amended thereof: this proposal is being submitted as per Ministry's O.M dated 11th April, 2022 regarding grant of EC under para 7(ii) of EIA Notification, 2006, amended from time to time.
In line with above, among the additional studies required to be carried out for the project as per Standard Terms of Reference (ToR) available on Parivesh Portal for Project/Activity 1(d) "Thermal Power Plant" includes Hydro-Geological Study and Rainwater harvesting Plan.
The objective of the assessment are:

- Identify the hydrogeology of the core study area and its 10 km buffer area.
- Identify the impacts of the project on surface water and groundwater during construction and operational phases.

7.7.1 Site Description

The project site is located at villages Laharpur, Murra, Guwari, Belia & Jaithari, Tehsil- Jaithari and Anuppur, District Anuppur, Madhya Pradesh.

7.7.2 Climate and Rainfall

The climate of Anuppur district, Madhya Pradesh is characterized by a hot summer and general dryness except during the south west monsoon season. The district is characterized by four seasons. The cold season, December to February is followed by the hot season from march to about the middle of June. The period from the middle of June to September is the south west monsoon season. October and November form the post monsoon or transition period. The normal annual means maximum and minimum temperatures of Anuppur district are 31.6º C and 18.2º C respectively. During the south-west monsoon, the relative humidity generally exceeds 80% during month of August. The normal average rainfall (average of 30 years) of Anuppur 1268.68 mm. The average annual rainfall of Anuppur District for the past 10 years (2014-2023) is 1249.29 mm.

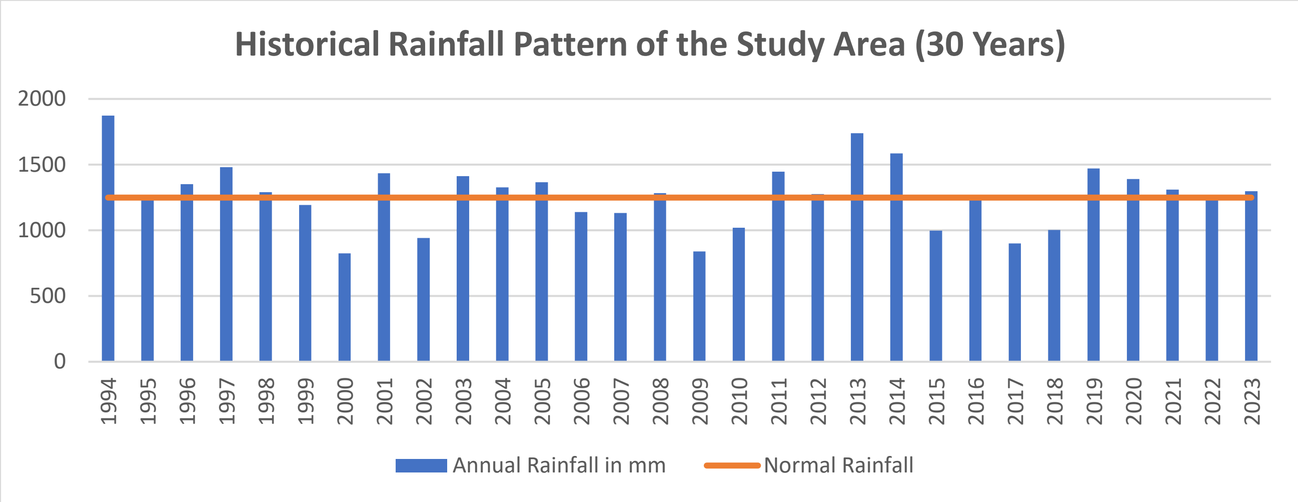

Figure 7-5: Annual Average Rainfall Pattern.

7.7.3 Hydrogeology of the Area.

Anuppur district is underlain by various geological formations, forming different types of aquifers in the area. Main lithological units of the area are, Archaeans, Gondwanas, Lametas and Basalts. Occurrence and movement of ground water in hard rocks is essentially by development and nature of secondary porosity through joints and fractures. Primary porosity in Gondwana rocks and vesicularity in basalts play and important role. Lametas are also potential aquifers made up of relatively loose and friable material. Ground water in general occurs under unconfined to semi confined conditions. Buffer zone of 10 km radius from the project site comprises of Fine-Grained Sandstone, Granite Gneiss, and Sandstone with Coal. The geomorphology within the study area are majorly Pediment and Pediment-Pediplain complexes with scattered Gullied lands and lateral bars along the Son River, Tiupan River and Fohirari Nadi.

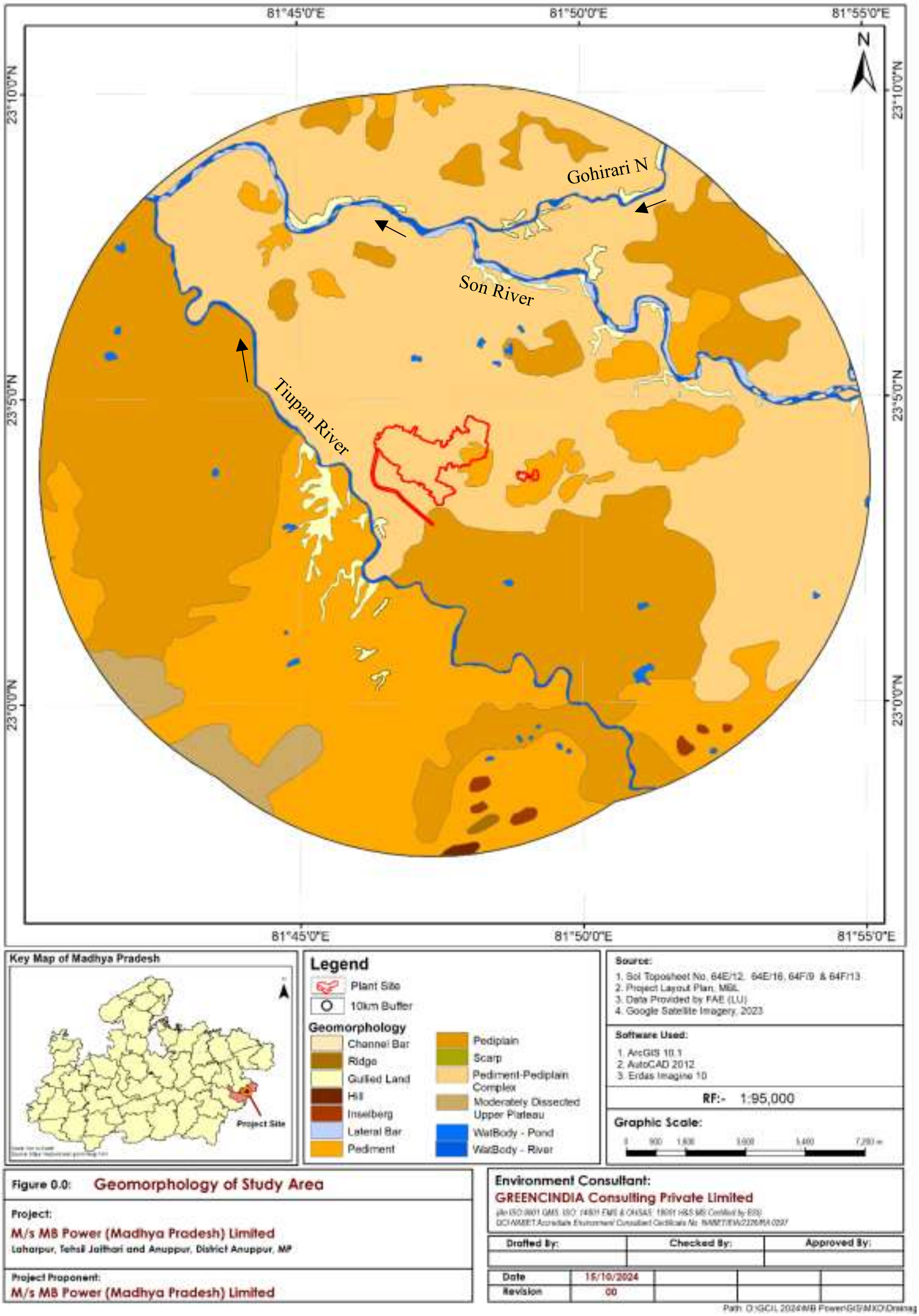

Figure 7-6: Geomorphology of the Study Area (Source: Bhukosh/ Geological Survey of India)

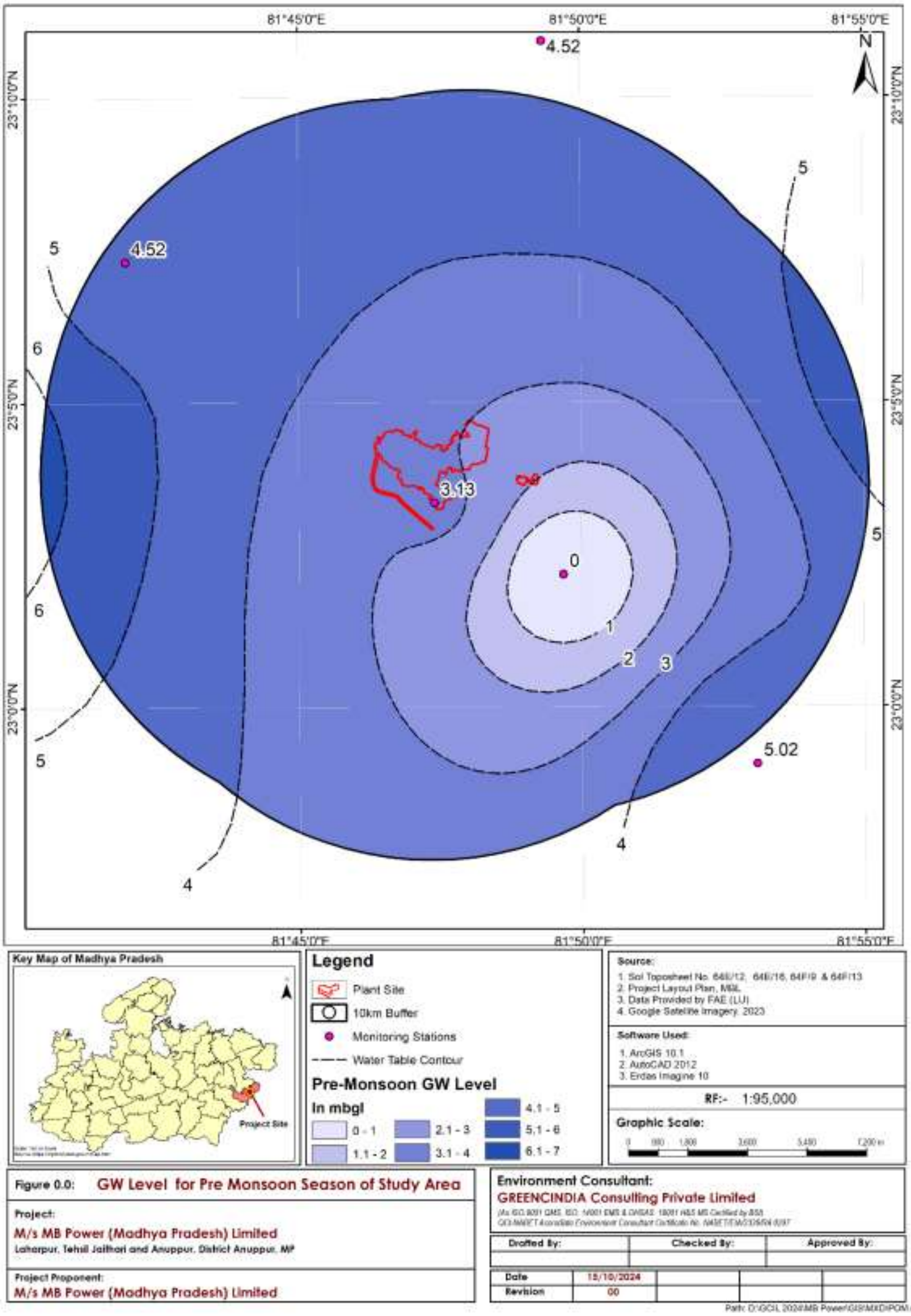

Figure 7-7: Depth to Groundwater of the study area for Pre-Monsoon Season (Source: WRIS)

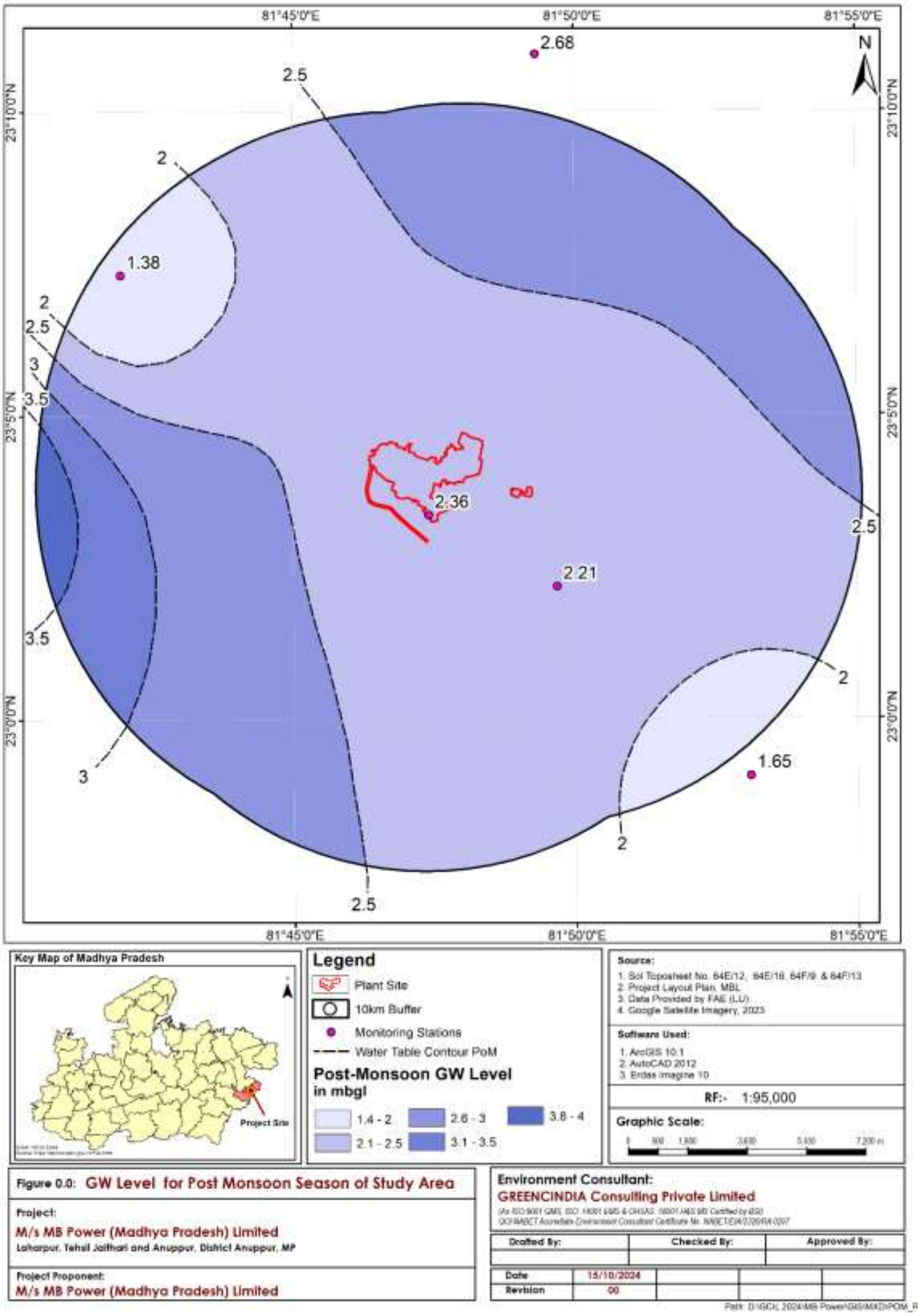

Figure 7-8: Depth to Groundwater of the study area for Post-Monsoon Season. (Source: WRIS)

7.7.4 Rainwater Harvesting Plan

Rainwater harvesting is a technique of collection and storage of rainwater into natural reservoir /tanks, or the infiltration of surface water into subsurface aquifers (before it is lost as surface runoff). Uses include water for garden, livestock, irrigation and domestic use with proper treatment, and indoor utilization for houses etc. In many places, the water collected is just redirected to a deep pit with percolation. The harvested water can be used as drinking water after treatment as well as for storage and other purposes like irrigation.

It makes use of a natural resource and reduces flooding, storm water runoff, erosion, and contamination of surface water with pesticides, sediment, metals, and fertilizers. Also, it is an excellent source of water for landscape irrigation, with no chemicals such as fluoride and chlorine, and no dissolved salts and minerals from the soil.

The basic principle of Rainwater harvesting systems is to channelize rainwater from a catchment surface (roof or other raised solid surface), through a distribution system (gutters, downspouts and pipes) and then into storage tank. The storage tank can be above ground or underground and can be made from a variety of materials including plastic and metal. Water storage tanks should be covered to prevent mosquito breeding and to reduce evaporation losses, contamination and algal growth.

7.7.4.1 Need for Rainwater Harvesting/Artificial Groundwater Recharge

Artificial groundwater recharge is to be done to minimize the undesirable effect on groundwater status. It is necessary that groundwater storage of an area must be arranged by rainwater harvesting so that the existence of any industry does not adversely affect the groundwater situation.

The artificial recharge to groundwater aims at augmentation of groundwater reservoir by modifying the natural movement of surface water utilizing suitable civil construction techniques. Artificial recharge techniques normally address to following issues –

- To enhance the sustainable yield in areas where over-development has depleted the aquifer.
- Conservation and storage of excess surface water for future requirements, since these
- requirements often changes within a season or a period.
- To improve the quality of existing ground water through dilution.
- To remove bacteriological and other impurities from sewage and waste water so that water is
- suitable for re-use.

The basic purpose of artificial recharge is to store rainfall where the captured rainwater is diverted to and stored for later use. The total fresh water requirement for the existing plant is 65232 m3/day and after proposed expansion it will be 68400 m3/day which will go up 24966000 m3/annum (as per 365 projects working days).

Water to be sourced form Son River.

7.7.4.2 Factors Affecting Run-Off Potential

i. Climate and Rainfall Pattern
ii. Evaporation Losses
iii. Geological Formation and Catchment Characteristics

7.7.4.3 Water Availability for Rainwater Harvesting

Table 7-10: Recharge potential for the Project area.

S No	Description	Total Area (m^2)	Effective area considered for Rainwater Harvesting	Average Annual Rainfall (m)	Coefficient as per annexure IV of revised guidelines for NOC, CGWA, 2017	Water available for Rainwater Harvesting (m^3)
1	Plant Area	17,92,230	16,13,000	1.2	0.7	13,54,920
2	Road/paved area (Switchyard, weigh bridge, road, tank etc.)	80970	73,000	1.2	0.6	52,560
3	Green belt	15,27,670	13,75,000	1.2	0.2	3,30,000
Total						17,37,480

Total Recharge Potential- 17,37,480 m^3/annum
Proposed recharge potential to be created in the project area premises would improve ground water regime of the project area and would contribute to positive water environment.
Detailed rain water harvesting plan, number of R W harvesting structure and their intake capacity
Design basis for storm water drainage system:

Run off discharge
Q= CIA
Where,
Q= run off (discharge) in cubic meters per hour
C= Co-efficient / Impermeability factor of the surface
I= Intensity of Rainfall
Taking 20 mm/hr or 0.020 m/hr
A= Total drainage area in Ha.

The Technicality Involved

There are both direct and indirect methods for artificial recharge and water conservation. Direct surface techniques include methods like flooding, recharge through ditches and furrows, spreading, and over-irrigation. Direct subsurface techniques involve injection wells, recharge pits and shafts, dug well recharge, etc. A combination of surface and subsurface methods includes percolation tanks with pit shafts, trenches, or wells. Indirect methods for groundwater conservation include subsurface dykes or groundwater dams.

Rainwater harvesting and groundwater recharge methods can be further classified based on their suitability for urban and rural areas:

- Urban techniques: Roof-top rainwater harvesting or runoff harvesting through recharge pits,
- trenches, tube wells, and dug wells.
- Rural techniques: Gully plugs, contour bunds, gabion structures, percolation tanks, check dams/cement plugs, recharge shafts, dug well recharge, and groundwater dams/dykes.

Structures like contour bunding, trenches, and terraces, designed to prevent soil erosion, also play a secondary role in groundwater recharge. Designing a rainwater harvesting system requires scientific and technical expertise since it involves enhancing nature's natural recharge process. Poorly designed systems without adequate technical support can lead to groundwater pollution, collapse of structures, or ineffective systems.

Recommendation For Rainwater Harvesting

On the basis of the analysis of the data generated from the systematic and comprehensive Hydrogeological survey, the Geophysical resistivity survey and lateral profiling, the lineament fabric studies of the area, thoroughly understanding the aquifer geometry and its disposition at depth, Hydro meteorological studies (rainfall, intensity etc.) the location and types suitable rainwater harvesting structures are finalized to impound as well as research groundwater.

Rooftop Rainwater Harvesting Structure:

To accommodate the runoff from rooftops roof top rainwater harvesting is proposed rain water harvesting structures in all buildings through tube wells. In the area where the shallow aquifer has dried up and existing tube wells are tapping deeper aquifer, roof top rain water harvesting through vertical shaft/ tube wells can be adopted to recharge the deeper aquifer.

Rain water from roof which taken to filtration chambers located on ground. These chambers are provided with a 150 mm dia tube well of 60.0 m. depth. Slotted casing is provided below filter media to facilitate the filtered water to enter into tube well. The dimension of filter pit is 1.4 x 1.4 x 2.0 m. The filtration chamber is backfilled with graded material, boulders at the bottom, gravel in the middle and sand on the top with varying thickness (0.30 to 0.40m) and may be separated by screen. The top 1.0 m of the chamber is left empty to accumulate unfiltered water drained from roof.

Recharge Calculation for the Proposed Rainwater Harvesting Structures

Proposed number of rainwater harvesting structure and their intake capacity:

As per the standard design of artificial recharge structure, a recharge structure having an area of 1 cubic meter is capable to recharge about 86.46 cubic meter volume of water in a rainy season.

Peizon-metric Surface before slug injection	Developed head after injection of slug	Water released in bore hole (in liter)	Time taken for initial water level in minute	Water intake in liter	Water intake in minute	Water intake per hour	Water intake per day	Cubic meter	During Rainy Season (Considering 45 days for recharge)
1	2	3	4	5	6	7	8	9	10
						6x60	7x24	8/1000	8x45
23.15	7.03	1000	7.0	1000	142.85	8571.42	205714.3	205.7	9257.14

So, the proposed structure is capable of accommodating 9257 m^3 of water

Proposed rain water harvesting structure in Open Area Rain water through recharge shaft and drilling one tube well in each shaft. The runoff will be diverted into the shaft then through tube well into the ground= 3,30,000/9257= 35

Proposed roof top rainwater harvesting in all building through tube wells = 13,54,920/9257= 146

The number of structure will reduce once the calculations are done for area specific rooftop and

Proposed rain water recharge through all structures = 35 No.
Total rainy days in the year = 87 Days.
Total rain hour in one year = 45 x 24 hours/ Day = 1080 Hours.
Total Recharge from one structure in a year = 2.38 x 3600 x 1080 / 1000 per year = 9253.44 Cum.
Expected recharge from 35 structures = 9253.44 x 35 = 3,23,870.40 m3
Total storage of storm water on surface / Raw Water Reservoir during Rainy Days in plant area = 360466.1 + 737316.9 = 1097783 m3
Deduct evaporation loss 10% = 988004.7 m3
Total storage of storm water in percolation tank during Rainy Days in township area = 26844.48 + 69501.37 = 96345.85 m3
Deduct evaporation loss 10% = 86711.27 m3
Recharge by gabion structures in Peripheral/ Diversion drain around plant and township area of 2.0 km length with average 1.0 m height and 3.0 m width = 4500.0 m3/yr
Total recharge from surface water storage = 988004.7 + 86711.27 + 4500.0 = 1079216 m3
Total Recharge from all rain water harvesting structures = 1079216 + 3,23,870.40 = 1403086.365 cum.

Proposed recharge potential to be created by the project premises would improve ground water regime of the project area and would contribute to positive water environment.
Water Saving:

- To the possible extent water is saved at each point of use by taking proper care in maintenance of drain pipe, tap etc. from leakage. There should be display board for optimum use of water in washroom, toilet or at other appropriate locations.
- Use of recycled water, if possible, in cleaning of toilets or gardening after proper treatment and testing for its intended use.
- Use of sprinkler or drip irrigation method in garden irrigation.
- Adoption of machinery– equipment, methods, if possible and economic viable, for manufacturing.
- Appropriate plantation to reduce evaporation.

Maintenance of the recharging system: Periodic maintenance required for reliable and higher quality water supply. During raining season, the entire system to be checked before and after rains and cleaned after every dry period. Before first shower storage tanks should be cleaned and flushed of all sediments and debris. Also, the roof top will be cleaned before monsoon and coarse mesh is used to prevent the debris on the entrance of the water at roof. The first shower should be flushed so the any sediment can be washed away.

7.8 Corporate Environment Responsibility

MBPMPL has been pioneers in implementing Environmental & Social Responsibility/Corporate Environmental Responsibility and made significant contribution to improve quality of people's life and Environment in all the regions they are operating in, around the nearby villages, MBPMPL have started key initiative in support of sustainable development.

All CSR initiatives were aligned with Sustainable Development Goals (SDGs). In recent times many new initiatives are taken like;

- Refurbishment of Government schools
- School bag distribution to Students
- SHG enterprise training and support
- School infrastructure and material support.
- WASH (Water, Sanitation and Hygiene) promotion

MBPMPL is committed to inclusive development and will further strengthen its activities for improvement in education, sanitation and health, livelihood, rural infrastructure, plantation drives and rural sports.

The CER Activity aims at bettering the Environment around the operated area as well as socio economic and cultural status of local people. The key Highlight of some initiatives & activities that MBPMPL is going to undertake in nearby villages are as follow:

Sustainable Livelihood Options & Woman Empowerment

- Skill development and placement of trained students in industries.
- Provide training on sustainable farming and organic practices.
- Offer animal husbandry
- Organize workshops for traditional crafts and artisan skills.
- Strengthening the community-based organization like self-help groups,.
- Capacity building of underprivileged communities on various market driven skills:
- Establishment of forward and backward market linkages through networking.
- Facilitating the easy reach to the technical institution for knowledge up gradation; and
- Promotion of livestock health management
- Facilitate the formation and support of women’s self-help groups.
- Conduct vocational training in tailoring, beauty services, and food processing.
- Support women entrepreneurs with mentorship and financial resources.

Educational Initiatives

- Modernization & expansion of identified Primary / Higher Secondary School within 10km radius of the project site.
- Distribution of drinking water filter/Drinking water coolers, Basic teaching and learning infrastructure support to Govt. Schools, Conducting Quiz competition for Students
- Community to provide awareness about education, health, hygiene, and discipline.
- Program for skill improvements of teaching staffs in govt. school.
- Implement digital education programs
- Facilitate after-school tutoring and mentoring programs.
- Support to Primary grade government students through Support Class Initiative.

Community Health Initiatives

- Rural Medical Camps through Medical Team of CSR team of MBPMPL, Safe Menstrual Hygiene Management Awareness, Mega Health Camp, Cataract Screening & Operation.

- Support the district health administration in the community health activities.
- Provide free or subsidized medicines to the local community.
- Offer dental care and eye care camps with free check-ups and treatments.
- Distribute sanitary napkins and promote menstrual hygiene management.
- Facilitate mental health awareness programs and provide counselling services.
- Implement health education programs focusing on nutrition and healthy lifestyles.
- Establish partnerships with local hospitals for advanced medical care and referrals.
- Establish and support maternal and child health clinics.
- Conduct regular health check-up camps for mothers and children.
- Offer prenatal and postnatal care services.
- Regular cleaning of stagnant water to reduce diseases like malaria and dengue.

Community Rural Infrastructure development:

- Repairing, Strengthening & Maintenance of Existing roads
- To provide facility for potable drinking water by providing Tube well installation, drinking water supply system, overhead tank, and underground pump in villages.
- Creation of clean and hygienic environment by proper drainage systems, community sanitation campaign etc.
- Upgradation of primary health centres, renovation of existing roads, construction of toilet facilities etc.
- Provision of solar street lighting, green nurturing programs, implementation of swachchh bharat initiatives
- Enhancement of green coverage.
- Protection of wildlife through awareness generation.
- Promotion of renewal energy; and
- Waste management through installation of recycling measures.
- Tree plantation in nearby villages or vacant land may be carried out under joint effort of MBPMPL, local government agency and the local community.
- Install solar street lights to enhance safety and security in villages.
- Construct public toilets to improve sanitation and hygiene.
- Develop rainwater harvesting systems for sustainable water management.

Sports & Culture Development

- Renovation existing community Parks & Maintenance of the same
- Establishing sports facilities and providing equipment for local schools and communities.
- Organizing annual sports tournaments and cultural festivals to promote local talent.
- Providing scholarships and training programs for young athletes.

General Management & Administration

- Programme Manager/Programme Coordinator (Team Leader),

- Project Officer (Female & Male),
- Village Coordinator(s), Vehicles & expanses,
- Capacity Building activities.

As per the OM F. No. 22-65/2017-IA.III dated 30th September 2020 on CER and subsequent amendments by Ministry of Environment, Forest and Climate Change, Project specific CER activities will be identified and action plan will be included in the Final EIA report after consultation in the Public Hearing.

7.9 Corporate Social Responsibility

MBPMPL is committed to develop the surrounding area in a well-coordinated and balanced manner while safeguarding the environmental and social aspects under its CSR programme. Wherever possible, MBPMPL shall provide infrastructure to help set up local schools, centres for primary learning and education, and repair/construction of primary schools in neighbouring villages. MBPMPL is committed to inclusive development and will further strengthen its activities for improvement in education, sanitation and health, livelihood, rural infrastructure and rural sports.

The details of work executed by MBPMPL under CSR activities are given in **Annexure 7.1.** Total amount of Rs. 8.83 Crore has been incurred on CSR activities since inception till 2022-23. Year-wise CSR expenditures are given bellow in **Table 7.11.**

Table 7-11: Yearly CSR Expenditure

S. No.	Activity Heads	Year						Total
		2017-18	2018-19	2019-20	2020-21	2021-22	2022-2023	
1	Education and Training	89,03,312	87,85742	28,04,348	38,39,999	61,59,695	8687624	39180720
2	Community Health & Sanitation	-	41,100	-	-	1,34,91,162	3421433	16953695
3	Infra & Development	24,71,970	-	-	-	-	15854799	18326769
4	Sports & Culture	-	9,610	-	-	-	13117	22727
5	Livelihoods Promotion	49,34,451	14,87,491	1,73,046	1,35,315	94,017	245820	7070140
6	Others	52,08,312	4,32,078	82,658	4,76,971	5,79,692		67,79,711
Total		**2,15,18045**	**1,07,56,021**	**30,60,052**	**44,52,285**	**2,03,24,566**	**28222795**	**88333764**

MBPMPL shall ensure that the following activities are taken up in the proposed CSR plan:

Education: Education must be given priority in CSR Schemes. Special attention is required for girls' education. Educational facilities provide to the handicapped should be free of cost. Activities related to athletics and games should be promoted to keep students healthy and fit. In order to create awareness regarding education, educational society must be constituted which will look after related activities such as libraries providing magazine and newspaper to the villages/ hamlets. These societies should play important role in creating awareness among the community regarding importance of education.

Community health: Health awareness camp must be organized to aware the people regarding health, hygiene and rural sanitation. To improve health status more emphasis should be taken regarding safe drinking water & personal hygiene. People should be informed well in advance regarding health development activities being implemented by MBPMPL so that more & more people may get benefitted.

Rural infrastructure: Ensuring that the communities are not left behind due to poor infrastructure and focusing on strengthening community structures such as schools and institutions of higher learning, community halls, playground, Anganwadi centres, panchayat offices and villages information Centre, amongst other.

Plantation: Afforestation is an important method for ensuring environmental sustainability including mitigating the negative effects of climate change. Tree plantation in nearby villages or vacant land may be carried out under joint effort of MBPMPL, forest department & other government agency and the local community.

Skill development training: This major problem of unemployment can be eliminated up to certain level by conducting skill development programmes. The programme can be organized to familiarize the existing participant with the latest technology available in their area of operation, sensitize them for the adoption of new technology by educating them about the support available from the different organizations. An effort will be made to improve the managerial skill of these entrepreneurs by arranging lecture discussions and cases on different aspects of enterprise management.

Additional manpower will be required during the construction phase and operation phase for proposed expansion project. The skilled manpower will be in general sourced from the present pool of MBPMPL, while the semi-skilled and unskilled workers will be sourced locally as per qualification and skill. For this purpose, local youth from neighbouring villages will be identified through the Gram Panchayat and provided training in trades such as fitters, welders, electricians, and plumbing from the nearest ITI. As part of the CER activity, the ITI will be upgraded.

The CSR activities for stage II are proposed to be implemented from the date of commencement of commercial operation for stage II. The proposed activities are given in **Table 7-12.**

Table 7-12: Proposed CSR Activities for Stage-II

CSR Activity	Tentative Year-wise Phasing of Budget (from the commencement of commercial operation of Stage II) , in Lakhs					Total, in Lakhs
	1st year	2nd year	3rd year	4th year	5th year	
Infrastructure	243.49	243.49	243.49	243.49	243.49	**1217.47**

CSR Activity	Tentative Year-wise Phasing of Budget (from the commencement of commercial operation of Stage II) , in Lakhs					Total, in Lakhs
	1st year	2nd year	3rd year	4th year	5th year	
Education	108.06	108.06	108.06	108.06	108.06	**540.3**
Health	19.74	19.74	19.74	19.74	19.74	**98.7**
Sports & Culture	0.08	0.08	0.08	0.08	0.08	**0.4**
Welfare Activities	54.49	54.49	54.49	54.49	54.49	**272.45**
Skill Development	54.14	54.14	54.14	54.14	54.14	**270.7**
Total (in Lakhs)	**480**	**480**	**480**	**480**	**480**	**2400**

**The amount and year-wise phasing is tentative which shall be finalized after consultation with stakeholders and District Administration.*

7.10 Biodiversity Study:

An extensive biodiversity assessment study was carried out by a team of Environmental Science Department of Indira Gandhi National Tribal University (IGNTU) in the month of January- February 2025. The entire report has been annexed as **Annexure 7.2.** A total of 418 species of trees, herbs, shrubs, climbers and creeper were recorded from the study area. One species, Tectona grandis (Teak), is listed as "Endangered," highlighting the urgent need for conservation efforts to protect this valuable timber species. Species like Aegle marmelos (Wood apple) and Gossypium anomalum (Tree Cotton) are listed as "Near Threatened," indicating that they are at risk of becoming endangered if conservation measures are not implemented. A total of 40 species of fishes were recorded from study area by primary and secondary surveys. The majority of the species (e.g., Labeo catla, Cyprinus carpio, Cirrhinus mrigala) are classified as "Least Concern," suggesting stable populations and no immediate threat of extinction. Tor putitora (Golden Mahseer) is classified as Endangered, indicating a high risk of extinction in the wild. Wallago attu (Helicopter catfish) is listed as Vulnerable, signifying a risk of becoming endangered if conservation efforts are not implemented. Ompok bimaculatus (Butter catfish) is Near Threatened, meaning it is close to qualifying for a threatened category. Hypophthalmichthys nobilis (Bighead carp) has a Data Deficient status, indicating insufficient information to assess its risk of extinction.

23 amphibian species have been reported from the area, and most of them are not in the threat list category. The study area is home to a diverse array of amphibian species, as evidenced by the 23 species listed in the table. These species belong to three orders: Anura (frogs and toads), Gymnophiona (caecilians), and Microhylidae (narrow-mouthed frogs). The majority of the species (20 out of 23) are from the order Anura, indicating that frogs and toads are the most prevalent amphibians in the region. The remaining species include two caecilians (Ichthyophis beddomei and Ichthyophis bombayensis) and one species from the family Microhylidae (Uperodon variegatus).

There are 45 species of reptiles in the region, the majority of which belong to the order Squamata 79% and Testudines 21%. The list includes many reptiles from different orders, such as Squamata (lizards and snakes) and Testudines (turtles and tortoises). The Squamata order is remarkably diverse, with numerous species from families like Gekkonidae (geckos), Scincidae (skinks), Agamidae (agamid lizards), Colubridae (colubrid snakes), Elapidae (elapid snakes), and Viperidae (vipers). The study area hosts a diverse range of reptiles, with 45 species documented across 6 orders and 15 families. The most represented order is Squamata, which includes lizards, snakes, and skinks, with 36 species listed. The Testudines order, comprising turtles and tortoises, is represented by 9 species.

The dataset includes 81 bird species, spanning various orders and families. The most represented order is Passeriformes, which includes common birds like the House Crow (Corvus splendens) and the House Sparrow (Passer domesticus). Most of the species listed are classified as Least Concerned according to the IUCN Red List, indicating that they are not currently at significant risk of extinction. A few species, such as the Rose-ringed Parakeet (Psittacula derbiana) and the Alexandrine Parakeet (Psittacula eupatria), are listed as "Near Threatened," highlighting the need for conservation attention (Figure 14). The majority of these species are classified under the Passeriformes order, which is the largest order of birds and includes species such as the Oriental magpie-robin (Copsychus saularis), House crow (Corvus splendens), and Common myna (Acridotheres tristis). Other prominent orders include Pelecaniformes, Charadriiformes, and Coraciiformes, which include species like the Cattle egret (Bubulcus ibis), Red-wattled Lapwing (Vanellus indicus), and White-breasted kingfisher (Halcyon smyrnensis), respectively.

Analyzing the provided dataset on mammals reveals several key insights regarding species diversity, conservation status, and occurrence patterns. The dataset includes 26 species across various orders, families, and conservation categories. The dataset encompasses many mammalian species, including primates, carnivores, rodents, and even large herbivores like elephants. The species are distributed across different orders, with Primates, Carnivora, and Artiodactyla being the most represented. Notably, the Cercopithecidae family within Primates and the Cervidae family within Artiodactyla are prominent, indicating a rich diversity in these groups.

The dataset highlights the urgent need for targeted conservation strategies, particularly for endangered and vulnerable species. Habitat preservation, anti-poaching measures, and community engagement are crucial for the survival of species like the Tiger, Wild Dog, and Elephant. Additionally, the near-threatened status of species like the Striped Hyena and Indian Flying Fox calls for proactive measures to prevent further decline. During our study, tiger and elephant were reported to rarely migrate to villages from the adjoining Marwahi area. However, people also declined the region being the regular migratory route of these animals. In conclusion, the dataset provides a comprehensive overview of the region's mammalian diversity and conservation status. It underscores the importance of continued monitoring and conservation efforts to ensure the survival of these species in the face of increasing anthropogenic pressures.

7.11 Watershed Development Plan:

Watershed development plan was furnished to identify the watersheds that might have inverse impact due to the project and to recommend measures for slope stabilisation, check dams and other irrigation measures for development of the surrounding watershed. The plan is attached in **Annexure 7.3.**

7.12 GHG Inventory Study:

A GHG inventory was created for the existing 2x630 MW Thermal Power Plant along with recommendation and action plan to reduce emissions. The plan is attached in **Annexure 7.5.** The result of the study is summarized below-

#	Sources of Emissions	Quantity	Emissions (mt CO2 eq)

#	Sources of Emissions	Quantity	Emissions (mt CO2 eq)
I	Scope-1 (Direct Emissions) from power plant operations		
1	Emission due to Coal Consumption, Mt	58,28,733	82,43,396.5
2	Emissions due to Diesel Consumption, lit	34,286.2	93.41
3	Emissions due to LDO Consumption, lit	11,55,640	3,148.29
4	Other Direct Emissions		
a	Emissions due to LPG Consumption, kg	779	2.33
b	Emissions due to HFC Consumption	60	108.6
c	Emissions due to Fire Extinguishers/CO2 use	80	0.08
d	Emissions due to Effluent Treatment, m3	45,046	36.08
e	Emissions due to Sewage Treatment	38,432.37	14.66
	Sub-Total		82,46,799.93
II	Scope-2 (In-direct) Emissions from power plant operations		
1	Purchased Power, MW	0.739	0.89
	TOTAL		**82,46,800.93**
	TOTAL GHG Emissions during 2023-24 (base-year): 8.25 million tons of CO2-e		

The direct and indirect GHG emissions were calculated and estimated to be 8.25milling tons of CO2-e for the base year of 2023-24.

7.13 Need based Social Impact Assessment:

A Need Based Survey and Social Impact Assessment study was carried out by Greencindia Consulting Private Limited in association with an NGO Mahila Swarojgar Samiti at the study area (10 km radius). The study seeked to understand the actual effects of the company’s business activities and the CSR works including whether they achieved the goals of community needs and aspirations and their intended and unintended goals. The study recorded the Sociocultural and economic status of the community. It also tried to record the living conditions, and economic examine the demographic profile, living standards, and economic conditions of communities within a 10 km radius of the power plant. A structured roadmap was formulated, including measurable indicators and monitoring mechanisms, to enhance CSR effectiveness and long-term sustainability. The entire report is attached as **Annexure 7.6.**

Since 2015, MBPMPL has been actively advancing women's empowerment through its diverse CSR initiatives. One of its flagship education-focused programs, the “Support Class” initiative, has provided academic support to over 2,600 primary and middle school students in 19 villages, with girls comprising 50% of the beneficiaries. This initiative has played a crucial role in enhancing learning outcomes and encouraging female education in rural areas.

Beyond education, MBPMPL has also invested significantly in vocational training to improve women's employability and financial independence. By 2022-23, around 1,800 individuals—predominantly women and girls—had completed various skill development courses. Notably, the “Apparel Design Course” has enabled many women to become self-reliant by launching home-based boutiques, generating substantial earnings that contribute to their household income and economic stability.

In addition to education and employment, MBPMPL has actively worked on other critical sectors, such as healthcare and livelihood enhancement, addressing women's broader social and economic challenges. Further, the finding of the study prompts the adoption of a more comprehensive service delivery approach towards gender mainstreaming. During the focused group discussions (FGDs) with a group of women and another with adolescents in school, several key challenges emerged. It was revealed that girls have to travel more than 2 kilometres for secondary and higher secondary level schooling. Poor road conditions further exacerbate these challenges, making school attendance difficult. Additionally, participants expressed concerns about the lack of good healthcare facilities in the vicinity. While Primary Health Centers (PHCs) and Anganwadi centers exist in almost all the villages, they are not fully equipped with essential services and they have to visit the Jathari or Anuppur in critical situations. Furthermore, the hospital run by MB Power is not accessible to all villagers, posing a significant challenge during emergencies such as childbirth. In such critical situations, villagers rely on the government-run emergency ambulance service (108), which is not always available.

Another pressing issue highlighted during FGDs was Maternal and Child Health (MCH) and Adolescent Health (ARSH) issues, such as menstrual hygiene management and nutrition. Adolescent girls and women shared their concerns regarding the absence of proper menstrual hygiene management facilities, which adversely affects women's health. The lack of adequate awareness of menstrual management, coupled with poor nutrition, has contributed to widespread issues such as anaemia and tuberculosis among women.

Additionally, nearly all women expressed a keen interest in receiving training and support for income-generating activities to contribute to their household income. The majority of women are engaged in agricultural activities, balancing both household chores and farm work. However, many women reported having neither the skills nor the resources to explore alternative economic opportunities. Some admitted that they had never considered pursuing new avenues for financial independence and expressed a strong desire for handholding from MB Power to help them reconsider potential livelihood opportunities.

To address these challenges, MBPMPL can enhance its CSR initiatives by integrating the latest safeguards and policy amendments. Improving infrastructure, such as constructing better roads, increasing access to education, healthcare services, and alternate livelihood opportunities can create a better situation for the women. The proposed CSR programs must ensure that the women are positioned as key stakeholders, enabling their social and economic empowerment. These efforts will not only uplift women but also contribute to long-term community development and social progress of the whole community.

MBPMPL prioritizes sustainable development and actively contributes to India’s social and economic progress through its corporate social responsibility (CSR) initiatives. At the global level, the United Nations adopted the Sustainable Development Goals (SDGs) on September 25, 2015, with 193 member states committing to ending poverty, protecting the planet, and fostering prosperity for all. The SDG framework comprises 17 goals and 169 strategies for implementation, guiding global efforts toward sustainable development. Aligning with this vision, MBPMPL's CSR initiatives have made significant strides in promoting universal education, gender equality, and addressing economic and health-related challenges. Through these efforts, the company has demonstrated a strong commitment to driving positive social impact and contributing to the broader sustainable development agenda.

During the construction and operational phases of the expansion project, additional workforce will be required. Skilled workers will primarily be sourced from MBPMPL’s existing workforce, while semi-skilled and unskilled laborers will be hired locally based on their qualifications and expertise. Local youth from nearby villages will be identified in collaboration with the Gram Panchayat and trained in trades such as fitting, welding, electrical work, and plumbing through the nearest Industrial

Training Institute (ITI). As part of the Corporate Environmental Responsibility (CER) initiative, the ITI will also be upgraded to enhance vocational training opportunities.

The CSR initiatives by MB Power aim to create long-term socio-economic benefits for the local community while ensuring environmental sustainability. The proposed interventions address critical needs, enhance community well-being, and strengthen the company's social license to operate. Through strategic planning and stakeholder collaboration, these initiatives will contribute to holistic regional development and improved quality of life for the local population.

8. Project Benefits

8.1 Introduction

Hindustan Powerprojects Private Limited ("**Hindustan Power**") is an independent power producer, and the company is headquartered in New Delhi and has power generation assets in the states of Madhya Pradesh, Assam, Karnataka, Bihar, and Tamil Nadu. Hindustan Power has been focusing on giving maximum returns to its stakeholders through corporate growth and social responsibility. The group is committed to working in tandem with communities and running a responsible business that contributes to our country's infrastructural goals. Hindustan Thermalprojects Limited, the thermal arm of Hindustan Power through its Special Purpose Vehicle ("SPV"), MB Power (Madhya Pradesh) Limited ("**MBPMPL**"), developed in 2 phases 1260 MW (2 X 630) coal-based generating capacity unit 1 in 2015 and unit 2 in 2016 at District Anuppur, Madhya Pradesh.

The SPV currently supplies about 70% of the power generated to the distribution utilities of Madhya Pradesh & Uttar Pradesh under long-term, and balance power is being sold through bilateral arrangements, under medium-term /short-term PPA and power exchanges. MBPMPL is generating 1260 MW of electricity through coal based thermal power plant benefitting 15 lakhs plus beneficiaries with 100% successful ash disposal.
Apart from infrastructural development, our community programs focus on four core developmental areas - Sustainable livelihood & Women empowerment, Education and Capacity building, Youth development, and Health & Family Welfare. All the interventions focus on catering to the needs of the most marginalized communities, within which women, children, and local tribes are given special attention.

It is anticipated that as a consequence of this expansion project there will be employment opportunity including skilled, semi-skilled, and unskilled workers. It has been assured alongside that the industry will bring improvement of physical infrastructure at local area like, building/strengthening of existing roads, providing drinking water, drainage system, transportation facility etc. with improved educational facilities and professional practices and by extending healthcare facilities it can be expected that the project will lead towards further development in literacy, economic status and standards of living. Thus, the basic requirement of the community needs will be strengthened by the project either by providing or by improving the existing facilities in the area, which will help in uplifting the quality of life of the local communities. Additionally, support in the areas of sports, recreation and environmental sanitation can also be undertaken to facilitate socioeconomic opportunities.

This chapter focuses on those points which become beneficial to the surrounding area or community in terms of infrastructural development, social development, employment generation and other tangible benefits due to upcoming project activities. The company will undertake socio-economic developmental activities for the benefit of the locals.

The proposed expansion of MBPMPL's Anuppur Thermal Power Project, Anuppur, by adding 1600 (2X800) MW will benefits local and regional economy. It will bring improvement in the standard of living of the local population by providing employment opportunities and improved infrastructure. The project will also attract the high-income groups to invest in the region and thus bring about economic growth of the region.

- Infrastructure development.
- Direct & Indirect employment opportunity
- Revenue generation to central & state government.
- Enhancement in CSR/CD activities.
- Trickledown effect of enhance profitability to the local populace
- Skill development and capacity building like vocational training, income generation programmes and entrepreneurship development program
- Awareness programme and community activities, like health camps, medical aides, family welfare camps, sanitization/ cleanliness awareness programme, immunization camp, sports & cultural activities, plantation, etc.
- Awareness about water borne diseases and pandemic diseases etc. will be done to local villagers.

8.2 Improvement in Physical Infrastructure & Community Development

Establishment of large developmental projects improve the availability of the physical infrastructure (like approach roads, drainage, communication and transportation facilities etc.) and social infrastructures (like education and health care system). These will also benefit the local population.
In addition to the plants & equipment for generation of power the following facilities shall be provided in this station:

- Construction offices and stores
- Time and security offices
- First Aid and fire-fighting station with appropriate equipment
- Canteen and welfare center
- Toilets and change/rest rooms
- Parking facility – 2 & 4 wheelers
- Safety Training center
- Development of additional residential facilities in existing township to provide accommodation for staff.

Office space shall be provided as per good practice and canteens, toilets and restrooms according to norms laid down in relevant factories act. The above facilities shall also be adequately furnished and equipped.
The proposed expansion of MBPMPL's Anuppur STPP will improve the power supply position in the state as well as in India, which is vital for economic growth as well as improving the quality of life. The power generated from this plant will benefit to a large extent leading to industrial/ commercial development in the state of Madhya Pradesh and also in the country.
The enhanced power supply will decrease the reliance of the general public and commercial establishments on DG Sets, thus lowering both noise and air pollution at the local level.
The construction and operation of the power plant is likely to attract influx of persons in the area in the form of equipment suppliers, material suppliers, maintenance technicians, etc. For their accommodation, the infrastructural facilities like lodging, eateries and transport facilities on the

outskirts or at nearby villages up to the plant area is expected to improve significantly. These will also benefit the local population.
The proposed project will induce the development of ancillary and small-scale industries in the area to meet the requirement of the project. The people residing in the nearby areas will be benefited indirectly. The construction and operation of the proposed power plant are expected to bring benefits to the local community in two distinct phases.

8.3 Improvement in Social Infrastructure

Social infrastructure is a component of the broader infrastructure sector, encompassing assets designed to support social services. Implementing the proposed project is expected to have a favourable impact on existing infrastructure, creating conditions conducive to urban development in the region. Company will employ additional workers, supervisors and engineers available locally to the extent possible.
Necessary medical facility will upgrade under CSR activities/ programs which will be beneficial to locals residing in the study area as per Companies Act.

People coming from outside are expected to be educated and skilled. In addition, some secondary developments like opening of new shops may take place in view of the increased family population due to the proposed employment. These factors will be beneficial to locals residing in the study area.

8.4 Employment Potential

Direct Employment: Power projects have mechanized and automated plants. Hence, the employment prospects during the operational phase are constrained. The number of MBPMPL employees during construction and operation phases are 300 and 150 respectively. The direct employment opportunities with MBPMPL are extremely limited and the opportunities would exist mainly with MBPMPL's contractors and sub-contractors. Providing jobs to local persons on a preferential basis wherever feasible would be facilitated through these agencies. The skilled manpower requirements for the operational phase of the power project shall come from outside the study area. Need of unskilled people would be satisfied from local population, depending on availability & feasibility.

In addition to the direct employment opportunities mentioned above, there will be indirect employment opportunities of local people by utilizing their expertise in different areas like horticulture, travel services, housekeeping and painting etc. Additionally, the advancement of the study area is expected to create new job opportunities.

Indirect employment: During operation phase, there will be employment opportunities, mainly in service sector, although its magnitude will be limited. Unskilled people and limited skilled people (depending on availability) may be hired by contractors from local population.

In addition, some secondary developments like opening of new shops may take place in view of the increased family population due to the proposed employment. These factors will be beneficial to locals residing in the study area. The local people may have opportunity to be engaged, under different agencies, as per their qualification & skill set, during the project expansion activities of MBPMPL - Anuppur TPP.

8.5 CORPORATE ENVIRONMENT RESPONSIBILITY

The Ministry of Environment, Forests & Climate Change issued the National Environment Policy (NEP) in the year 2006, as a "response to our national commitment to a clean environment as mandated in the Constitution in Articles 48A and 51A (g) and strengthened by judicial interpretation of Article 21.” The NEP is intended to mainstream environmental concerns in all development activities. The dominant theme of the policy is that “while conservation of environmental resources is necessary to secure livelihoods and well-being of all, the most secure basis for conservation is to ensure that people dependent on particular resources obtain better livelihoods from the fact of conservation than from degradation of the resource.” Whereas Corporate Social Responsibility (CSR) is mandatory as per Companies Act 2013, Corporate Environmental Responsibility (CER) gives specific stress on environment as per NEP. To meet the needs of NEP, MoEF&CC, w.e.f 1.5.2018, has issued an OM on CER. Another OM was issued in supersession of this OM by MoEF&CC dated 30th September, 2020 as revision of CER, Corporate Environment Responsibility.

Hence, additional fund shall be allocated towards CER activities (as per Ministry’s OM dated 01.05.2018) after addressing issues raised during Public Consultation.

The details of work executed by MBPMPL under CSR activities are given in **Annexure 7.1.** Total amount of Rs. 8.83 Crore has been incurred on CSR activities since inception till 2022-23. Year-wise CSR expenditures are given below in **Table 8.1.**

Furthermore, proposed TPP activities for Stage-II has been envisaged and mentioned in **Table 8.2**.

Table 8-1: Existing TPP- R&R-Community Development Activities for Stage-I

S. No.	Activity Heads	Year						Total
		2017-18	2018-19	2019-20	2020-21	2021-22	2022-2023	
1	Education and Training	89,03,312	87,85742	28,04,348	38,39,999	61,59,695	8687624	39180720
2	Community Health & Sanitation	-	41,100	-	-	1,34,91,162	3421433	16953695
3	Infra & Development	24,71,970	-	-	-	-	15854799	18326769
4	Sports & Culture	-	9,610	-	-	-	13117	22727
5	Livelihoods Promotion	49,34,451	14,87,491	1,73,046	1,35,315	94,017	245820	7070140
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Total		**2,15,18045**	**1,07,56,021**	**30,60,052**	**44,52,285**	**2,03,24,566**	**28222795**	**88333764**

The CSR activities for stage II are proposed to be implemented from the date of commencement of commercial operation for stage II.

Table 8-2: Proposed CSR Activities for Stage II.

CSR Activity	Tentative Year-wise Phasing of Budget (from the commencement of Commercial Operation of Stage II					Total in Lakhs
	1st Year	2nd Year	3rd Year	4th Year	5th Year	
Infrastructure	243.49	243.49	243.49	243.49	243.49	**1217.47**
Education	108.06	108.06	108.06	108.06	108.06	**108.06**
Health	19.74	19.74	19.74	19.74	19.74	**19.74**

CSR Activity	Tentative Year-wise Phasing of Budget (from the commencement of Commercial Operation of Stage II					Total in Lakhs
	1st Year	2nd Year	3rd Year	4th Year	5th Year	
Sports & Culture	0.08	0.08	0.08	0.08	0.08	**0.08**
Welfare Activities	54.49	54.49	54.49	54.49	54.49	**54.49**
Skill Development	54.14	54.14	54.14	54.14	54.14	**54.14**
Total (in Crore)	**480**	**480**	**480**	**480**	**480**	**2400**

Figure 8-1: Different CSR Programmes conducted by MB Power.

9 Environment Cost Benefit Analysis

9.1 Introduction

Environmental Cost-Benefit Analysis (CBA) involves evaluating the economic impacts of policies and projects designed to enhance environmental services or those that may influence the environment, sometimes negatively. Originating from welfare economics, CBA addresses how different outcomes compare in terms of societal benefits. Welfare economics, grounded in eighteenth-century Utilitarian philosophy, aims to maximize benefits for the largest number of people. This approach focuses on assessing outcomes based on their overall utility to the population. The environmental costs and benefits of a development project are best understood when expressed both qualitatively and quantitatively (in monetary terms), and then compared to determine their relative value.

9.2 Stages Of Cost-Benefit Analysis

- Defining the Project
- Identifying Impacts of the Project
- Valuing Impacts
- Valuing Benefits
- Cost Benefit analysis ratio
- Inference

The existing MBPMPL's Anuppur TPP has an installed capacity of 2x630 MW. All the units of Stage-I are under commercial operation.

In recent years, coal-based power generation has risen by 16.1% compared to previous years. According to the Central Electricity Authority (CEA), the installed capacity for coal and lignite power generation is projected to reach 251 GW by the end of 2029-30 to satisfy growing power demands, requiring an additional 34 GW from new coal and lignite projects. Given the current trend of retiring older, less efficient sub-critical units in line with emission standards set on 07.12.2015 and government policies on upgrading older units, there is a proposal to establish a 1600 MW (2x800 MW) Ultra-Super Critical TPP. This new TPP is expected to decrease greenhouse gas emissions by utilizing more advanced, efficient technologies.

9.3 Identifying Impacts of the Project

The impacts of construction and operational phases of the proposed expansion project comprise various activities each of which have an impact on some or other environmental parameters. Various impacts during the construction and operation phase on the environment have been studied to estimate the impacts on the environmental attributes and are discussed in the subsequent sections. Impacts of the project activates are given in **Table 9.1**.

Table 9.1: Impacts of the Proposed Stage – II project during construction & operation phase

S. No.	Sector	Probable Impact
1.	Air Environment	➢ Stack emissions (PM, SO2 and NO2).
2.	Water Environment	➢ Effluent generation from project site and township.

S. No.	Sector	Probable Impact
3.	Noise Environment	➢ Generation of noise due to plant.
4.	Solid Waste Environment	➢ Generation of Solid waste from plant and township.
5.	Ecology & Biodiversity Environment	➢ Diversion of forest land for the additional land requirement. Forest land has already been diverted during Phase I
6.	Socio-economic Environment	➢ Impact on people due noise and air pollution. ➢ Damage to public facility like road due to proposed expansion project.
7.	Land Environment	➢ Change in land use pattern and land degradation. Land use pattern has been already changed during Phase-I

9.4 Evaluation of Impacts

There is no approved methodology for Cost Benefit Analysis of thermal power projects. However, the same has been undertaken based on the parameters identified under the following two documents:

(a) The Methodology for Cost Benefit Analysis for Projects involving Forest Diversion as per Consolidated Guideline & Clarification issued under Van (Sanrakshan evam Samvardhan) Adhiniyam, 1980 and Van (Sanrakshan evam Samvardhan) Rule 2023. Although the project does not involve any additional forest land, the parameters specified in the analysis, as applicable have been considered.

(b) MEF&CC OM dated 05.03.2020 on Draft Guidelines for Environmental Damage assessment Cost- Although the project does not involve any violation or damage, the parameters for emission & discharge have been considered as per Draft Guidelines.

The study focuses on analysing and evaluating the environmental and socioeconomic impacts including environmental pollution, plantation, job creation, displacement, health risks, and changes in local community in terms of qualitative and quantitative. Evaluation of the impact during construction and operation is showing in **Table 9.2.**

Table 9.2: Estimation of Environment cost

SI	Parameters	Remarks	Monetary Equivalent
1	Ecosystem services losses due to proposed forest diversion.	Economic value of loss of ecosystem service due to forest diversion of forest shall be the net-present value (NPV) of the forest land being diverted as prescribed by the Central Government (MoEF&CC) Note: In case of National parks the NPV shall be ten (10) times the normal NPV and in case of wildlife Sanctuary the NPV shall be five (5)	Nil No Forest land is proposed for diversion in Stage-II and the land is already in Industrial use.

SI	Parameters	Remarks	Monetary Equivalent
		times of normal NPV or otherwise prescribed by the ministry or any other competent authority	
2	Loss of animal husbandry productivity including loss of fodder	To be quantified and expressed in monetary terms or 10% of NPV applicable whichever is maximum.	Nil
3	Cost of human resettlement/ rehabilitation	To be quantified and expressed in monetary terms as per approved R&R Plan	Nil Human resettlement is not required, since land is in possession of PP.
4	Loss of public facilities and administrative infrastructure (Roads, building, schools, dispensaries, electric lines, railway etc.) on forest land. Which would require forest land if these facilities were diverted due to the project.	To be quantified and expressed in monetary terms on actual cost basis at the time of diversion	Nil No Forest land is proposed for diversion in Stage-II and the land is already in Industrial use.
5	Possession value of forest land diverted	10% of environment costs (NPV) due to loss of forests or circle rate of adjoining area in the district should be added as a cost component as possession value of forest land whichever is maximum	Nil
6	Cost of suffering to outees	The social cost of rehabilitation of outees (in addition to the cost likely to be incurred in providing residence, occupation and social services as per R&R Plan) be worked out as 1.5 times of what oustees should have earned in two years had he not been shifted	Nil
7	Habitat Fragmentation Cost	While the relationship fragmentation and forest goods and services is complex for the sake of simplicity the cost due to fragmentation has been pegged at 50% NVP applicable as a thumb rule	Nil

<table>
<tr><th>SI</th><th>Parameters</th><th>Remarks</th><th>Monetary Equivalent</th></tr>
<tr><td>8</td><td>Compensatory afforestation and soil & moisture conservation cost.</td><td>The actual cost of compensatory afforestation and soil moisture conservation and its maintenances in future at present discounted value.</td><td>Nil</td></tr>
<tr><td>9</td><td>Cost of air emissions</td><td>Impact Cost; per kg of emission.
PM10 – Rs. 340/Kg Emission
SOx – Rs. 165/Kg Emission
NOx – Rs. 96/Kg Emission
(Source: As per MoEF&CC OM. No. 19-125/2019-IA.III dated 05.03.2020).
Although above parameters are mentioned for emission beyond the limits, the same rate has been considered for emission above the present levels.
Total Emission/ Year based on Air Quality Modeling considering 24 hrs. operation for 330 days for all units of stage: -II with FGD for 25 years of design life of plant
<table>
<tr><th>Pollutant</th><th>Emission rate (g/s)</th><th>Total emission/ year (Kg)</th><th>Impact cost in Rs (Lakh)/yr</th></tr>
<tr><td>PM10</td><td>16.33</td><td>515073.68</td><td>1,751</td></tr>
<tr><td>SOx</td><td>81.66</td><td>2576295.36</td><td>4,250</td></tr>
<tr><td>NOx</td><td>81.66</td><td>2576295.36</td><td>2,473</td></tr>
</table></td><td>Rs. 84.74 Cr / year, taking average 25 as the life of the plant. Total cost of emission = 2118.5 Cr</td></tr>
<tr><td>10</td><td>Water Environment</td><td>(ZLD based ETP & STP shall be installed at project site, hence no impact on water environment envisaged).</td><td>Nil
(Cost included at Environment Management Plan)</td></tr>
<tr><td>11</td><td>Noise Environment</td><td>(Proper Equipment’s design, and PPE kit will be provided, no major impact envisages).</td><td>Nil</td></tr>
<tr><td>12</td><td>Solid Waste Environment</td><td>(MBPMPL has a facility for management and disposal of solid waste, no adverse impact due to solid waste is envisaged).</td><td>Nil</td></tr>
</table>

SI	Parameters	Remarks	Monetary Equivalent
13	Cost of EMP	Environment Management Plan includes all the Pollution control equipment's, CEMS, EQMS, Rain water Harvesting, and Green Belt development cost	Rs 30.65 Cr

Total estimated cost as per **Table: 9.2**= Rs. 2149.15Cr

9.5 Evaluation Of Benefits

The commissioning of the proposed MBPMPL's Anuppur TPP Stage-II (2x800 MW) project is expected to significantly enhance the power supply in various Indian states, which is crucial for both economic development and improving living standards. This upgraded power infrastructure will lessen the reliance of the public and businesses on diesel generators, thereby decreasing local noise and air pollution.

As part of its corporate social responsibility, the project will initiate several activities, including support for disadvantaged and physically challenged individuals, capacity-building programs, sports events, assistance to government schools, and scholarships. A key advantage of this expansion will be the creation of numerous temporary jobs during both the construction and operational phases.

Additionally, community development initiatives under CSR/CER such as education, healthcare, water, and sanitation improvements will be implemented in nearby villages affected by the project. MBPMPL will also invest in essential infrastructure, including water supply, sewage systems, and medical facilities. Evaluation of benefits from the proposed stage – II project is given in **Table 9.3.**

Table 9.3: Estimating Environment of Benefits from the project

SI. No.	Parameters	Remarks	Monetary Equivalent
1	Increase in Productivity attribute to the specific project	To be quantified & expressed in monetary terms avoiding double counting	**Rs. 30,750 Cr** (Profit after Tax over the design life of 25 yrs.)
2	Benefits to economy due to the specific project	The incremental economic benefit in monetary terms due the activities attributed to the specific project	**Rs.46,562 Cr** (Total cash flow during construction and operation of the project)
3	No. of Population benefited due to specific project	As per the Detailed project report	Based on average electrical consumption of 1331units/capita/year, Total 105.3 Lakh population shall be benefitted. It will help to improve socio- economic development of the area.

SI. No.	Parameters	Remarks	Monetary Equivalent
4	Economic benefits due to of direct and indirect employment due to the project	As per the Detail project report	a) **During construction (5 yrs)** No of employment: 4,000 nos. Period of Employment- 1740 Days No of Mandays- 69,60,000 Considering Rs.500/man-day =69,60,000 = **Rs 34,800 Lakh** No of permanent employment=300 Period of Employment- 1740 Days No of Mandays- 5,22,000 Considering Rs.5000/per employee/day = **Rs. 26,100 Lakh** b) **During operation phase**: No of temporary employment= 500 Period of employment= 7800 Days Man-days in 25years=39,00,000 Considering Rs.800/manday =39,00,000*800= **Rs 31,200 Lakhs** No of permanent employee =150 Period of employment= 7800 Days Man-days in 25years=11,70,000 Considering average value @Rs.6000 per employee/day = 11,70,000x6,000 = **Rs.70,200 Lakh** Considering 05 years for construction period and 21 years of plant life, the direct employment potential of the project proposal = Rs (34,800+26,100+31,200+70,200) Lakhs = **1,62,300 Lakhs (Rs 1,623 Cr)**
5	Economic Benefits due to Compensatory afforestation/ Afforestation	Benefits from such compensatory forestation accruing over next 50 years monetized and discounted to the present value should be included as benefits of compensatory. Afforestation * For benefits of CA the guideline of the ministry for NPV estimation may be consulted.	Considering cost of tree plantation on 45.991 Ha of land for Stage-II is **Rs 5 Cr**. With a 4% discount rate the NPV for 5 years will be **Rs.4.11 Cr**

9.6 Cost Benefit Analysis Ratio

The cost benefit analysis ratio based on above calculations is as under:

Impact Evaluation: Rs 2149.15Cr.

Benefits Evaluation: Rs 78,939.11 Cr.

Environmental Cost Benefit Analysis ratio = Value of Impact: Value of Benefits

Environmental Cost Benefit Analysis ratio = **1: 36.7**

Hance, the project benefits are 36.7 times is higher than the impacts evaluated.

9.7 Inference

The cost benefit analysis for the proposed MBPMPL's Anuppur TPP Stage- II (2x800 MW) indicates in favour of the project. The financial expenditure incurred in preventing, containing, mitigation or removing environmental contaminations occurring as a result of the proposed project activity will further add to the environmental benefit.

10. Environment Management Plan

10.1 Emp Implementation, Inspection and Monitoring

Environmental Management Plan (EMP) is proposed for its implementation during development of the project so objective of environmental protection can be achieved as per MoEF&CC norms & guidelines. If any adverse impact on the environment shall be identified during the operation of project, suitable mitigation measures, along with the monitoring mechanism shall be prepared to control the adverse impact of the operation. This covers description of the administrative aspects of ensuring that mitigative measures are implemented and their effectiveness monitored, after approval of the EIA/EMP report and grant of Environment Clearance (EC).

In order to manage environmental issues, appropriate institutional arrangements with suitable organizational structure need to be in place, with clear definition of a range of required activities, powers and responsibilities. The assessment of environmental impacts and mitigation measures have been identified for effective operation of environmental management activities in the pre-construction, construction, commissioning and operation & maintenance (O&M) activities. These have to be operated with necessary resources i.e manpower, hardware and software to establish and monitor appropriate indicators for suitable remedial measures.

10.1.1 Components of EMP

Environment Management Plan (EMP) comprises of the components: (i) Institutional Arrangements; (ii) Monitoring Programme/plan; (iii) Environmental Enhancement Measures; and (iv) Social Enhancement Measures.

10.2 Institutional Arrangements

In order to maintain the environmental quality within the standards, regular inspections, audits & monitoring of various environmental components is necessary. An Environmental Management Cell (EMC) is envisaged which is responsible for monitoring EMP and its implementation. Environment management is the responsibility of the environment management cell headed by the Head – HSE and comprising of Head Environment, Engineers, Safety Officer, Chemists etc. Head HSE is directly reporting to the CEO/ Plant Head of the organization. Plant Head is responsible for environment management activities for the organization. The company has well established compliance management system. A separate legal team available for the same. EMC members meet periodically to assess the progress and analyse the data collected during the month. The EMC team is responsible for pollution monitoring aspects and implementation of control measures. A group of qualified and efficient engineers with technicians will be deputed for maintenance, up keeping and monitoring of the pollution control equipment, to keep them in working mode at the best of their efficiencies.

Training programs will be conducted to educate staff on environmental monitoring, stack emission monitoring, AAQMS, CEMS, EQMS, ambient air & water quality assessments, municipal & hazardous waste management, noise reduction measures etc.

To ensure operational efficiency, pollution control equipment will be equipped with spare parts and maintenance facilities. Staff will receive specialized training to operate Electrostatic Precipitators (ESP), Flue Gas Desulphurisation System, ETP, STP and other pollution control systems optimally.

10.2.1 Structure of EMC

Structure of Environment Management Cell at M/s. MB Power (Madhya Pradesh) Limited is given in Figure 10.1.

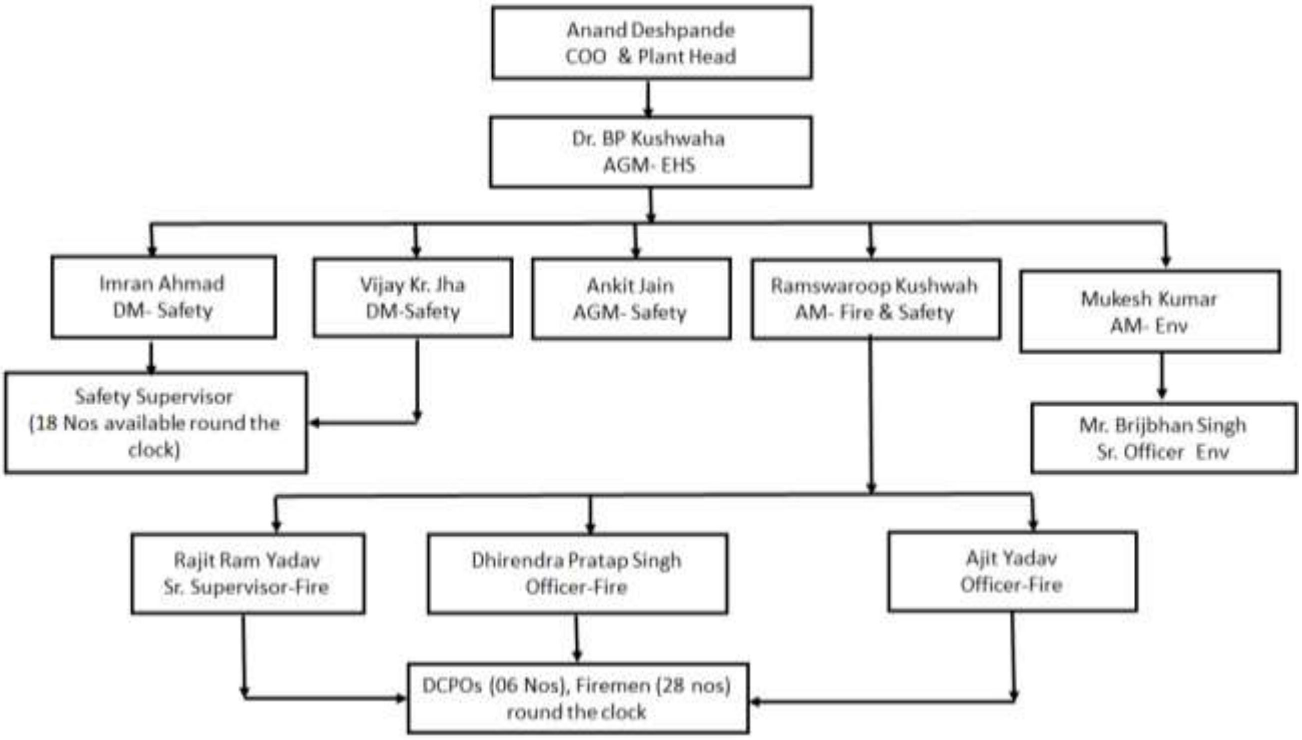

Figure 10-1: EMC Structure of MB Power (Madhya Pradesh) Limited.

10.2.2 Responsibilities of EMC

The EMC looks after and implement the various functions to ensure that environmental status of the area remains within the statutory standard of MOEF&CC, CPCB and SPCB.

The responsibilities of the EMC include the following:

- Procurement and commissioning of Pollution Control/Monitoring Equipment.
- Ensuring calibration of all the monitoring equipment on time.
- Environmental monitoring of the core and buffer zone and evaluation of the results. Keeping of records to track the surrounding environment quality status.
- Specification and regulation of maintenance schedules for pollution control equipment.
- Ensuring that prescribed standards are maintained.
- Ensuring optimum water usage.
- Implementation of the mitigation measures suggested in EIA/EMP Report.

- Ensuring greenbelt development/plantation & its maintenance.
- Compliance with guidelines and statutory requirements. Reporting of non–compliances (if any) to the Board and other stakeholders.
- Coordination with statutory bodies, functional groups of the unit, Corporate Project/Environment & Engineering department etc.
- Interaction with engineering & operation team for implementation of any modification programmes intended to improve the availability/ efficiency of pollution control devices.
- Regular environmental review and performance appraisal (Internal) and organizing Environmental/Energy and Water Audits by independent agencies/ 3rd party agencies.
- Coordination with the vendors dealing in waste supplies and disposal.
- Ensuring that the waste handling and disposal is carried out as per prescribed conditions.
- Ensuring utilization of fly ash according to fly ash notification and CPCB guidelines.
- Conducting regular training programmes on various environmental requirements especially sustainable development, climate change, environmental monitoring etc.
- Organizing promotional activities such as World Environment Day, Water Day, Earth Day, Ozone Day, Fire service Day. National Safety Day, Road Safety weeks etc.
- Developing & implementing occupational health & safety policy, program, and procedure & increasing health & safety awareness at all levels within the organization.

10.2.3 Operation & Maintenance Group

O&M team head would have primary responsibility for the operation & maintenance of the power station. MBPMPL Anuppur has Operation & Maintenance Group Management Organization headed by a GM (O&M) and is assisted by a team of managers & engineer. This O&M Group Organization will take up additional responsibility of operations, maintenance and monitoring of pollution control equipment/system related to proposed Ultra Super Critical Thermal Power Plant. O&M team is expected to comprise four broad functional areas viz. operations, maintenance, engineering, support service and administration. The fundamental responsibilities associated with each of these functional domains are outlined below:

10.2.3.1 Operations

Operation of Power Plant, coal and ash handling systems, water systems including water treatment system, switchyard and other auxiliary plant, will be carried out by the personnel of operation section. Except for the Operations Manager who would be overall in charge of operations, all other operation personnel would be on three - shift basis. Shift personnel manpower planning for key areas will be generally done on (3+1) concept to take into account leave taken by shift personnel.

The shift operation of the power station shall be overseen by a Shift In charge, one in each main control room, one for coal, fuel oil, ash handling systems and water systems. Shift In charges will be assisted by Control Engineers and other operation staffs.

10.2.3.2 Maintenance

Maintenance of all mechanical and electrical plant, control systems, buildings, roads, drainage and sewage systems, etc., operation of the plant workshop, planning for scheduled maintenance works and deciding requirement of spare parts, will be done in general shift by the personnel of the maintenance section.

10.2.3.3 Engineering

Personnel of this section will be responsible for Monitoring of plant performance, maintenance of documentation, improvements in plant systems, plant safety aspects including, information services and training. All personnel in this functional area would be in the general shift.

10.2.3.4 Administration & support services

Purchase of spares and other equipment/ materials, stores management, fuel supply coordination, plant security, finance & accounts, medical services, personnel services, secretarial and clerical services, will be taken care by this functional area.

10.2.3.5 Set up of the Project's O&M Groups

Operation & Maintenance Head would represent the Project's Company's interest in the operation & maintenance of the power station and would oversee the functioning of O&M Groups of the project. He would be assisted by a team covering the following functional areas:

Technical: For monitoring overall plant performance, purchase of spare parts, consumables, etc., metering energy sent to the grid and for resolving any other technical aspects required to be resolved.

Finance & Accounts: To oversee the operational and maintenance (O&M) expenses related to the plant, manage billing for energy supplied to the grid, ensure timely repayment of loans and interest, handle staff salaries and expenses, and coordinate the renewal of necessary insurance coverage at regular intervals.

Administration & Personnel: For providing administration support such as secretarial, clerical and transport services & providing personnel services and managing the staff colony.

10.2.4 Corporate Environment Policy

M/s. MB Power (Madhya Pradesh) Limited have Corporate integrated HSE Policy been formulated and adopted by the Board of Directors of MB Power (Madhya Pradesh) Limited to provide a framework to become an environmentally sustainable company and a site level Integrated management Policy (IMS) duly signed by Mr. BK Mishra, (COO/Plant Head).

Environment Policy represents company's general position on environmental issues, policies and practices for conducting business. Also conveys the company's commitment towards empowering the environment by adopting various measures. In addition to site IMS Policy, Corporate EHS policy has also been prepared and signed by Chairman. The Health, Safety and Environment Policy is attached in **Annexure 10.1**

10.3 Environmental Monitoring Programme

A robust environmental monitoring program is essential to gather scientifically valid data for assessing the environmental quality around the power station and ensuring critical pollutants remain within acceptable limits. This initiative provides an early alert system for detecting unacceptable environmental conditions, enabling prompt implementation of control measures. Furthermore, it facilitates timely detection of changes in local environmental conditions.

The program specifies the monitoring locations, duration, and frequency of parameters to be observed. Monitoring during both construction and operation phases is integral to environmental mitigation efforts. Regular monitoring is vital for evaluating the effectiveness and performance of pollution control equipment. Regular monitoring is being carried out for existing Anuppur TPP which covers monitoring activity for air quality, water quality, soil quality and noise levels and the data is submitted to Madhya Pradesh State Pollution Control Board (MPPCB) at regular intervals. The same would be augmented/ strengthened encompassing proposed 2x 800MW Anuppur STPP.

Environment Monitoring Plan is described in **Chapter 6**. Monitoring during construction phase is given in **Table 6.1**. The final post-study environmental monitoring program including number and location of monitoring stations, frequency of sampling and parameters to be covered have been summarized and presented in **Table 6.2**.

10.4 Laboratory

The monitoring will be done by an internal & external NABL/ MoEF&CC approved laboratory and in-house laboratory is also proposed.

10.5 Occupational Safety

To control and minimize the risks at workplace, Coal Based Sub-Critical Thermal Power Plant by M/s. MB Power (Madhya Pradesh) Limited has implemented Health, Safety and Environment Policy (HSE) with the following objectives:

- To prevent hazards
- To provide safe and healthy environment to all the employees.
- Healthy & Safe working environment for employees is the prime concern of the company.
- MB Power (Madhya Pradesh) Limited is committed to maintain safe & healthy work environment for employees, against hazards & risks through:
- Continuously developing & maintaining safe work practices.
- Focus on operational & occupational hazards & risks.
- Creating awareness about preventive health & safety measures.
- A well-equipped first aid health center established at plant site.
- Carrying out risk assessment associated with its operation and taking the remedial measures. The company, therefore, will adopt the HSE policy (fig 10.4) for the purpose of creating and maintaining safe and healthy environment.

Health and Safety Policy

- Health, Safety and Environmental Protection (HSE) is a vital part of MB Power (Madhya Pradesh) Limited commitment to conduct the activities in harmony with society and nature. The company expects all its employees to follow the HSE Policy.
- Integration process of Health & Safety must start at the inception of a project since HSE consideration must be addressed at the design stage, which also helps in optimizing the support process.
- MB Power (Madhya Pradesh) Limited has Integrated Health, Safety and Environment Protection (HSE) into the business strategies to add value to the enterprise, to manage risk and to enhance the reputation.

- The health and safety of the employees, and the visitors and the protection of the environment are company's priorities consistently pursued throughout
- Company is being/ will organize / conduct awareness programs and camps periodically and on need basis on health, safety and environment in the vicinity for the health and wellbeing of community.
- Each employee will be made to comply with the HSE guidelines and the laws applicable to their area of operational responsibility.

10.6 Occupational Health Surveillance

In Thermal Power plant, the occupational health surveillance of the employee is being/ will be done on a regular basis and records of the same are being/ will be maintained as per the Factories Act. The occupational health surveillance Programme has been / will include lung function; sputum analysis and audiometric analysis on regular basis to observe any contraction due to exposure to dust and noise and corrective measures are/ will be taken accordingly.

Vocational training programmes are/ will also be conducted. Under vocational training the workers will be given training related to all safety and health aspects pertaining to their vocation and special training courses/ Awareness Programme for Malaria eradication, HIV and health effects on exposure to dust, heat, noise, chemicals are/ will be organized periodically for employed person.

Periodical medical camps are/ will be organized with specialized doctors of various disciplines to provide the specialized medical assistance to employees as well as neighbouring communities. Annual sample report of health status of worker with special reference to Occupational Health and Safety has been enclosed as **Annexure 10.1** along with this EIA/EMP Report.

A. List of Equipment for Occupational Health Monitoring

- ECG
- Noise Monitoring device (dosimeter)
- Spiro meter
- X-ray machine
- Audiometric device
- Vision screener
- Tele Medicine Facility

B. Pre-Placement and Periodical Health Status

Pre/Post-employment Periodical checkup is being/ will be carried out and following test will be conducted:

- BMI (Body Mass Index)
- Chest x ray PA view
- Vision testing (Far & Near vision, color vision and any other ocular defect)
- ECG
- Haemogram (examination of the blood)
- Blood Pressure &Blood Sugar Fasting

- Serum Cholesterol
- Liver Function Test (S. Bilirubin, Alk. Phosphatase, SGOT and SGPT)
- Complete physical examination
- Post-employment Periodical occupational health check-up such as lung function, audiometry, CBC, Blood Sugar, Lipid Profile etc.
- Medical records of each employee will be maintained separately and will be updated as per finding during monitoring.
- Medical records of the employee at the end of his / her term will be updated.

C. Frequency of Medical Examination

As per Factory Act, Frequency of Medical Examination are-

- Pre-Placement Medical examination: Prior to joining
- Periodical Medical examination: After every 1 year

D. Personal Protective Devices and Measures

- Industrial Safety helmets,
- Face shield
- Safety goggles and Gas Cutting Goggles
- Welders equipment for eye and face protection i.e. welding shield
- Ear muffs and Ear Plugs
- Full body Safety harness
- Hand gloves, Asbestos hand gloves, Electrical hand gloves, Heat Resistive hand gloves, Chemical hand gloves and Cut resistance hand gloves
- Safety net, Barricading net
- Industrial safety shoes with steel toe
- Electrical safety shoes without steel toe and Gum boots
- Retractable and fall arrestors
- Reflective Jackets
- Protective clothing, Dangari etc.
- Safety belt / line man's safety belt
- Rope grabs fall arrestor.

E. Anticipated Occupational &Safety Hazardous

- Heat Stress and Stroke
- Physical activity
- Dehydration
- Skin disorders
- Dust Exposure
- Noise
- Burns and shocks due to electricity

10.7 Implementation of OHS standards as per OSHAS/ USEPA

The overall objective of the company is to provide a system that is capable of delivering healthy and safe workplace. Following measures will be adopted for implementation of OHS standards.

- Well-equipped Occupational Health Centre with adequate paramedical staff
- Routine and special investigation related to occupational health
- Health surveillance and maintenance of health record
- Rules and procedure for effective implementation of Safety Health and Environment policy and made to know all employees
- Round the clock Ambulance facility
- Sufficient number of First aid boxes
- Implementation of ISO45001 for Occupational Health and Safety Management System
- Implementation of ISO 14001 for Environment Management System
- Formulation of OHS implementation team/ cell
- Risk assessment of each and every activity
- Implementation of OHS management program
- Displaying the safety and health policy and instructions at various locations
- Display of safe operating procedure (SOP) at various locations
- Job safety analysis
- Carry out daily plant safety inspection by internal safety department
- Investigation of fatal, serious accidents and near miss accident and it its reporting
- Investigation of reports of occupational diseases
- Monthly safety meeting of all employees & workers to discuss last month accident if any, reason and corrective measures taken.
- Organize campaigns, competitions, contests etc. to promote safety
- Organize safety training, seminars for safe working and safe vehicle and traffic movement within the plant premises and regular training for safe driving outside the plant premises
- Prepare annual reports of accidents and occupational diseases.
- Ensure use of PPEs according to the job like helmet, safety shoes, goggle, dust mask, ear plug and hand gloves etc.
- Establishment of Occupational Health Centre for pre and periodic medical examination of workers and staff to detect any onset of occupational disease and corrective manures
- Display Material Safety Data Sheets (MSDS) for use of every hazardous substance
- Periodic Safety Audits both internal and external, review and implementation of recommendations.
- Taking factory license from factory inspectorate
- Review of legal compliances and report to management
- Ensuring implementation of work permit system
- Conducting promotional and motivational activities to improve the safety of the plant

Medical Facilities

The medical facility is being/ will adequately be manned by doctors and paramedical staff to provide round the clock services in case of any emergency.

Investigation Facility

Full-fledged pathological laboratory, X-ray machine with routine and specialized investigation facilities are being/will be made available at the plant.

Ambulance Services

The Health Centre is being/ will be provided with an ambulance to bring the patients to Health Centre in case of emergency.

First Aid Boxes

First aid boxes are being/ will be provided at prominent places with following items:

- Small size sterilized dressing.
- Medium size sterilized dressing.
- Large size sterilized dressing.
- Burnol Ointment.
- Packets of sterilized cotton wool.
- Bottle (120 ml) of cetrimide solution (1%) of suitable antiseptic solution.
- Mercurochrome solution (in 2% water).
- Scissors.
- Adhesive plaster (2cm x 1 m).
- Sterilized eye pads in separate sealed packets.
- Aspirin tablets.
- Potassium Permanganate crystals.

First aid boxes will be kept in every department for emergency. First aid training will be organized for the employees.

10.8 Ash Utilisation Plan

Fly ash will be collected in dry form in silos for subsequent utilization or transportation via rail wagons or bulk trucks to nearby cement plants. The existing Anuppur STPP Stage-I (2x630 MW) has already achieved 100% ash utilization from last six years. Moving forward, all ash will be fully utilized in cement manufacturing, reclamation of abandoned mines, brick production, road construction, and as an aggregate replacement in concrete, in compliance with the Fly Ash Notification of December 31, 2021. For any unutilized ash, provisions will be in place to dispose of it in high-concentration slurry form to the ash dyke. Ash Generation and Utilization Data of Stage-I from 2018-19, 2019-20, 2020-21, 2021-22, 2022-23 and 2023-24 in **Table 10.1**

Table 10-1: Ash Utilization Report from 2018-19 up to 2023-2024

FLY ASH UTILIZATION			
Period	**Total Ash generation (MT)**	**Total Ash Utilization (MT)**	**% Utilization**
2018-19	1577875.30	1635958.00	103.68

FLY ASH UTILIZATION			
Period	**Total Ash generation (MT)**	**Total Ash Utilization (MT)**	**% Utilization**
2019-20	1552755.00	1598765.00	102.96
2020-21	1540524.00	1751594.64	113.7
2021-22	2184816.659	2189356.102	100.21
2022-23	2117475.21	2155390.612	101.79
2023-24	2295675.29	2311283.00	100.7
Total	11269121.46	11642347.35	103.84
Total Ash in Ash Pond as on 31-03-2024		**73445.40**	

A Detail Ash Utilization Plan has been prepared from FY 2021-22 to 2023-24:

- As per MoEF&CC Fly Ash Notification on dated 31.12.2021, starting w.e.f. April 2022, all TPPs to utilise 100% current ash (fly ash and bottom ash) generated during that year with minimum utilization of 80% every year in 03-year cycle while achieving average 100% AU in each 03-year cycle. However, there is relaxation of two years for Plants with Ash utilization below 60 % in FY 2021-22.

- Since Ash utilization in Financial Year 2021-22 was 100 %, 03-year cycle shall start from April 2024. So accordingly, Ash Utilization Plan For MOEF&CC 3-Compliance Cycle (from FY 2023-24 to FY 2032-33) is given below.

Table 10-2: Fly Ash Utilization from FY 2021-22 to FY 2023-24

Fly Ash Utilization

Year	Fly Ash Generation	Fly ash [based product Bricks, blocks or tiles	Cement Manufacturing`	Ready mix concreate	Ash and Geo-polymers based construction material	manufacturing of sintered or cold bonded ash aggregates & Other Industries	Construction of Roads/ Fly over embankments	Construction of dams	Filling of low laying areas	Filling of mine voids	Use in overburden dumps	Agriculture	Construction of Shoreline protection structures	Export of ash to other countries	Others	Total Ash Utilized (LMT)	Ash Utilization (%)
Operating 2x630 MW																	
2021-22	1.75	0.015	0.93	0.00	0.00	0.00	0.00	0.00	0.8		0.00	0.00	0.00	0.00	0	1.7490	100
2022-23	1.77	0.055	1.168	0.00	0.00	0.00	0.00	0.00	0.463	0.084	0.00	0.00	0.00	0.00	0	1.77	100
2023-24	1.83	0.003	0.75	0.00	0.00	0.00	0.00	0.00	0.19	0.89	0.00	0.00	0.00	0.00	0	1.831	100

Table 10-3: Bottom Ash Utilisation from 2021-22 to 2023-24

Bottom Ash Utilization

Year	Fly Ash Generation	Fly ash [based product Bricks, blocks or tiles	Cement Manufacturing`	Ready mix concreate	Ash and Geo-polymers based construction material	manufacturing of sintered or cold bonded ash aggregates & Other Industries	Construction of Roads/ Fly over embankments	Construction of dams	Filling of low laying areas	Filling of mine voids	Use in overburden dumps	Agriculture	Construction of Shoreline protection structures	Export of ash to other countries	Others	Total Ash Utilized (LMT)	Ash Utilization (%)
Operating 2x630 MW																	
2021-22	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0	0.00	0.00	0.00	0.00	0	0.43	100.00
2022-23	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.09	0.00	0.00	0.00	0.00	0	0.35	100.00
2023-24	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.33	0.00	0.00	0.00	0.00	0	0.46	100.00

Table 10-4: Ash Utilization Plan for next 10 years.

Ash Management Plan upto 10 years																				
Year	**2025-26**		**2026-27**		**2027-28**		**2028-29**		**2029-30**		**2030-31**		**2031-32**		**2032-33**		**2033-34**		**2034-35**	
Capacity (MW)	1250		1250		1250		1250		1250		2850		2850		2850		2850		2850	
Coal Fired (MT)	6132000		6132000		6132000		6132000		6132000		13980960		13980960		13980960		13980960		13980960	
Description	**Quantity**		**Quantity**		**Quantity**		**Quantity**		**Quantity**		**Quantity**		**Quantity**		**Quantity**		**Quantity**		**Quantity**	
	MT	**% age**	**MT**	**% age**	**MT**	**% age**	**MT**	**% age**	**MT**	**% age**	**MT**	**% age**	**MT**	**% age**	**MT**	**% age**	**MT**	**% age**	**MT**	**% age**
Ash Generation	2452800		2452800		2452800		2452800		2452800		5592384		5592384		5592384		5592384		5592384	
Abandoned Mines	1387000	56.55%	730000	29.76%	730000	29.76%	730000	29.76%	730000	29.76%	1898000	33.94%	1898000	33.94%	1898000	33.94%	1898000	33.94%	1898000	33.94%
Low Lying areas	329750.5	13.44%	69350	2.83%	69350	2.83%	69350	2.83%	69350	2.83%	365000	6.53%	365000	6.53%	365000	6.53%	365000	6.53%	365000	6.53%
By Road to Cement Plant	365000	14.88%	182500	7.44%	182500	7.44%	182500	7.44%	182500	7.44%	365000	6.53%	365000	6.53%	365000	6.53%	365000	6.53%	365000	6.53%
By Rake to Cement Plant	360000	14.68%	1460000	59.52%	1460000	59.52%	1460000	59.52%	1460000	59.52%	2920000	52.21%	2920000	52.21%	2920000	52.21%	2920000	52.21%	2920000	52.21%
Brick Plant	11049.65	0.45%	10950	0.45%	10950	0.45%	10950	0.45%	10950	0.45%	44384	0.79%	44384	0.79%	44384	0.79%	44384	0.79%	44384	0.79%
Ash Utilization	**2452800**	**100.00%**	**2452800**	**100.00%**	**2452800**	**100.00%**	**2452800**	**100.00%**	**2452800**	**100.00%**	**5592384**	**100.00%**	**5592384**	**100.00%**	**5592384**	**100.00%**	**5592384**	**100.00%**	**5592384**	**100.00%**

Bottom Ash System:

- The bottom ash and coarse ash slurry from all the units will be transported from the bottom ash slurry disposal pump house using slurry duty pumps.
- In the case of a dry bottom ash extraction system, the ash will be transported to the Ash Pond.
- In the case of a wet bottom ash extraction system, the ash will be transported to either the Ash Pond or dewatering bins.
- Each pumping stream will have its own dedicated disposal pipes.
- No crossover is planned for the disposal piping between the different streams.

Fly Ash System:

- Fly ash from the ESP hoppers and APH hoppers will be evacuated in dry mode pneumatically.
- Fly ash will be stored in 3 Nos. buffer silos each 2000 T capacity.
- From the buffer silos fly ash will be transported to 4 Nos. remote silos each 1000T capacity.
- Remote silos will be equipped with closed wagon loading facility for the dry fly ash.
- Ash conditioners for conditioned ash disposal is also available in the Remote silos.
- Buffer silos will have bulker loading options for transport to cement companies.
- Fly ash will be converted into slurry in the buffer silo and transported to ash dyke in case of emergency.
-

Ash Water System:

- An ash water re-circulation system is proposed to comply with environmental regulations.
- Decanted water from the ash pond will be pumped back to the plant using 915 m3/hr capacity ash water recirculation pumps.
- This recycled water will be conveyed through pipes from the ash dyke to the plant area for use in the ash handling system.
- A blowdown process will be implemented to maintain a scale-free system.
- The normal makeup water for the ash system will be sourced from the cooling water (CW) blowdown water.
- Provision will be made to operate the ash water system in a "Once Through" mode when recycled ash water is unavailable.
- During "Once Through" mode, additional makeup water will be supplied from the plant's raw water reserves.
- An ash pond fugitive dust suppression system will be installed in the ash dyke area to control dust emissions.

Ash Pond:

- Efforts to promote ash utilization, with unutilized ash disposed in Ash Dyke if necessary.
- Ash Dyke are provided with adequate HDPE liners, with green belt, raised in stages, and with an Ash water recovery system.

Mill Reject System:

- A Mill Reject system will be implemented to handle mill rejects continuously.
- The system's capacity must be at least 1% of the mill's design capacity for the worst quality coal, or whichever is higher, accounting for the maximum number of operational mills.
- Each mill will be equipped with a pyrite hopper to collect mill rejects.

- Mechanical conveyors will transport the mill rejects from the mill area to a storage silo.
- The storage silo will have the capacity to hold 16 hours' worth of mill rejects for all units.
- From the storage silo, the mill rejects will be loaded onto trucks for disposal.

10.9 Plastic Waste Management Plan

The Government of India notified Plastic Waste Management (PWM) Rules, 2016 on 18th March, 2016.As per the Rule '5(b)' of PWM Rules, 2016,'local bodies shall encourage the use of plastic waste for road construction as per Indian Road Congress guidelines or energy recovery or waste to oil etc. The standards and pollution control norms specified by the concerned prescribed authority for these technologies shall be complied with.'

Plastics are made from long chains of hydrocarbons derived from petroleum products. Broad range of application of plastics are in packaging films, wrapping materials, shopping and garbage bags, fluid containers, clothing, toys, household & industrial products, medicinal applications, packaging and storage of food and other perishable items, electronic and electrical applications and building materials etc. Many petro-based plastics are non-biodegradable and remain a cause of concern in the environment for several years, thus becoming an eyesore. However, its uses are increasing day by day due to low cost and convenience.

As per BIS, there are '7' different types of plastics. Short name, chemical name and general uses of different types of plastics are shown in **Table-10.5.**

Table 10-5: Different types of Plastic & it's uses.

SN	Short Name	Scientific Name	Uses
01	PET	Polyethylene terephthalate	Soft drink bottles, furniture, carpet, paneling etc.
02	HDPE	High-density polyethylene	Bottles, carry bags, milk pouches, recycling bins, agricultural pipe, base cups, playground equipment etc.
03	PVC	Polyvinyl chloride	Pipe, Window profile, fencing, flooring, shower curtains, lawn chairs, non-food bottles and children's toys etc.
04	LDPE	Low-density polyethylene	Plastic bags, various containers, dispensing bottles, wash bottles, tubing etc.
05	PP	Polypropylene	Auto parts, industrial fibers, food containers, dishware etc.
06	PS	Polystyrene	Cafeteria trays, plastic utensils, toys, video cassettes and cases, clamshell containers, insulation board etc.
07	O	Other	Thermoset Plastics, Multilayer Packaging and Laminates, Bakelite, Polycarbonate, Nylon SMC, FRP etc.

Category of Plastic: Plastics are generally categorized into two types:

- **Thermoplastics:** Thermoplastics or Thermo-softening plastics are the plastics which soften on heating and can be moulded into desired shape. The examples of Thermoplastics are PET, HDPE, LDPE, PP, PVC, PS, etc.
- **Thermosets:** Thermoset or thermo-setting plastics get moulded on heating, but cannot be remolded or recycled subsequently. The examples of Thermoset plastics are Sheet Moulding Compounds (SMC), Fiber Reinforced Plastic (FRP), and Bakelite etc. are the examples of the same.

Generally, the thermoplastics are recyclable plastics and thermosets are non- recyclable plastics. However, due to the contamination, technical or economic considerations a large quantity of thermoplastic waste remains non-recyclable and littered in the environment. Some of the typical examples of multilayered and non-recyclable plastics materials- that include both thermoplastics and thermosets are shown in **Table 10.6**.

Table 10-6: Source and Uses of Non-recyclable Plastic Waste.

S. No.	Sources	Uses
1	Food packaging	Multilayered films are used for packing of biscuits, namkeen, chips, edible oil, juices etc.
2	Pharmaceutical& cosmetics products	Multilayered packing for packing of medicines, tablets and cosmetics etc.
3	Electrical and electronic goods	Multilayered films such as bubble raps, laminates are used for packing of electrical and electronic items, housing, fuses, switchgear, MCB boxes etc..
4	Item used for food storage & serving	Thermocol products such as plates, cups etc. are used for serving food, tea, coffee etc. Also used as fillers in packing of goods/items etc.
5	Automotive industry and mass transportation	Cars, trucks and other commercial and agricultural vehicles, trains, trams, light railways and monorail (body parts, structure and engine parts)
6	Building & construction	Civil engineering and household fixtures etc.
7	Domestic appliances	Coffee machines, toasters, irons etc.
8	Sanitary	Bathroom suites and hygienic surfaces etc.

Definition (as per Plastic Waste Manage Rule 2016)

- **Application:** These rules shall apply to every waste generator, local body, Gram Panchayat, manufacturer, Importers and producer.
- **Carry bags:** mean bags made from plastic material or compostable plastic material, used for the purpose of carrying or dispensing commodities which have a self-carrying feature but do

not include bags that constitute or form an integral part of the packaging in which goods are sealed prior to use.

- **Commodity:** means tangible item that may be bought or sold and includes all marketable goods or wares;
- **Compostable plastics**: mean plastic that undergoes degradation by biological processes during composting to yield CO2, water, inorganic compounds and biomass at a rate consistent with other known compostable materials, excluding conventional petro-based plastics, and does not leave visible, distinguishable or toxic residue;
- **Consent:** means the consent to establish and operate from the concerned State Pollution Control Board or Pollution Control Committee granted under the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974), and the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981);
- **Disintegration:** means the physical breakdown of a material into very small fragments;
- **Extended producer's responsibility:** means the responsibility of a producer for the environmentally sound management of the product until the end of its life;
- **Food-stuffs:** mean ready to eat food products, fast food, processed or cooked food in liquid, powder, solid or semi-solid form;
- **Facility:** means the premises used for collection, Storage, recycling, processing and disposal of plastic waste;
- **Importer:** means a person who imports or intends to import and holds an Importer -Exporter Code number, unless otherwise specifically exempted.
- **Institutional waste generator:** means and includes occupier of the institutional buildings such as building occupied by Central Government Departments, State Government Departments, public or private sector companies, hospitals, schools, colleges, universities or other places of education, organization, academy, hotels, restaurants, malls and shopping complexes;
- **Manufacturer:** means and include a person or unit or agency engaged in production of plastic raw material to be used as raw material by the producer.
- **Multilayered packaging:** means any material used or to be used for packaging and having at least one layer of plastic as the main ingredients in combination with one or more layers of materials such as paper, paper board, polymeric materials, metalized layers or aluminum foil, either in the form of a laminate or co-extruded structure;
- **Plastic:** means material which contains as an essential ingredient a high polymer such as polyethylene terephthalate, high density polyethylene, Vinyl, low density polyethylene, polypropylene, polystyrene resins, multi-materials like acrylonitrile butadiene styrene, polyphenylene oxide, polycarbonate, Polybutylene terephthalate;
- **Plastic sheet:** means Plastic sheet is the sheet made of plastic;
- **Plastic waste:** means any plastic discarded after use or after their intended use is over;
- **Producer:** means persons engaged in manufacture or import of carry bags or multilayered packaging or plastic sheets or like, and includes industries or individuals using plastic sheets or like or covers made of plastic sheets or multilayered packaging for packaging or wrapping the commodity;
- **Recycling:** means the process of transforming segregated plastic waste into a new product or raw material for producing new products;

- **Registration:** means registration with the State Pollution Control Board or Pollution Control Committee concerned, as the case may be;
- **Local body:** means urban local body with different nomenclature such as municipal corporation, municipality, nagarpalika, nagarnigam, nagarpanchayat, municipal council including notified area committee (NAC) and not limited to or any other local body constituted under the relevant statutes such as gram panchayat, where the management of plastic waste is entrusted to such agency;
- **Virgin plastic:** means plastic material which has not been subjected to use earlier and has also not been blended with scrap or waste;
- **Waste generator:** means and includes every person or group of persons or institution, residential and commercial establishments including Indian Railways, Airport, Port and Harbour and Defense establishments which generate plastic waste;
- **Waste management:** means the collection, storage, transportation reduction, re-use, recovery, recycling, composting or disposal of plastic waste in an environmentally safe manner;
- **Waste pickers:** mean individuals or agencies, groups of individuals voluntarily engaged or authorised for picking of recyclable plastic waste.

Scope:

Generated plastic waste will be collected from all the unite /departments of plant, township, hostel, hospital, school and Samvet Bhawan and will be handed over to store department. Department heads have to ensure for its proper handing over to store department for disposal through co-processing or supply to authorized recyclers.

Estimation of Plastic Waste Generation:

- At present, estimated quantity of plastic waste generation from plant (2.x 630 MW) and township is 1.0 MT per year.
- After Establishment of proposed (2.x 8000 MW) phase-II this quantity may be increased from 1 MT to 2.5 MT per year.

Disposal of Plastic Waste as co-processing:

Co-processing is a more environmentally friendly and sustainable method of waste disposal as compared to land filling and incineration because of reduced emissions and no residue after the treatment. Co-processing refers to the use of waste materials in industrial processes as alternative fuels or raw material (AFR) to recover energy and material from them. Due to the high temperature in cement kiln and sponge iron kiln different types of wastes can be effectively disposed without harmful emissions. As per the Basal Convention, variety of wastes including hazardous wastes, get disposed in an environmentally safe and sound manner through the technology of co-processing in cement and sponge iron kiln. Disposal of different categories of plastic wastes through co-processing is practiced in many countries as a regular method for their environmentally sound disposal. This practice has also started in India since a few years ago and most of the cement companies are using plastic waste in the kiln.

Authorized Vendor / Agency nearby area

- At present, M/s. A.C.C. Ltd., (Kymore Cement Works) Kymore, City : Khalwara, Tal : Vijayraghogarh, Dist : Katni 483880 (M.P.) has been identified to supply the plastic waste for co-processing in cement kiln.
- In future, more parties may be identified to supply of plastic waste for co-processing/ recycling.

Responsibility of respective departments:

(1) All HOD's will be responsible for collection, storage and handing over plastic waste to store department time to time.

(2) The HOD Admin is responsible for collection, segregation, transportation and handing over to store of plastic waste generated from hospital, school, hostel, township and offices of the different department of the plant.

(3) HOD admin will be responsible for complete ban on the single use plastic in all premises of company without deviation, discourage use of artificial flowers, decorative material made of plastic, reuse of plastic based material wherever possible.

(4) HOD Store will maintain the record of generation of plastic. Store department will be responsible for its proper storing so that it could not be spread here and there. After collection of sufficient volume, store will intimate to Procurement department for supply of plastic to authorized party within one month.

(5) HOD Procurement will be responsible for supply of plastic waste to authorized party for recycling or co-processing on time.

(6) HOD EHS will provide support for identification of authorized party from nearby area or from wherever possible.

(7) HOD EHS will be responsible for creating awareness among employee, associates and township residents (Through training/ Quiz/ Display Board etc.).

(8) HOD Environment will be responsible for Registration with MPPCB and its renewal for disposal/co-processing of plastic waste (if required).

10.10 Environment Enhancement Measures

10.10.1 Solar Power Harnessing

For harnessing solar power, the building structures will be so designed that daylight enters the shops through roofs. Daylighting can be especially helpful in industrial environments where natural light is often non-existent, presenting a prime opportunity for implementation.

10.10.1.1 Windows and Skylights

Incorporating windows and skylights is the most popular option for introducing natural light into a building.

To ensure the effectiveness of windows and skylights, correct placement is essential. The selection and placement of windows and skylights should be determined by the amount of light needed, regional climate, security requirements and the design of the building. This will be done during detailed engineering stage.

10.10.1.2 Tubular Daylight Devices (TDDs)

Tubular daylighting devices are a versatile alternative to traditional skylights because they can be used to provide light to areas that are not in a direct line of sight with the sun. Tubular daylighting devices (TDDs) utilize a rooftop dome to harness sunlight, which is then directed through a reflective tube. TDDs are more effective than traditional skylights or windows because of the reflective tubing, delivering maximum daylight with minimal heat transfer.

10.10.2Greenbelt

The green belt will be composed of indigenous and rapidly growing tree species. Additional trees will be strategically planted around the coal stockpile and ash disposal areas to reduce fugitive dust pollution.

It is preferable to cultivate a diverse mix of tree species rather than relying on monocultures. Line and rows of green belt will be break with the resistant tree species. This practise will help in improving the life of green belt by improving the disease resistance. The treated sewage water will be used for developing the green belt area. The survival rate of trees & plantation should be more than 90%, and it can be achieved by proper administration and good technical skill.

Out of the total area for the Existing plant of 417.996 Ha, greenbelt encompasses 110.33 Ha, accounting for 26.4% of the project area. Density of 2500 trees/ha will be maintained. A total of more than 2 lakh trees have been already planted within the plant premises. Further, -45.991 Ha land is proposed to be developed as greenbelt & plantation inside and outside MBPMPL premises. The greenbelt shall have 3-tier plantation as per the CPCB guidelines with re-densification & strengthening of existing greenbelt. Details of tree plantation in Stage-I is given in **Table 10.7** and a green belt development plan for Stage-II is given **Table-10.8.**

Table 10-7: Tree Plantation from 2014-15 up to 2023-2024

Period	Plantation inside plant premises, Nos	Plantation outside plant premises, Nos	Total trees planted, Nos
2015-16	128952	250	129202
2016-17	25893	0	25893
2017-18	21905	100	22005
2018-19	17413	0	17413
2019-20	13748	0	13748
2020-21	14944	1200	16144
2021-22	16290	0	16290
2022-23	20014	2000	22014

Period	Plantation inside plant premises, Nos	Plantation outside plant premises, Nos	Total trees planted, Nos
2023-24	10402	1500	11902
Township area (2015-23)	3439	0	3439
2024-25*	8700	600	9300
Total	**281700**	**5650**	**287350**
Approximate cost incurred toward plantation is Rs. 5 Cr. (till 2023-24) **Plantation work for FY 2024-25 is in progress.*			

Figure 10-2: Existing green belt plantation.

10.10.2.1 Site Assessment:

Area: Current plantation is done for 110.33 Ha. Target area to achieve 33% of plantation is 45.991Ha.

Table 10-8: Existing and proposed Green belt area.

Existing Plant Area (Ha)	Existing Green belt (Ha)	Percentage (%)	Proposed Plant Area (Ha)	Target Green Belt Area (Ha)	Percentage (%)	Gap Area for Plantation (Ha)
417.996	110.33	26.4	45.202	148.629	33	45.991

The following plan is to develop green belt in the 45.991 ha to achieve 33% of the total Project area. The existing green belt spans 110.3 Ha. For the proposed expansion, the target area for green belt development is 148.629 Ha, which will constitute 33% of the total plant area. However, as 7.681 Ha of the existing green belt will be repurposed for other used, the resultant gap area requiring new plantation has been identified as 45.991 Ha.

Climate Conditions:

- Temperature range: 9°C to 40°C

- Annual Average rainfall: 1268.68 mm (primarily during monsoon)

- Topography: Ensure proper drainage; identify slopes or depressions.

10.10.2.2 Species Selection:

Plant species were selected based on the DFO approved native flora list.

Tree Layer (Tall Trees):

1. *Shorea robusta* (Sal)
2. *Terminalia arjuna* (Arjun Tree)
3. *Tectona grandis* (Teak)
4. *Albizia lebbeck* (Siris Tree)
5. *Sterculia urens* (Kullu)
6. *Albizia procera* (Safed Siris)
7. *Dalbergia sissoo* (Shisham)
8. *Ficus religiosa* (Peepal)
9. *Madhuca indica* (Mahua)
10. *Azadirachta indica* (Neem)
11. *Bauhinia variegata* (Kachnar)
12. *Syzygium cumini* (Jamun)
13. *Ziziphus jujuba* (Ber)
14. *Acacia catechu* (Khair)
15. *Butea monosperrma* (Palash)
16. *Cochiospermum religlosum* (Galgal)
17. *Ficus hispida* (kotgular)

18. *Mangifera indica* (Aam)

19. *Schieichera oleosa* (Kushum)

20. *Pterocarpus marsupium* (Bijasal)

Shrub Layer:

1. *Carissa carandas* (Karonda)

2. *Clerodendrum infortunatum* (Glory Bower)

3. *Vitex negundo* (Nirgundi)

4. *Cassia tora*

5. Calotropis procera (Aiton) (Gulabiaak)

6. *Carissa opaca*

7. *Ricinus communis* (Arandi)

8. *Zizyphus rugosa* (Patodi)

9 *Jatropha curcas* (Ratanjot)

10. *Euphorbia neriifolia* (Sehud)

Ground Cover Layer (Grasses and Herbs):

1. *Vetiveria zizanioides* (Vetiver)

2. *Cymbopogon citratus* (Lemongrass)

3. *Chloris barbata*

4. *Bacopa monnieri* (Bacopa)

5. *Hibiscus sabdariffa* (Amrona)

6. *Euphorbia fusiformis* (Jungle Muli)

7. *Oxalis corniculate* (Changori)

8. *Limnophila rugosa* (Meethi Patti)

9. *Leucas aspera* (Bhodki)

10. *Indigofera linifolia* (Tokari)

10.10.2.3 Plantation Plan:

A. Preparation:

- Clear debris and weeds from the site.
- Enrich soil with compost, organic manure, and microbial inoculants.
- Ensure soil moisture by mulching with organic material.

B. Planting Design:

- Create clusters of species with varying heights to mimic natural forest stratification.
- Spacing:
  - Trees: 0.5–1 meter apart
  - Shrubs: 0.3–0.5 meters apart
- Plant approximately 2,500 trees per hectare.

C. Watering:

- Install drip irrigation systems for the initial two years.
- Schedule daily watering for the first three months, reducing gradually.

D. Maintenance (First 3 Years):

- Regular weeding every 2-3 months.
- Monitor for pests and diseases.
- Apply organic fertilizers if necessary.

E. Fencing:

- Protect the plantation site from grazing or human interference using chain-link or bio-fencing with thorny shrubs like *Carissa carandas*.

10.10.2.4 Estimated Budget:

Approximate Cost per Hectare: ₹ 23 lakhs

Table 10-9: Cost estimation per hectare green belt development over 5 years

	Activity	Details	Cost (₹)
Site Preparation Costs	**Site Clearing**	Removing debris, weeds, and existing vegetation.	50,000
	Soil Testing	Lab analysis for pH, nutrients, and texture.	10,000
	Soil Preparation	Adding compost, manure, and organic matter.	1,50,000
	Mulching	Organic mulch (e.g., straw or wood chips).	30,000

	Land Levelling (if required)	Grading and drainage adjustments.	40,000
Seedling Procurement and Planting Costs	**Seedling Cost**	Approx. 2,500 saplings (native species) at ₹180/sapling.	4,50,000
	Transport of Saplings	From nursery to site.	30,000
	Planting	Labor for planting (₹10 per sapling).	3,00,000
Irrigation System Costs	**Drip Irrigation Setup**	Pipes, emitters, pumps, and fittings for 1 hectare.	1,50,000
	Water Storage Tank	For temporary water storage (5,000 liters capacity).	50,000
	Water Supply Cost	Transportation and refilling for the first 2 years.	60,000
Fencing and Protection Cost	**Fencing**	Chain-link fencing or bio-fencing (Karonda shrubs).	2,50,000
	Signage and Awareness Boards	Informational boards for awareness.	20,000
Maintenance Cost for 1st 3 years	**Watering**	Regular irrigation (manual and drip).	50,000
	Weeding and Mulching	Removing weeds and reapplying mulch.	30,000
	Fertilizer and Pest Control	Organic fertilizers and pest management.	30,000
	Labor for Monitoring	Quarterly monitoring and replacement of dead saplings.	60,000
Contingency Cost	**Miscellaneous Costs**	Tools, transportation, and unforeseen expenses.	50,000
	Contingency	5% of total project cost for contingencies.	1,50,000

Overall Cost Prediction

Table 10-10: Cost estimation

Site Preparation	2,80,000
Seedling Procurement & Planting	7,80,000
Irrigation Setup	2,60,000
Fencing and Protection	2,70,000
Maintenance (3 Years)	5,10,000
Miscellaneous and Contingency	2,00,000
Total	**23,00,000**

The total land area designated for green belt development is 45.991 hectares, with an estimated cost of Rs. 1057.793 lakhs for its development.

10.10.2.5 Monitoring and Evaluation:

- Quarterly survival surveys to ensure a survival rate of at least 85%.

- Replace any dead or unhealthy plants within the first two years.

- Long-term evaluation every five years to track biodiversity and ecosystem benefits.

This plan ensures ecological restoration around Anuppur Thermal Power Plant while aligning with sustainability goals.

10.10.2.6 Implementation Timeline:

The site preparation time is estimated to be one year. Timeline for developing 1ha of land for green belt is given in the following table.

Table 10-11:Implementation timeline

Phase	Activity	Timeline
Site Preparation	Land clearing, soil enrichment	Month 1
Plantation	Planting of seedlings	Months 2–3
Maintenance Phase 1	Watering, mulching, weeding	Months 4–12
Maintenance Phase 2	Pest management, monitoring	Years 2-3

The whole area envisaged for green belt is 45.991 ha. For the purpose of developing green belt in the area the designated area is divided into 3 equal parts of 15.33 ha. The year wise development of the green belt is shown in the chart below-

Table 10-12: Five-year plan for developing Green-belt within the Project Site.

Months-	1	2	3	4	5	6	7	8	9	10	11	12	
Year 1	Site Preparation of Patch 1												
		Plantation											
				Maintenance Phase I (Watering, Mulching, Weeding)									Maintenance Phase 2 Pest management, monitoring)
Year 2	Site Preparation of Patch 2												
		Plantation											
				Maintenance Phase I (Watering, Mulching, Weeding)									
Year 3	Site Preparation of Patch 3												
		Plantation											
				Maintenance Phase I (Watering, Mulching, Weeding)									
											Replacement of non-survival plants		
Year 4	Continued Maintenance Phase 2 Pest management, monitoring) for Patch 2 and 3												
Year 5	Replacement of non-survival plants												
	Continued Maintenance Phase 2 Pest management, monitoring) for Patch 2 and 3												

Green Belt by afforestation is a key element in environment conservation and protection. The establishment of a vegetation covering land in and around the proposed thermal power plant will result in many direct and indirect benefits as:

- Plants can absorb a wide variety of atmospheric pollutants emitted from thermal power plant and attenuates the noise levels.
- Plants will be able to control the build-up of atmospheric greenhouse gases (e.g., CO2) that are emitted during power generation and thereby will postpone global warming.
- Afforestation will help restore the eco dynamics around the plant. It checks soil erosion and increases soil fertility.
- A green belt acts as a buffer zone and increases the aesthetic value of the surrounding area by adding to the greenery and providing a visual filter.
- A green belt will also compensate the vegetation loss during the construction phase and will help in reclamation of land used for ash disposal.
- Provision of one third land of the project area will help in complying with the statutory requirements.

An appropriate greenbelt plantation programme is envisaged for expansion as per CPCB guidelines which will help in establishing the harmony with the environment of the proposed power plant and surrounding environment. The above tree plantation program would consider the following:

- Native plant species would be preferred for green belt development. Introduction of monocultures and alien plant species would be avoided.
- Heterogeneous native tree species will be selected and planted considering soil and climate adaptability, flowering, growth characteristics, canopy structure and resistance to pollution load.

A nursery will be maintained at site or sapling may be taken from local forest nursery to develop good planting stock to meet the plantation requirements.

10.10.3 Rainwater Harvesting

Summary of rainwater of last 30 years as per IMD climatological normal is given in **Table 3.12** of Chapter 3. The effective area available for the rainwater harvesting is tabulated in the **Table 10.13**. The effective area is considered on the basis of rainwater harvesting comes in contact with other possible contaminants. The average annual rainfall is taken as 1268.68.6mm.

Table 10-13: Rainwater available for harvesting

S No	Description	Total Area (m^2)	Effective area considered for Rainwater Harvesting	Average Annual Rainfall (m)	Coefficient as per annexure IV of revised guidelines for NOC, CGWA, 2017	Water available for Rainwater Harvesting (m^3)
1	Plant Area	17,92,230	16,13,000	1.2	0.7	13,54,920
2	Road/paved area (Switchyard, weigh bridge, road, tank etc.)	80970	73,000	1.2	0.6	52,560
3	Green belt	15,27,670	13,75,000	1.2	0.2	3,30,000
Total						**17,37,480**

The rainwater available for harvesting is calculated 17,37,480 m3 or 1.7 MCM per annum (Table 10.13). There is no extraction of groundwater for project. Provision is made for rainwater harvesting to collect stormwater from roof top, road/paved areas, greenbelt and open areas. Refer **Table 10.13** for Rainwater available for harvesting.

Water Saving:

- To the possible extent water is saved at each point of use by taking proper care in maintenance of drain pipe, tap etc. from leakage. There should be display board for optimum use of water in washroom, toilet or at other appropriate locations.
- Use of recycled water, if possible, in cleaning of toilets or gardening after proper treatment and testing for its intended use.
- Use of sprinkler or drip irrigation method in garden irrigation.
- Adoption of machinery– equipment, methods, if possible and economic viable, for manufacturing.
- Appropriate plantation to reduce evaporation.

Maintenance of the recharging system: Periodic maintenance required for reliable and higher quality water supply. During raining season, the entire system to be checked before and after rains and cleaned after every dry period. Before first shower storage tanks should be cleaned and flushed of all sediments and debris. Also, the roof top will be cleaned before monsoon and coarse mesh is used to prevent the debris on the entrance of the water at roof. The first shower should be flushed so the any sediment can be washed away.

10.11 Social Enhancement Measures

10.11.1 Training

The education and training of employees in good safety practices will be the responsibility of management. Employees will be instructed in the proper use of all equipment operated, safe lifting practices, location and handling of fire extinguishers, and the use of personal protective equipment.

An experienced O&M crew will be placed at an early stage to introduce the best system and operational management and practices. O&M crew will be assisted by a group of experienced technical personnel, to carry out the operation of the plant.

The O&M crew will be associated with the plant commissioning stage itself to get them fully familiar with the plant. A suitable training schedule will be developed for this purpose.

10.11.2 Welfare Activities & Facilities for Employees

Employees required for 2x800MW Units O&M are estimated to be around 216 nos. excluding contract labour. In addition to the plants & equipment for the generation of power the following facilities shall be provided in this station:

- Construction offices and stores
- Time and security offices
- First Aid and fire-fighting station
- Canteen and welfare centre Toilets and change rooms.
- Car parks and cycle/ scooter stands

- Training centre

Office space shall be provided as per good practice and canteens, toilets and restrooms according to norms laid down in the relevant factories act. The above facilities shall also be adequately furnished and equipped.

The main health hazards due to working in coal handling areas, ash handling areas, acid and alkali using areas, oil storage areas etc. are skin diseases and chemical burns. The workers will be encouraged to wash frequently and good sanitary and washing facilities shall be provided. A separate lunch room will be provided outside the work area. This will help to reduce dermatitis among the employees due to contact with acids, caustic chemicals, solvents, oils, as well as coal ash and fuel oil residues. The work atmosphere will be monitored for SPM, SO_2, and NO_x etc. to avoid excessive exposure.

10.12 Cost of Environment Management Measures

A capital cost provision of **Rs. 3,067.6 Crores** towards environmental protection measures/EMP and the recurring cost of **Rs. 72.22 Crores per annum** (as an operations & management cost) have been earmarked. The break of EMP cost is mentioned below in **Table 10.14.**

Table 10-14: Environment Management Cost Provisions

S. No.	Item Description	Cost (Rs. In Crores)		
		Capital Cost	Recurring Cost	Total
1	Electrostatic Precipitator	534	11	545
2	Chimney	58.8	1.2	60
3	Aux. Cooling Towers incl. Civil Works	188.2	3.8	192
4	Ash Handling incl AWRS	225.4	4.6	230
5	Ash Dyke	23.75	1.25	25
6	Dust extraction & suppression System	8	1	9
7	DM plant waste treatment systems	58.2	1.8	60
8	Sewerage collection, treatment & disposal	1.96	0.04	2
9	Green Belt & Landscaping	9.68	0.92	10.6
10	FGD and De-NOx Control	1862	38	1900
11	Rainwater harvesting	5.88	0.12	6
12	Environmental Laboratory & Environmental Monitoring	11.83	0.17	12
13	CEMS, CAAQMS, EQMS monitoring system & Main gate display board	11.76	0.24	12
14	Wind Breaking wall, Dry Fog System & RCC Flooring in coal storage Area	3.92	0.08	4
Total in Rs in Lakhs		**3003.38**	**64.22**	**3,067.6**

11 Summary and Conclusion

11.1 Introduction

MB Power (Madhya Pradesh) Limited (MBPMPL) is operating a 2x630 MW coal based sub-critical power plant on the left bank of Sone River near village Laharpur, Murra, Guwari, Belia & Jethari in Anuppur district of Madhya Pradesh in an area of 417.996 hectares which is under possession of MBPMPL.

Initially MBPMPL planned to set up 2x600 MW subcritical power plant. Environment Clearance for 2x600 MW in the name of M/s Moser Baer Power & Infrastructure Ltd. was obtained vide letter no.-J-13012/99/2008-IA.II(T) dated 28.05.2010. Transfer of EC - From “M/s Moser Baer Power & Infrastructure Ltd.,” to “M/s. MB Power (Madhya Pradesh) Ltd” vide letter no. J-13012/99/2008-IA.II(T) dated 23.11.2010. Forest clearance for 37.875 ha (93.6 acres) forest land coming under revenue forest land was obtained in two stages, Stage 1 vide letter no. 6MPCo51/2009-BHO/1032 dated 04.06.2010. and Stage 2 vide letter no. 6MPC051/2009-BHO/3598 dated 17.08.2011. Environment Clearance (Under clause 7(ii)(a)) - for 2 x 630 MW in the name of M/s MB Power (Madhya Pradesh) Ltd. vide letter no. J-13012/99/2008-IA.II(T) dated 07.05.2024.

MB Power (Madhya Pradesh) Limited (MBPMPL) is now proposing to expand 2x630 MW Sub-Critical Coal Based Thermal Power Plant by adding 2x800 MW Ultra Super Critical unit, which is based on Ultra Super Critical Technology. Total capacity after proposed expansion would be 2860 MW.

Location: Anuppur Super Thermal Power Project is located on the left bank of Sone River near village Laharpur, Murra, Guwari, Belia & Jethari in Anuppur district of Madhya Pradesh.

Elevation & Topography: 502 m amsl. The topography of land is plain.

Plant Capacity: Existing 2x630 MW (Stage-I), Proposed 2x800 MW (Stage-II), Total 2860 MW

Technology: Sub-Critical (existing), Ultra Super Critical (proposed)

Land Area: 451.202 Ha

Main Fuel/Coal Consumption: Existing requirement- 6.17 MTPA, Requirement for proposed plant- 7.36 MTPA. Total Coal consumption- 13.53 MTPA

Water Requirement: 1,64,208 KLD from Son River by WRD, Govt of Madhya Pradesh.

The Project Proponent

The proposed project Anuppur TPP, Stage-II shall be constructed and operated by MB Power (Madhya Pradesh) Limited.

Location of the Project

MBPMPL is proposing to expand 2x630 MW Sub-Critical Coal Based Thermal Power Plant by adding 2x800 MW Ultra Super Critical units. Which is based on Ultra Super Critical Technology. Anuppur Super Thermal Power Project is located on the left bank of Sone River near village Laharpur, Murra, Guwari, Belia & Jethari in Anuppur district of Madhya Pradesh. The site is at a distance of about 20 km from Anuppur and is approachable from NH 43 (Gulganj to Chaibasa). Shahdol town is about 47.6 km from the project.

Demand Justification

Electricity is a cornerstone of national infrastructure, driving economic development and enhancing quality of life. The proposed Anuppur TPP Stage-II aims to support this growth by providing a significant boost to the power supply in the Central Region and beyond. As of October 2024, India's total installed power generation capacity stands at 4,54,452.18 MW, with substantial contributions from both fossil fuels and renewable sources.

The Central Electricity Authority (CEA) has observed a consistent increase in power generation, with notable growth in both overall and coal-based electricity production over recent years. Projections for 2029-30 indicate that India's installed capacity could reach approximately 2,66,911 MW, with significant expansions in solar and wind energy, alongside traditional coal and hydro power.

Process Of Obtaining Environmental Clearance

Projects are classified into Category A or B based on potential impacts. Category A projects, like this one, require clearance from the Expert Appraisal Committee, MoEF&CC. The clearance process involves four stages: Screening (for Category B), Scoping, Public Consultation, and Appraisal.

11.2 Project Description

MB Power (Madhya Pradesh) Ltd is planning to expand the Anuppur Thermal Power Plant by adding 1600 MW (2x800 MW) of Ultra Super Critical Technology to the existing 1260 MW (2x630 MW) capacity within the current plant boundary in Village Laharpur, Murra, Guwari, Belia & Jethari in Jaithari Tehsil, Anuppur District, Madhya Pradesh.

Capacity & Unit Configurations: Proposed expansion for State II- 1600 MW (2 X 800 MW) Ultra Super Critical Technology.

Location of the project: MBPMPL's Anuppur Thermal Power Project is located on the left bank of Sone River near village Laharpur, Murra, Guwari, Belia & Jethari in Anuppur district of Madhya Pradesh

Land Requirement and Availability: A total of 451.202 Ha of land has been acquired to accommodate the MBPMPL's Anuppur Thermal Power Plant. Out of that, 417.996 hectares of land is within Plant boundary and has been utilized for Stage-I and some un-used area The Stage-II of the project will be accommodated within the existing Plant boundary and the remaining 33.206 hectares of land outside the plant boundary will be used for incoming railway line and green belt development for the Stage-II expansion.

Fuel Requirement: The annual coal requirement for Stage-I is estimated at 6.17 MTPA. The estimated coal requirement for Stage-II is approximately 7.36 MTPA.

Support Fuel: Light Diesel Oil (LDO) will be used for initial startup and as secondary fuel.

Fuel Transportation: Indigenous Coal to be transported through Railways. The secondary fuel shall be sourced from the refineries located nearer to the project by surface transportation.

Coal Handling System: Coal handling facility, which comprises receipt of coal through Rail, with on-line crushing and stacking by stacker-cum-reclaimer in the coal yard and finally feeding the bunker level conveyors.

Ash Disposal system: The ash produced by the project comprises 80% fly ash and 20% bottom ash. The fly ash handling system will include Compressors/ vacuum pumps, aeration blowers and heaters, intermediate surge hopper, air compressors and dryers, fly ash transmitter, all valves, piping, supports, platforms etc. The bottom ash shall be conveyed in lean slurry form from the slurry sump to the hydrobin or ash dyke. It is envisaged to have disposal system sized for 100% generation of ash.

The ash management scheme for fly ash and bottom ash involves dry collection of fly ash, supply of ash to entrepreneurs for utilisation, promoting ash utilisation and safe disposal of unused ash if any.

Water Requirement: The water requirement for Stage-I of the project is approximately 68,400 KLD. For the MBPMPL's Anuppur TPP Stage-II (2x800 MW) project, the water requirement is expected to be around 95,808 KLD.

Source of Water: The source of water for 2x800 MW expansion project is Son River. 36 MCM Water allocated by WRD vide letter ref: पत्र.क्र.वृ.प.नि.मं./31/तक/रा.स्त.-160/2008/589 dated 29/11/2024.

Power Generating Unit: MBPMPL's Anuppur TPP Stage-II will be a pulverized coal-fired thermal power project utilizing Ultra Super Critical boiler technology. The plan includes building and operating two units, each with a capacity of 800 MW.

Power Evacuation: The Stage-II generation switchyard shall be interconnected to Stage-I at 400 kV/756 kV level.

Project Time Frame: The schedule of commissioning of first unit is envisaged as 48 months from the NTP (Notice to Proceed) to EPC Contractor or the Main Plant (BTG Contractors) and second unit shall be commissioned within a gap of 6 months thereafter.

Project Cost

The estimated Cost of the proposed Expansion Project is Rs. 19,200 Crores.

11.3 Technology and Process Description

The proposed power plant will utilize Ultra Super-critical steam parameters and domestic coal, with cooling water sourced from the Son River. The plant layout includes a main powerhouse with designated areas for various components such as the TG bay, boiler, and administrative buildings, ensuring compliance with national and international design codes and standards. Key performance metrics include a gross heat rate of 2070 kcal/kWh and an auxiliary consumption of 7.5%, with an expected availability rate above 85%. The mechanical systems feature advanced steam generators, turbines, and electrostatic precipitators designed for efficient operation and compliance with environmental regulations. The ash handling system will manage both fly ash and bottom ash, with the latter disposed of in slurry form, while fly ash will be stored in silos for potential reuse. A comprehensive water management system will ensure recycling and treatment of wastewater, adhering to a zero-liquid discharge policy. The power plant will also incorporate robust fire detection and protection systems, along with advanced control and instrumentation systems to facilitate efficient operation and monitoring. Civil works will include structural foundations, cooling towers, coal handling areas, and chimneys designed to withstand seismic and wind loads, ensuring the durability and safety of the facility.

For each 800 MW TG unit encompass a comprehensive array of systems designed to ensure efficient and reliable operation-

1. **Steam Turbine (TG):** Tandem compound, single reheat, regenerative, condensing design. Designed for base load operation with flexibility for varying operational modes. Features optimized HRH temperature and safeguards against water induction.
2. **Condenser:** Water cooled condenser. Two pass i.e., HP and LP condenser.
3. **Air Extraction System:** Includes 2x100% vacuum pumps for each condenser air evacuation. Features startup air evacuation system with pumps and accessories.
4. **Lube Oil System:** Comprehensive system meeting turbine bearings' lubrication needs. Provides for turbine turning gear and emergency jacking oil requirements. Utilizes main oil pump (MOP), auxiliary oil pumps (AOP), and emergency oil pump (EOP).
5. **Turbine Control Fluid System:** Self-contained system using fire-resistant fluid for turbine control. Includes reservoir, AC motor-driven pumps, and coolers for fluid circulation and cooling.
6. **Gland Steam Sealing System:** Ensures effective sealing of turbine shaft glands to prevent steam and air leakage. Utilizes seal steam from auxiliary steam header with provisions for various load conditions.
7. **Governing / Regulation System:** Features throttle or nozzle-controlled governing for precise speed control. Includes electrohydraulic governor with backup for stability and safety.
8. **HP/LP Bypass:** Enables quick startup and operation during load changes. Designed for specific steam flow capacities to match turbine conditions.
9. **Regenerative Feed Heating Cycle:** Handles condensate flow through LP heaters to deaerator and boiler feed pumps. Utilizes turbine extraction steam for heating before entering boiler.
10. **HP & LP Heaters:** Includes LP heaters, drain coolers, deaerator, and HP heaters optimized for feed heating. Compliant with standards for heat exchanger design and material use.
11. **Deaerator:** Features Spray-cum-tray deaerator with integral direct contact vent condenser. Ensures effective deaeration of incoming condensate and HP heater drains.
12. **Boiler Feed Pumps (BFP):** Includes turbine-driven and motor-driven pumps with booster pumps on common shaft. Designed for efficient and reliable feed water delivery to steam generator.
13. **Condensate Extraction Pumps:** Three motor-driven pumps for condensate extraction, handling various operational conditions.
14. **Turbine Hall EOT Cranes:** Electric overhead travelling cranes for installation and maintenance of turbogenerators and equipment.
15. **On-Line Integrated Blade Vibration Monitoring System:** Monitors blade health of critical turbine stages using non-contact sensors.
16. **Deaerator Level Control Station:** Manages condensate flow with control valves and variable frequency drive system.

Plant Water System

- **Water Drawl:** The river water will be drawn from the barrage constructed on the River Son and pumped to the plant through an existing pipeline. The total make-up water requirement would be around 3992 m3/hr (35 MCM).
- **Water Pre-treatment System:** Pre - Treatment plant will be designed to treat raw water drawn from raw water reservoir. Raw water will be pumped to cascade aerator through a centric pipe and will be allowed to flow down in steps. In this process entrapped gas in water is allowed to escape into the atmosphere.
- **Makeup Water System:** Re-circulating cooling water system using wet evaporative Induced Draft cooling towers will be deployed for the proposed station. It will be used for the condenser and auxiliary equipment cooling in a semi-open cooling water circuit. Raw water at the plant end will be received in raw water reservoir, which will have an overall storage capacity of about fifteen (15) days' raw water requirement of the Plant. Raw water will thereafter, be pumped to the Raw water pre-treatment plant and Ash handling plant by 3x50% capacity Raw water pumps and Ash water make-up pumps.
- **Circulating and Auxiliary Cooling Water System:** The river water will be sourced to meet the water requirements for condenser cooling and also for cooling the plant auxiliaries. The plant cooling water system will be of re-circulating type cooling system with Induced Draft Cooling Towers, which consists of 2 numbers of Concrete Volute Circulating Water pumps per unit. Circulating Water pump house shall consist of five (5) nos of CW pumps for both the units. Two (2) pumps will be under operation for each unit, one will remain as common standby. Type of pumps will be Concrete Volute casing type or any other proven design of OEM. Circulating Water pumps for each unit to circulate cooling water to condenser and plant auxiliaries. The capacity of each pump would be 48000 cum/hr approximately.
- **Water Treatment Systems:** The waste water from neutralization pits of condensate-polishing plant, DM plant shall be collected in the respective neutralization pits and neutralized before pumping to the central monitoring basin before final disposal. Total domestic sewage generated is being and will be treated in STP (DM Plant STP of 1 KLD, STP near MGR of 15 KLD, Fire Station STP of 5KLD). Domestic sewage of Colony is being treated in STP (2x120 KLD). Treated water will be utilized in dust suppression during coal handling, fly ash unloading & on roads; ash handling; Floor washing & horticulture purposes.

Fire Protection System

The Fire Detection and Protection system will be designed in conformity with the recommendations of the Tariff Advisory Committee of Insurance Association of India. While designing the fire protection systems for this power station its extreme ambient conditions need special attention. Codes and Standards of National Fire Protection Association (NFPA), USA will be followed, as applicable.

- **Fire Detection and Alarm System:** A microprocessor-based Fire Detection and Alarm system will be provided for the entire plant area consisting of Intelligent Analogue Addressable type detectors. The system will consist of a central monitoring station and the main Fire Alarm Panel (FAP) located in unit control room and one fire alarm and control panel and repeater panel provided in the fire station office. Manual Call point (MCP) shall be provided at different strategic location in the entire power plant as per TAC/ NFPA 72.

Fuel Handling System

- **Coal Handling System:** Coal handling facility, which comprises receipt of coal through Rail, crushing house and stacking by stacker-cum-reclaimer in the coal yard and finally feeding the bunker level conveyors.

Fuel Oil Handling System: The fuel oil system shall be meant for start-up of the plant and to provide support in flame stabilization while firing coal at and below 30% BMCR capacity. The Light Distillate Oil (LDO) shall be used for boiler light up and flame stabilization during low load operation. Two (2) nos. of LDO storage tank of 2000 KL will be constructed. From the storage tank LDO will be forwarded to LDO burners by means of 3 x 50% forwarding pumps. The pumps shall be fitted with duplex suction filters with all necessary piping, valves and instruments etc.

Ash Handling System

The ash handling system at the power plant manages various types of ash produced during operations. Bottom ash, economizer ash, and air preheater ash are handled in wet form, while fly ash is managed in dry form.

- **Bottom Ash Removal System:** The bottom ash shall be collected from the boiler in a water impounded bottom ash hopper placed below the furnace of each boiler. Bottom ash from the bottom ash hopper of each unit shall be removed in 2.0 hours per shift of 8 hours. Bottom ash shall be conveyed through jet pumps in wet slurry form from water impounded hoppers to the bottom ash slurry sump. Further, bottom ash slurry pumps shall convey the bottom ash slurry from slurry pump house to dewatering hydro bins. Decanted water from hydro bins shall be fed to settling tank & surge tank; clear water from surge tank shall be circulated back to ash handling system for re-use. Provision shall be provided for unloading of semi-wet bottom ash from hydro bins to open trucks for disposal to mine and low lying area backfilling. Ash from economizer hoppers shall be conveyed in to bottom ash hopper in slurry form by means of flushing apparatus.
- **Fly Ash Handling System:** The fly ash handling system will extract fly ash pneumatically from electrostatic precipitator (ESP) & Air Preheater hoppers and store fly ash in intermediate surge hoppers. From surge hoppers fly ash will be conveyed pneumatically under pressure to ash storage silos. Four (4) ash silos shall be provided common for 2X800MW Units. Combined storage capacity of all the silos shall be considered as 24 hours minimum. One boiler unit will be provided with one pneumatic conveying system for handling of fly ash collected in the fly ash hoppers. Fly ash from the ESP and APH hoppers of each unit shall be removed in 5.0 hours per shift of 8 hours.
- **Ash Disposal System:** The fly ash generated from these units will be either used in cement industries around the plant area or exported for its utilization by end users. Fly ash will be collected in 4 Nos. silos with wagon loading facilities over railway line will be constructed. Fly ash removal from Silos will be thru' various mode i.e. Dry ash to trucks /bulkers, Conditioned ash to cement industries.

Pollution Control System

- **Air Pollution Control System:** Electrostatic Precipitators (ESP): High-efficiency ESPs will limit particulate emissions to 30 mg/Nm3. Chimneys with appropriate height will disperse emissions effectively.
    - **Dust Suppression:** Systems for coal dust extraction and suppression in critical areas like Coal Handling Plant (CHP) and ash handling facilities.
    - **Flue Gas Desulphurization (FGD) System:** Wet limestone-based FGD system to capture SO_2 emissions, producing gypsum. Includes bypass system for operational flexibility.
    - **NOx Control:** Combines low NOx burners (LNB) and combustion staging techniques to minimize NOx emissions from the steam generator.
    - **Water Pollution Control System:**
    - **Air Cooled Condensers:** Reduce raw water consumption; ash water recirculation system minimizes wastewater discharge.
    - **Effluent Management:** Comprehensive system for treatment, recycling, or disposal of effluents from various plant processes, ensuring zero liquid discharge (ZLD) where feasible.
- **Noise Pollution:** Acoustic enclosures and personal protective equipment for personnel working in high-noise areas to keep noise levels below 90 dB(A).
- **Solid Waste Management:** Ash Management: Dry collection of fly ash and decantation-based collection of bottom ash. Emphasis on ash utilization; surplus disposed in ash dyke with dust control measures.
- **Afforestation and Green Belt Development:** Continued planting initiatives to enhance green cover and biodiversity within and around the project site.
- **Sustainable Development Mechanism (SDM):** Intent to leverage SDM or Article 6.2/6.4 mechanisms of the Paris Agreement for emission reductions and revenue generation once operational.
- **Post Operational Monitoring Programme:** Continuous monitoring of air and water quality parameters, expansion of monitoring program for new units. Data submitted to Madhya Pradesh State Pollution Control Board.
- **Institutional Set-Up:** Environmental Management Group (EMG): Existing EMG oversees monitoring activities, collaborates with regulatory bodies for compliance and issue resolution.

11.4 Baseline Environment

Baseline environment data forms a part of the Environmental Impact Assessment study and helps to evaluate the predicted impacts on various environmental attributes and also required in preparing Environmental Management Plan (EMP) outlining the measures for improving the environment quality and scope of future expansions for environmentally sustainable development.

Study Area and Period: An area of 10km radius (aerial distance) from the boundary of the project area is the study area for the EIA Study. The project site is located at Villages Laharpur, Murra, Guwari, Belia & Jethari, Jethari Tehsil, District Anuppur in Madhya Pradesh District. The study period for baseline data collection was October to December, 2024.

Methodology Adopted: Baseline data was generated for various environmental parameters including air, water (surface and groundwater), land and soil, ecology and socio-economic status to determine quality of the prevailing environmental settings. Sampling of soil and water, monitoring of air quality and noise level and other field data collection were carried out by the team operating from this field station.

Regional and Locational Setting: MBPMPL's Anuppur - Thermal Power Project is located on the left bank of Sone River near village Laharpur, Murra, Guwari, Belia & Jethari in Anuppur district of Madhya Pradesh. The site is at a distance of about 20 km from Anuppur dist Head Quarter and is approachable from -NH 43 (Gulganj to Chaibasa) (~10.6 km in N direction). Shahdol town is about 47.6 km from the project.

Connectivity: The nearest Railway Station is Jaithari Railway station which is at an approx. distance of 2.6 km SE from the project site. The approximate distances from the nearest commercial airports to the site are 237 km from Jabalpur and 281 km from Raipur.

Land use/ Land Cover Details: Land Use pattern of the study Area has been analyzed based on FCC, SOI Toposheet and the graphical projection. The buffer zone of the project site area is of total 45,479.37 ha among which agricultural area is 28299.62 Ha. (62.23%) total study area. The forest land 6197.95 Ha. (13.63%), Scrub land and vegetation is 6,641.78 (13.63%), barren land is 803.19 (1.77%), and plant area is 451.20 Ha. (0.99%) are also crucial land use characters of the study area. About 2.04% of the study area is covered by the water body which covers primarily rivers, channels, ponds and reservoirs. Built up area (1,803.04 Ha) of the study area is which is 3.96% of the total study area.

Physical Environment

- **Topography:** The elevation in the study area is observed to range from 604m to 396m above mean sea level with a general slope from east site to west side. Project site falls under area having elevation between 421m to 460m.
- **Drainage:** Two perennial rivers- Son River and Tipan Nadi are flowing from the study area. Son River is flowing from the East to North-West direction and is located at 4.7 km in the North East direction from the project site. Another River Tipan Nadi is flowing from South- East to North West direction and is located at 1 km distance from the project site. One of the tributaries of Son River, Kirnar Nala is flowing through the project site
- **Geology:** The lithology of the 10 km study area consists mostly of Shale, Sandstone, Clay, Conglomerate, Siltsone, Diamictite and Shale Conglomerate of Lower Gondwana Group of Late Carboniferous to Permian Age. Limestone, Sandstone Conglomerate of Meso-Proterozoic and Neo-Proterozoic age and Chhotanagpur Gneissic Complex of Proterozoic Age could also be found within the study area. The project site consists Majorly of Lower Gondwana Group and Chhotanagpur Gneissic complexes.
- **Geomorphology:** Buffer zone of 10 km radius from the project site comprises of Fine-Grained Sandstone, Granite Gneiss, and Sandstone with Coal. The geomorphology within the study area are majorly Pediment and Pediment-Pediplain complexes with scattered Gullied lands and lateral bars along the Son River, Tiupan River and Fohirari Nadi.

- **Hydrogeology:** Groundwater is the principal source of irrigation in the district and during pre-monsoon ground water were recorded in the level of 1.55mbgl to 15.86 mbgl, the same for the post monsoon season was recorded as 1.25 mbgl to 15.86 mbgl.

Vulnerability of Study Area:

- **Earthquake:** The district Anuppur has fall under Zone III: Moderate Damage Risk Zone. The project site falls in moderate damage risk zone.
- **Wind:** The project site falls in Moderate Damage Risk Zone -B(V= 39 m/s) of Wind Hazard zones.

Soil Quality:

- **pH:** The pH value recorded in the study area varies from "Slightly Alkaline" as per ICAR report.
- **Electrical Conductivity (EC):** In the study area soil conductivity varies between 12 µmhos/cm at S8 to 210 µmhos/cm at S3.
- **Soil Texture:** According to the study of soil texture, the soil of the study area varies form 20% Clay, 20% silt and 60% Sand.
- **Bulk Density:** Bulk density of the study area ranges between 1.22 gm/cm3 at S8 to 1.41 gm/cm3 at S7.
- **Moisture:** The field moisture of all the samples from the study area ranges between 4.24% at S8 to 7.12% at S2. The moisture of the study area remains lower than the wilting point.
- **Soil nutrients:**
  - **Phosphorus:** Available Phosphorus ranges between 26.48 kg/ha at S8 site to 47.26 kg/ha at S5. As per ICAR classification the phosphorus in the study area present is classified as "less" to "medium".
  - **Potassium:** Potassium content in the study area ranges between 92.1 kg/ha at S8 to 205.4 kg/ha at S5. As per ICAR classification the potassium in the study area present is classified as "very less" to "medium".
  - **Nitrogen:** Nitrogen content in the surface soil of the study area varies between 124.26 kg/ha at S8 to 244.8 kg/ha at S5. As per ICAR classification the nitrogen in the study area presents as "good".
  - **Organic Matter:** In the study area organic matter varies between 0.88% to 1.8%. As per ICAR classification, the organic matter found in the study area is "more than sufficient".

Climatology and Meteorology

- **Temperature:** Temperature of the study area is generally high during April to June. The maximum temperature was recorded in the month of May (40.31°C) & minimum temperature is recorded in the month of January (8.57°C).
- **Rainfall:** The annual rainfall is 1268.68mm. It rains 12 months and the intensity varies from 10 mm to 349.7 mm per month. The maximum annual rainfall is received during the months from June to September.

- **Relative Humidity:** The humidity is highest in July to December with average relative humidity of 80.3%.
- **Wind Pattern:** The wind rose shows that the dominant directions of the wind flow throughout the year is WNW and during the post-monsoon the pre-dominant wind direction is from NNE.

Air Environment

- **PM_{10}:** The 98th percentile value of PM_{10} varies between 76.23µg/m^3 at AAQ7 to 52.44 µg/m^3 at AAQ5.
- **$PM_{2.5}$:** The 98th percentile value of $PM_{2.5}$ varies between 42.04 µg/m^3 at AAQ1 to 23.59 µg/m^3 at AAQ5.
- **SO_2:** The 98th percentile value of SO2 in the study area ranges from 16.66 µ g/m3 in AAQ6 to 9.43 µ g/m3 in AAQ5.
- **NO_2:** The 98th percentile of NO_2 varies between 19.86 µg/m^3 at AAQ1 to 13.53 µg/m^3 at AAQ5.
- **CO:** The CO in the study area varies from 1.10 mg/m^3 at AAQ1 to 0.20 mg/m^3 at AAQ10. The values recorded were below the prescribed standard of NAAQ.
- **Ammonia, Lead, Nikel and Mercury** was below detection limit at all locations.

Noise Environment:

- **Day Time:** The day time noise levels showed maximum 62.4 dB(A) at (N1) Project Site to minimum 51.4 dB(A) at (N3) Jaithari. It is observed that the day time noise levels are high at (N7) Anuppur because of high anthropogenic activity.
- **Night Time:** The night time noise levels showed maximum 53.1 dB(A) at N1 Project Site and minimum 42.2 dB(A) at Anjani. In study area during night time all locations observed noise value under prescribed limits for all zones except for Anuppur. Anuppur being the highest order settlement, District headquarter the higher anthropogenic activity the noise quality exceeds the prescribed standards. As per CPCB prescribed limit during night time is 45 dB (A) for rural/residential areas and 70 dB (A) for industrial zones.

Water Environment:

- **Surface Water Quality**
  - **pH:** pH of the study area varied from 6.811 (SW10) in month of May to 7.714 (SW 01) in the Post Monsoon season, which is neutral to slightly alkaline in nature.
  - **TDS:** TDS was observed in the range of 98.02 mg/l at SW05 to max. 481 mg/l at SW01 in the post monsoon season
  - **TSS:** Analysis of total suspended solids was observed 1.4 mg/l to 5.11mg/l.
  - **Conductivity:** Conductivity of water samples indicated non saline in nature it was varied between 150.8 µS/cm at SW05 to 740 µS/cm at SW2 in the monitoring period.
  - **Nitrate & Fluoride:** Both Nitrate and fluoride were under limit in post-monsoon season i.e. October to December, 2024.
  - **DO:** Dissolved oxygen was recorded sufficient in the study area i.e min 6.5 mg/l (SW08) to max. 7 mg/l (SW09).

  - **BOD:** BOD in surface water found high which is varied between <2 mg/l in SW04 to 6.2 mg/l in SW08 during Post monsoon months.
  - **Alkalinity:** The maximum alkalinity of water bodies samples was found to range between 56.8-255.72 mg/l in the study area.
  - **Chloride:** The minimum chloride concentration (10.6 mg/l) was found at SW07 and the maximum (54.07 mg/l) was recorded at SW02 during the post monsoon season.
  - **Fluoride:** The level of fluoride ranged between 0.22 mg/l at SW1 in April to 0.35 mg/l at SW4 in April and were found to be within the tolerance limit of surface water.
  - **Nitrate:** The nitrate in surface water ranged between 3.26 mg/l at SW05 to 15.6 mg/l at SW02
- **Ground Water Quality**
  - **pH:** The pH value of ground water samples varied from 6.78 to 7.54.
  - **Electrical Conductivity (EC):** Electrical conductivity of ground water ranged between 535 µS/cm to 88o µS/cm during the study period.
  - **TDS:** All the samples are within the permissible limits.
  - **TH:** The maximum total hardness of ground water was found to be 296.2 mg/l in sample at GW5 in the post monsoon period and the minimum was observed as 132.1 mg/l in the sample at GW.
  - **Calcium and Magnesium:** The range of Ca2+and Mg2+ are also remaining within the acceptable limits 27.58-74.42 mg/l and 15.36-26.8 mg/l respectively
  - **Alkalinity:** The alkalinity of Hand pump water was found to be 313.58 mg/l at GW02 and the minimum was observed as 186.72 mg/l at GW03 during the monitoring period.
  - **Chloride:** The maximum chloride concentration 80.1 mg/l was found at GW06 and the minimum 32.04 mg/l was recorded at GW03. The samples were compared with the BIS standard and all the samples were within the acceptable limit of 250 mg/l.
  - **Fluoride:** The minimum level of fluoride 0.18 mg/l was found in GW05 and the maximum value 0.31 mg/l was found at GW07. All samples were within permissible limits of 1.5 mg/l.
  - **Nitrate:** The concentration of nitrate in ground water samples ranged from 2.26 mg/l at GW02 to 10.2 mg/l at GW05. All the samples were compared with the BIS standard and found within the acceptable limit of 45 mg/l.
  - **Heavy Metals:** Zinc concentration in the ground water samples were within the acceptable limit of 5 mg/l prescribed by BIS. Other heavy metals like arsenic, cadmium, chromium, copper, lead and selenium were recorded below detection limit.

Traffic Scenario: The results of the survey, the existing passenger car unit (PCU) of each location were compared with the capacity of each type of road as suggested by Indian Road Congress thus determining the existing Level of Service (LoS) for each location. The existing conditions shows A Level of service at Pendra Road which represents a condition of free flow

Terrestrial Ecological Survey and Biodiversity Study:

- **Forest type:** As per the Champion and Seth classification (1968) Anuppur lies in the Tropical Dry Decious Forest and Tropical Moist Deciduous Forest.
- **Floral Study:** In the study region, During the survey, an inventory of the various plant groups discovered in the study region was created. 19 Near Threatened species, 24 vulnerable species, 7 Endangered species & 2 Critically Endangered species were identified in the study area. In the research region, 192 species of flora were identified. Out of which 85 species of trees and small trees,19 species of Grasses, 29 species of Climbers, 24 species of Shrubs & 36 species of Herbs have been recorded in the study area based on primary observation as well as based on information collected from the secondary data.
- **Faunal Study:** No Schedule-I species were found during the field survey within 10 km radius of the plant site. A number of faunal terrestrial species comprising mammals, avi fauna, reptiles, Amphibians & fishes were recorded from the study area. Among fauna, 12 species of mammals, 73 species of avi fauna, 3 species of reptiles, 3 species of amphibians & 18 species of fishes were recorded from the study area. 1 Near Threatened species & 1 vulnerable species were identified in the study area.
- **Aquatic Ecology:** The aquatic ecology of Anuppur, is characterized by its river systems, especially the Tipan River and Son River and several ponds and wetlands. Studies indicate that the water quality is affected by both natural and anthropogenic factors, including contamination from industrial and agricultural activities. The region's groundwater, heavily relied upon for irrigation and drinking, faces quality issues due to contamination. Additionally, the area is rich in aquatic biodiversity, supporting various fish species and aquatic plants.
- **Wetland Ecology:** As per the Interactive Wetland Map available on Wetlands of India Portal, within the 10km radius of the project site no Ramsar Wetland or significant wetland located, however, two wetlands belonging to other categories namely Dulha Talab and Samtapur Talab are within 10km radius.

Social Environment

There are 72 villages and two Census towns in the study area. These villages have total population of 1,03,195 (in 2001) & 1,23,189 (in 2011). The average household size in the study area was found to have reduced from 4.93 in 2001 to 4.45 in 2011.

- **Vulnerable Group:** As of the 2011 census, the study area encompasses a Scheduled Caste population of approximately 7.76% and a Scheduled Tribe population of 38.20%.
- **Literacy Rate:** The female literacy rate of the study area has increased with time (35% in 2001 & 49% in 2011), whereas the male literacy rate which was 59% in 2001 have increased to 67% in 2011. Which are significantly lower than the national (74%, 82.14% for male and 65.46% for female) and the state (78.73% for male and 59.24% for female) literacy rate.
- **Occupational Structure:** As per the District Census Handbook, Anuppur, the villages around the study area, people mainly earn from agriculture and animal rearing. The percentage of non-workers is high (>50%) in the study area as compared to the total workers. It can also be seen that the percentage of workers have increased marginally from 2001 to 2011.

Infrastructure

- **Educational Facilities:** There is a total of 129 Primary Schools, 49 Middle Schools, 14 Secondary School and 5 Senior Secondary Schools in the study area as per Census 2011. It can be seen that there has been a substantial increase in the number of middle and secondary schools over the 10 years in the study area. This is a very healthy sign which is reflected in the increase of literacy rate of the area.
- **Banking and Post Office Facilities:** Number of banking infrastructures like Cooperative banks have increased whereas infrastructure like Post offices (from 11 in 2001 to 4), Commercial Bank (from 1 to 0) and Agricultural Society (from 4 to 3) have decreased in 2011.
- **Drinking water facilities:** One of the most important factors responsible for the emergence of a settlement is availability of water. Many water sources such as wells, hand pumps, tanks, etc. are available in rural areas. In the villages under study, the main source of water is tap water, well, followed by hand pump and service reservoirs.
- **Health Facility:** The healthcare facilities present in the study area did not have any significant improvement except for the increase in number of primary health sub-centers. Mother and Child Welfare Centers have reduced significantly. Overall, Health Care facilities are poor compared to the population it serves.

11.5 Impacts Assessment & Mitigation Measures

Possible environmental impacts on various features such as air quality, noise level, water use and quality, land-use, ecological status, soil quality and socioeconomic factors are evaluated and appropriate mitigation measures are proposed both for construction phase and operation phase.

Ambient Air: During construction site preparation, transportation and storage of construction material/ equipment, civil construction activities, mechanical and electrical erection activities and transportation and disposal of construction debris will have an adverse impact on ambient air quality of the area. The same for the operation phase are caused by plant operation, unloading and storage of coal, coal combustion, water withdrawal and treatment and ash handling. For mitigation of the impacts necessary dust suppression measures like water sprinkling using road tanker will be deployed, suitable surface treatment to the roads and regular sprinkling of water shall be provided, proper periodical tuning and maintenance of vehicles are recommended.

Water Resources: Impact on water resources during construction phase will be caused during site preparation, influx of labour and construction of temporary houses and transportation and disposal of construction debris. Where as water quality will be affected due to transportation and storage of construction material/equipment, civil construction activities, mechanical and electrical erection activities, and transportation and disposal of debris. During operation phase, water quality will be affected by plant operation, unloading and storage of coal, water withdrawal and treatment, ash handling and disposal and storage of Gypsum. The mitigation measures suggested includes directing wash offs to a sedimentation basin before discharge, storage of fuel oil, lubricants, grease etc in closed containers and proper drainage and disposal of wastewater

Ambient Noise: During construction site preparation, transportation and storage of construction material and equipment, civil construction activity, mechanical and electrical erection activities and transportation and disposal of construction debris will disturb the ambient noise environment. During operation phase unloading and storing of raw material will disturb the noise environment. For mitigating the impacts any machinery or equipment generating excessive noise levels will be taken out for maintenance, use of proper personal protective equipment will be encouraged, well-tuned vehicles will be used and loud noise will be checked every day, D.G set to be used during construction phase shall be provided with acoustic enclosure to reduce noise disturbances.

Soil Quality: Transportation related activities during construction phase including raw materials and construction debris and during operation phase coal combustion, ash handling and disposal and storage of Gypsum will adversely impact the soil quality. To mitigate the impacts it is recommended that the truck movement shall be carried out through existing roads, trucks shall be covered with tarpaulin and overloading shall be avoided and appropriate soil conservation measures associated with improved construction techniques should be implemented.

Ecology: Fugitive dust deposition during construction may lead to temporary reduction of photosynthesis in nearby flora. The runoff from construction area may lead to a short-term increase in suspended solids and decrease in DO near the discharge point in receiving waterbody. For mitigation of those impacts measures like sprinkling water in dust-generating areas, green belt development and channelizing stormwater runoff though sedimentation basin are to be implemented.

Traffic: After the proposed expansion, there will be increase in number of vehicles. It is considered that 100% of the additional traffic shall travel through the selected locations. In that scenario the level of service will remain LOS A of free flow condition for the Pendra Road.

11.6 Analysis of Alternative Technologies

Site Alternative: No alternative site is explored for this expansion.

Technology Alternative

Sub-Critical Boiler: Subcritical boilers functions at temperatures up to 374°C and at a pressure of 3,208 psi (Critical point of water). These boilers compose a system with constant evaporation endpoint. Inside the boiler, the natural circulation of the fluid is generated by heating the risers. Water is circulated, water returns to the evaporator inlet through down corners while steam flows into the super-heater chamber.

If the fluid is allowed to undergo natural circulation, the application range is limited to about 190 bar as the maximum drum pressure. But if the circulation is done using a circulating pump (known as forced circulation), this range can be extended. It also sets the size of the heating surface in the evaporator and in the super-heater. A major drawback of the subcritical boiler is, in these boilers, bubble formation can occur which leads to more water consumption.

Super Critical and Ultra-Super Critical Boiler: Super critical and ultra-super critical boilers' ability to operate at much higher pressures and temperatures than subcritical boilers translate into noticeably better efficiency rating. Improved plant efficiency also translates into reduced emissions, particularly CO and Mercury.

For all fossil fuel-fired plants, fuel represents the largest operating cost. By reducing the amount of fuel needed to yield the requisite energy, supercritical plants make a noticeable dent in bottom lines when compared to subcritical plants.

Summary of Advantages of Ultra Super Critical Thermal Power Plant:

- Improve thermal efficiency attainable.
- Reduce fuel cost.
- Reduction of CO_2 emission by as much as 15% per unit of electricity generated compared to typical sub-critical units. This may help in meeting country's GHG Reduction target.
- Very good part load efficiency.
- Very low emissions of NOx, SO_2 and PM achievable using modern flue gas clean-up equipment.
- Initial investment requirement marginally higher than super critical technology and less than other clean coal technology. This, however, depends on the unit size considered.

11.7 Environmental Monitoring Programme

The monitoring program is designed to verify the implementation of environmental measures and confirm their effectiveness in delivering the intended benefits to the target population. The primary aims are to monitor impacts of the surrounding environment and the effectiveness of mitigation measures during the construction and operation phases, to ensure that environmental control systems are installed and operating satisfactorily and to suggest ongoing improvements in mitigation measures, if required for subsequent effective monitoring.

Environment Monitoring Program during Construction Phase: The formulated monitoring programme includes multiple parameters for five different aspects Metrological (wind speed & direction, temperature, rainfall and humidity), Ambient Air Quality (PM_{10}, $PM_{2.5}$, SO_2, and NOx), Noise (Equivalent noise pressure level), Ground water quality (Physical, chemical and biological parameters including heavy metals) and Surface water quality (Physical, chemical and biological parameters including heavy metals) at different frequency and different locations.

Environment Monitoring Program during Operation Phase: Monitoring programme during operation phase includes nine aspects of Metrology (Wind speed & direction, temperature, rainfall and Humidity), Work zone air quality (PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO), Ambient Air Quality (PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO within and outside the plant area at least at four locations) and Process stack (PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO the project proponent shall install a 24X7 continuous emission monitoring system at main process stack emission concerning standards prescribed in Environmental Protection Rules 1986 and connected to MPPCB and CPCB online servers), Noise, Surface Water Quality (Physical, Chemical and biological parameters including heavy metals), Ground Water Quality (Physical, chemical and biological parameters including heavy metals.), Soil (Physical and chemical parameters with organic content) and Ecology (Visible damage to crops density and diversity of local fauna).

Wastewater Quality Monitoring: the wastewater monitoring programme consist of wastewater parameters monitoring monthly prior to reuse, recycle and recirculation, Surface water and ground water quality monitoring will also be covered. The monitoring should be done for the waste water sources of Boiler blow down (temperature suspended soils, oil & grease, dissolved solids, copper, iron etc to be examined), Water treatment plant effluent (pH, suspended solids, COD, BOD, dissolved solids to be monitored) and Ash Pond effluent (pH, suspended solids, oil & grease, dissolved solid, heavy metals like chromium, zinc, iron, manganese, aluminium, nickel, phosphate etc. to be monitored).

Data Analysis and Reporting Schedule: Data generated from monitoring and analysis of the sample will be compared with the prescribed/ stipulated limits. If any parameter is not found within the prescribed/stipulated limit appropriate control measures will be taken to satisfy the limit.

Regular monitoring and data analysis shall be followed through proper documentation and reporting system. Provision will be made for online monitoring of emission and effluent data is already available for the existing unit and same arrangements shall be made for the upcoming expansion units and the data shall be uploaded to MPPCB/CPCB server to make them available on real-time basis as public disclosure. A full record will be kept as part of normal contract monitoring.

Emergency Procedures: Emergency procedures including drills shall be employed viz, Emergency Evacuation Plan, Disaster Management Plan and Industrial Safety plan to meet the requirement in case of failure of any pollution control equipment.

Environmental Monitoring Cost: Total environmental monitoring cost during construction phase (recurring) is 3,68,000 and the same during operation phase is 17,18,000.

11.8 Additional Studies

MBPMPL, Anuppur is carrying out additional studies of Public Consultation, Risk Assessment, Social Impact Assessment and Rehabilitation and Resettlement Action plan as suggested in EIA Notification 2006.

Public Hearing & Consultation: As per the conditions of the granted ToR and the EIA Notification 2006 & its subsequent amendments, public consultation will be held for the project based on this draft EIA&EMP report.

Hydrology & Hydrogeology Study: A hydrology and Hydrogeological study was conducted in the study are to assess the ground water dynamics, water quality, soil characteristics for ground water recharge potential and to identify potential impacts on ground water due to the project. Action plan for implementation recommended mitigation measures were also furnished.

Biodiversity Study: Biodiversity analysis of the surrounding area was conducted to assess the Floral and Faunal diversity of the area and potential impact of the proposed project on the ecological environment and to recommend mitigation measures.

Watershed Development Plan: Watershed development plan was furnished to identify the watersheds that might have inverse impact due to the project and to recommend measures for slope stabilisation, check dams and other irrigation measures for development of the surrounding watershed.

GHG Inventory Study: A GHG inventory was created for the existing 2x630 MW Thermal Power Plant along with recommendation and action plan to reduce emissions.

Need based Social Impact Assessment: A Need Based SIA was carried out in the village falling within the 10 km study area to determine the infrastructure and services that were prioritized by the residents. Special focus was given for the Tribal villages and needs. Along with the study proposals were also furnished for inclusion in the CSR programmes.

Risk Assessment: Risks present in a thermal power plant operation mostly arises due to involvement of hazards like High pressure super-heater, re-heaters, economizer units exchanging heat with the hot flue gases, Turbines utilizing HP steam, Fuel oil storage and handling units, Coal handling units, Hydrogen as coolant in turbo generators drawn from hydrogen cylinders, Chlorine as water treatment chemical drawn from cylinders and Switchyard including transformers, isolators etc.

Hazard Identification: Hazard identification includes **Component-1:** Identification of contaminants being released which are hazardous. Estimation of probability of an expected event and its consequences form the basis of quantification of risk in terms of damage to property, environment, or personal. Therefore, the type, quantity, location, and conditions of release of a toxic or flammable substance have to be identified in order to estimate its damaging effects, the area involved, and the possible precautionary measures required to be taken.; **Component-2:** Estimation of the amounts of contaminants released from all sources or the source of concern. Fuel oils (LDO/HFO/HSD) will be used in small quantity for initial start-up. Chlorine and other chemicals are used in the makeup water treatment & DM Plant. The hazards associated with the use of these materials would be taken careful consideration and due precaution would be taken for its safe handling at various stages of usage.; **Component-3:** Estimation of the concentration of contaminants through Preliminary Hazard Analysis considering i) Spillage of chemicals while handling and ii) Leakage of chlorine.

Mitigation Measures of Fire & Explosion Hazards: Fire prevention and relevant code enforcement is one of the major responsibilities of project proponent. The fire service facility shall be equipped with- Smoke and fire detection alarm system, Water supply, Fire hydrant and nozzle installation, Foam system, Water fog and sprinkler system and First aid appliances. Apart from the general mitigation measures site specific mitigation measures are also suggested for LDO Storage.

Disaster Management Plan: Anuppur STPP has already implemented a Disaster Management Plan for existing unit. New units shall also be included in the same plan. Emergency preparedness planning is divided in two subsections:

- **Onsite Disaster Management Plan:** The Onsite Disaster Management Plan is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operation in this same order of priorities. The important elements in the DMP suggested for emergency planning are- Reliable and early detection of an emergency and careful planning, Command, co-ordination, and response organisation structure along with efficient trained personnel, availability of resource for handling emergencies, appropriate emergency response actions, effective notification and communication facilities, regular review and updating of the EMP and proper training of the concern personnel.

  The management plan will include a sequence of action in order to handle disaster/emergency situations, with organizational chart entrusting responsibility to various plant personnel with their specific roles. Infrastructures & operational systems should be provided to meet emergencies. Assembly points, evacuation path should be marked. Different types of alarms to differentiate types of emergencies should be provided along with warning system and control, emergency services and fire protection systems.

- **Off-site Disaster Management Plan:** Under the Environmental Protection Act 1986, the responsibility of preparation of Off-site Emergency Plan lies with the State Government. The Collector/ Deputy Collector are ordinarily nominated by State Government to prepare Off-site Emergency Plan.

Natural Disasters: Madhya Pradesh State Disaster Management Authority is a nodal agency for preparation of disaster management plan of natural disaster of Madhya Pradesh. The plant and surrounding area fall in a moderate damage risk zone as per the recent earthquake categorization zone and subsequently general precautions and safety measures are recommended to be taken by the people before and after the earthquake.

Occupational Health and Safety Management Plan: Large industries, in general, and power plants in particular where multi-functional activities are involved during construction, erection, testing, commissioning, operation and maintenance, occupational health needs attention during all phases. However, the problem varies both in magnitude and variety in the above phases.

Assessment of Endemic Diseases of Environmental origin: Jaundice, measles and malaria are the endemic diseases in the region which occurs due to lack of hygiene and health facilities. District Health Department is a nodal agency to prevent the occurrence of diseases of environment origin. During construction of project, community toilets and sanitation facilities will be provided in labour colony so that stagnation of wastewater can be prevented. The following activities are being undertaken by MBPMPL to maintain sanitation & hygiene.

Corporate Social Responsibility: MBPMPL is committed to develop the surrounding area in a well-coordinated and balanced manner while safeguarding the environmental and social aspects under its CSR programme. Wherever possible, MBPMPL shall provide infrastructure to help set up local schools, centres for primary learning and education, and repair/construction of primary schools in neighbouring villages. MBPMPL is committed to inclusive development and will further strengthen its activities for improvement in education, sanitation and health, livelihood, rural infrastructure and rural sports.

The company has contributed substantially to the overall economy and social development of the area through CSR activities. The same will be continued in future, in addition to the social developmental activities for proposed expansion project. The operation zone of the social developmental activities for the proposed expansion project will be extended to the nearby villages of plant site.

The CSR Projects have been carried out in the area to align with the Sustainable Development Goal covering each segment and domain of the society which includes broadly the area of Education & Training, Livelihoods, Infrastructure & Development, Sports & Culture, Horticulture, Health & Sanitation.

A total amount of Rs 8.83 Crore has been incurred on CSR activities since inception till 2022-23.

11.9 Project Benefits

Hindustan Thermalprojects Limited, the thermal arm of Hindustan Power through its Special Purpose Vehicle ("SPV"), MB Power (Madhya Pradesh) Limited (“**MBPMPL**”), developed in 2 phases 1260

MW (2 X 630) coal-based generating capacity unit 1 in 2015 and unit 2 in 2016 at District Anuppur, Madhya Pradesh. The project benefits include-

- Improvement in infrastructure and community development.
- Improvement in Social infrastructure
- Direct & indirect employment opportunity
- Revenue generation to central & state government.
- Allocation of project cost towards the CSR activities.
- Trickledown effect of enhance profitability to the local populace
- Skill development and capacity building like vocational training, income generation programmes and entrepreneurship development program
- Awareness programme and community activities, like health camps, medical aides, family welfare camps, sanitization/ cleanliness awareness programme, immunization camp, sports & cultural activities, plantation, etc.
- Awareness about water borne diseases and pandemic diseases etc. will be done to local villagers.

Improvement in Physical Infrastructure & Community Development: Establishment of large developmental projects improve the availability of the physical infrastructure (like approach roads, drainage, communication and transportation facilities etc.) and social infrastructures (like education and health care system). These will also benefit the local population.

The power generated from this plant will benefit to large extent leading to industrial/ commercial development in the state of Madhya Pradesh and also in the country.

Improvement in Social Infrastructure: Implementing the proposed project is expected to have a favourable impact on existing infrastructure, creating conditions conducive to urban development in the region. Company will employ additional workers, supervisors and engineers available locally to the extent possible. Necessary medical facility will upgrade under CSR activities/ programs which will be beneficial to locals residing in the study area as per Companies Act.

Employment potential: Employees required for the proposed project are estimated to be around 450 nos through direct employment which would exist mainly with the contractors and sub-contractors along will unskilled people would be satisfied from the local population, depending on availability and feasibility. In addition to the direct employment opportunities, there will be indirect employment opportunities of local people in different sectors like horticulture, travel services, housekeeping and painting etc. During operation phase, there will be employment opportunities, mainly in service sector.

11.10 Cost Benefit Analysis.

The impact of the project was evaluated as per the current values in monetary terms. Most of the impacts were on the Air environment, as per MoEF&CC OM. No. 19-125/2019-Ia.III dated 05.03.2020 the monetary equivalence of the emissions was evaluated to be 21.49 crore. The water, noise, solid waste, ecology, social and land environments were not adversely impacted due to the mitigation measures.

Evaluating the benefits of the project including ecological benefit of the green belt, benefit to social environment through generation of electricity, benefit to economy through employment was a total of 789.39 crore.

The cost benefit ratio for the project was evaluated to be 1:36.7. The cost benefit analysis for the proposed MBPMPL's Anuppur TPP Stage- II (2x800 MW) indicates in favour of the project. The financial expenditure incurred in preventing, containing, mitigation or removing environmental contaminations occurring as a result of the proposed project activity will further add to the environmental benefit.

11.11 Environment Monitoring Plan

EMP Implementation, Inspection and Monitoring: This covers description of the administrative aspects of ensuring that mitigative measures are implemented and their effectiveness monitored, after approval of the EIA/ EMP report and grant of Environmental Clearance (EC). The assessment of environmental impacts and mitigation measures have been identified for effective operation of environmental management activities in the pre-construction, construction, commissioning and operation & maintenance (O&M) activities.

Components of EMP: Environmental Management Plan comprises of the components of i) Institutional Arrangements; ii) Monitoring Programme/ plan; iii) Environmental Enhancement Measures; and iv) Social Enhancement Measures.

Institutional Arrangements: An Environmental Management Cell (EMC) is envisaged which is responsible for monitoring EMP and its implementation. Environment management is the responsibility of the environment management cell headed by the Head – HSE and comprising of Head Environment, Engineers, Safety Officer, Chemists etc. Head HSE is directly reporting to the CEO/ Plant Head of the organization. Plant Head is responsible for environment management activities for the organization. The company has well established compliance management system. A separate legal team available for the same.

Operation and Maintenance Group: O&M team head would have primary responsibility for the operation & maintenance of the power station. MBPMPL Anuppur has Operation & Maintenance Group Management Organization headed by a GM (O&M) and is assisted by a team of managers & engineer. This O&M Group Organization will take up additional responsibility of operations, maintenance and monitoring of pollution control equipment/system related to proposed Ultra Super Critical Thermal Power Plant. O&M team is expected to comprise four broad functional areas viz. operations, maintenance, engineering, support service and administration.

Occupational Safety: In power plant, primary safety hazards include burns, slips, falls, fire and explosions. Electrical hazards and the risk of electrocution are significant due to high voltage in electrical lines. To prevent and reduce accidents safety measures including spatial measures, insulation, guard rails, shield guards, grounding of electrical equipment, protective measures, mock drills and regular safety awareness programs and training will be conducted for all workers.

Ash Utilisation Plan: 100% Ash will be utilised in Cement Industries, reclamation of abandoned mines and low lying areas, manufacturing of bricks and road construction.

Environment Enhancement Measures:

- **Tubular Daylight Devices (TDDs):** Tubular daylighting devices are a versatile alternative to traditional skylights because they can be used to provide light to areas that are not in a direct line of sight with the sun. Tubular daylighting devices (TDDs) utilize a rooftop dome to harness sunlight, which is then directed through a reflective tube. TDDs are more effective than traditional skylights or windows because of the reflective tubing, delivering maximum daylight with minimal heat transfer.
- **Greenbelt:** Out of the total area for the Existing plant of 417.996 Ha, greenbelt encompasses 110.33 Ha, accounting for 26.4% of the project area. Density of 2500 trees/ha will be maintained. A total of more than 2 lakh trees have been already planted within the plant premises. Further, -45.991 Ha land is proposed to be developed as greenbelt & plantation inside and outside MBPMPL premises. The greenbelt shall have 3-tier plantation as per the CPCB guidelines with re-densification & strengthening of existing greenbelt.
- **Rainwater Harvesting:** The rainwater available for harvesting is calculated 17,37,480 m3 or 1.7 MCM per annum. There is no extraction of groundwater for project. Provision is made for rainwater harvesting to collect stormwater from roof top, road/paved areas, greenbelt and open areas.

Social Enhancement Measures:

- **Training:** Management will be responsible to instruct employees in proper use of all equipment operated, safe lifting practices, location and handling of fire extinguishers, and use of personal protective equipment and overall education and training in good safety practices.
- **Welfare Activities & Facilities for Employees:** In addition to the plants & equipment for the generation of power facilities like construction offices and stores, time and security offices, first aid and fire-fighting station, canteen, parking, training stations, toilets and restrooms shall also be adequately furnished and equipped. The work atmosphere will be monitored for SPM, SO_2, and NO_x etc. to avoid excessive exposure.
- **Cost of Environment Management Measure:** A cost provision of Rs. 3,067.6 crores towards providing environmental measures have been earmarked and the recurring cost (Operations & Management will be about Rs. 72.22 Crore per annum).

12 Disclosure of Consultant

12.1 Introduction to the ACO

Greencindia Consulting Private Limited (GCPL) is an environmental consultancy organization, manned by a highly qualified, experienced and multidisciplinary team of scientists and engineers. The company has received accreditation from the Quality Council of India (NABET-QCI) as an EIA Consultancy organization. The company has its own sophisticated in-house laboratory which is accredited by NABL.

The primary aim of GCPL is to sensitize policy planners and local people about their development needs through the capacity building process. The company facilitates managerial and technical expertise to people and associations for the development of areas and regions.

GCPL has undertaken more than 110 EIA and other associated studies and clearances for township & area development projects, mining projects, thermal power projects; airports, road and highways, special economic zones (SEZs); urban infrastructure projects, etc.

GCPL has been appointed by the Project proponent to carry out Environment Impact Assessment Studies for the proposed project.

The main objects of the Company are as follows;

- To carry on the business of providing all types of consultancy services related to Social And Environmental Impact Assessment, Environment Action Plan, Tribal Development Plan, Resettlement and Rehabilitation Action Plan, Project Information Report, Detailed Project Report, Need Assessment Report, Corporate Social Responsibility Plan, Forest Diversion Plan, Wildlife Conservation Plan, Drainage Plan and Hydrogeology Environment, Social & Land related legal services and any other consultancy services and studies related to urban development, rural development, environment, forest and legal aspects.
- To provide consultancy services in environment monitoring, sample collection of air, water, soil, meteorological data and publish testing results for the collected samples
- To undertake research study in the field of environment, social, legal, agriculture, urban planning, rural planning, alternate sources of energy etc. and provide consultancy/advisory/training services in these fields to government, quasi-government, and non-government and private institutions.
- EPFI reporting, environmental and social impact assessment according to IFC guidelines and equator principles.

12.2 Area of Expertise

- Environmental Impact Assessment

- Environmental Management Plan
- Disaster Management Plan
- Risk Assessment
- Rehabilitation & Resettlement Plan
- Pre-feasibility Report
- Detailed Project Report
- Geo-Technical Investigation
- National, Regional and Urban Plans
- Management Information System and Geographic Information system
- Urban Infrastructure Development including Water Supply and Solid Waste Management
- Environmental Monitoring and Assessments
- Impact Assessment Formulate Policies & Mitigation Measures R&R
- Natural Resource Management
- Terminal Planning and Design
- Institutional Strengthening
- Development, Functional and Strategic Planning and Design
- Preparation of Manuals
- Training Programmes

12.3 Achievement of the Company

Greencindia Consulting Private Limited (GCPL) is an ISO 9001:2008-QMS, 14001:2004-EM and 18001:2004-OHSAS certified company. The company is accredited with QCI-NABET since 2010. We are accredited for following sectors: -

- Townships & Area development projects.
- Thermal Power Plants.
- Mining Project-Open Cast & Underground Mining.
- Coal Washery.
- River Valley Projects.
- Metallurgical Industries (Ferrous and Non-Ferrous).
- Industrial Estate/Parks/Complexes/areas, export processing zones, special economic zones, biotech parks, leather complexes.
- Highways.
- Cement Plants.
- Oil & gas transportation pipelines.
- Common Municipal Solid Waste Management Facility.

- Airports.
- Buildings and construction projects.

12.4 Team Involved

GCPL comprises of a group of professionals drawn from development-related fields. The core members of the GCPL team hold experience in Developmental Planning, Pollution Control, Economic Analysis, Social Work and Information Technologies. In addition, there is a panel of senior associates and young voluntaries facilitating the various programmes. The brief resume of the Environment Coordinator and Functional Area experts (Core Functional Areas & Significant Functional Area) is discussed in **Table 12.1**.

Table 12-1: Brief Description of Team

Sl. No.	Name of Expert	Years of Experience	Area of Specialization	Involvement (Period & Task)
1	Nandini Choudhury	22	EC	**FEBRUARY 2024 TO TILL DATE** Selecting the team to be involved in the EIA report. ▪ Visiting the site for appropriate duration for the selection of sampling locations and deciding the type of samples in consultation with the FAEs. ▪ Reviewing the process write-up ▪ Developing the EIA report and circulating the same amongst EIA team members for final feedback and ensuring coverage of the respective functional areas FA in the EIA.
CORE FUNCTIONAL AREAS				
2	Dr. Subinoy Mondal	10	Water Pollution-WP	▪ **FEBRUARY 2024 TO TILL DATE** Selection of Monitoring location for ground water and surface water ▪ Assessment of Impact associated with the project operation activities ▪ Preparing cost estimate for treatment of waste water. ▪ Development of Water Management Plan.
3	Nandini Choudhury	22	Socio-economy-SE	**FEBRUARY 2024 TO TILL DATE** ▪ Assessment of impact associated with the project. ▪ Interpretation of primary and secondary data to derive socio-

Sl. No.	Name of Expert	Years of Experience	Area of Specialization	Involvement (Period & Task)
				economic status of PAFs/PAPs and related stakeholders. ▪ Assessment of social changes arising out of the project. ▪ Suggesting measures to enhance the socio-economic status of the people living in and around the project.
4	Dr. Sangeeta Verma	6	Ecology & Biodiversity-EB	**FEBRUARY 2024 TO TILL DATE** ▪ Survey of existing flora & fauna in the study area ▪ Assessment of impact associated with project ▪ Selection of species for greenery development. ▪ Preparation of conservation plan for scheduled species ▪ Assistance during development of project management plan.
SIGNIFICANT FUNCTIONAL AREAS				
5	Nandini Choudhury & Dr. Sangeeta Verma	22	Land-use	**FEBRUARY 2024 TO TILL DATE** ▪ Development of Land-use Map ▪ Impact of project on surrounding land use ▪ Assistance during development of project management plan. ▪ Suggestion of mitigation measures due to change in land uses by the project.
			Soil Conservation-SC	**FEBRUARY 2024 TO TILL DATE** ▪ Baseline data generation for soil sampling analysis and characterization of soil. ▪ Assessment of fertility/productivity of soil. ▪ Suggesting soil conservation measures.
6	G.C. Patnaik	40	Air Pollution-AP	**FEBRUARY 2024 TO TILL DATE** ▪ Identification of sources of air pollution and most suitable control device and mechanism.

Sl. No.	Name of Expert	Years of Experience	Area of Specialization	Involvement (Period & Task)
	Shyam Sunder	30		**JULY 2024 TO TILL DATE** ▪ Assessment of impact associated with the project operation activities ▪ Assessment of impact associated with vehicle movement operation ▪ Development of management plan to control the air pollution & its mitigation.
7.	G.C. Patnaik	40	Risk & hazard-RH	**FEBRUARY 2024 TO TILL DATE** ▪ Assessment of risk likely to be generated from the project activities. ▪ Preparation of emergency preparedness plan. ▪ Development of disaster management plan for the project.
8	Shyam Sunder	30	Air quality modeling-AQ	**FEBRUARY 2024 TO TILL DATE** ▪ Study of wind pattern & wind conditions.
				JULY 2024 TO TILL DATE ▪ Developing micro-meteorological data for use in modeling. ▪ Quantitative assessment of project impact associated with project activities using AERMOD.
9	Nirzar Ajay Lakhia	18	Geology-Geo	**FEBRUARY 2024 TO TILL DATE** ▪ Study of geological and rock structure of the study area based on secondary data and literature survey.
			Hydrogeology-HG	**FEBRUARY 2024 TO TILL DATE** ▪ Study of hydrogeological study of the study area. ▪ Study rainwater harvesting and groundwater fluctuation in the study area.

Sl. No.	Name of Expert	Years of Experience	Area of Specialization	Involvement (Period & Task)
10.	Rahul Singh	20	Noise & Vibration-NV	**FEBRUARY 2024 TO TILL DATE** ▪ Assessment of noise and vibration likely to be generated from the project activities. ▪ Assessment of impact associated with project. ▪ Assistance during development of project management plan.
11.	Shyam Sunder	30	Solid & Hazardous Waste-SHW	**JULY 2024 TO TILL DATE** ▪ Identifying source of waste generation. ▪ Quantitative assessment of hazardous and industrial solid waste likely to be generated. ▪ Development of management, handling and disposal techniques. ▪ Suggesting measures for minimization of waste generation.

12.4 QCI Accreditation Certificate

GCPL is accredited under the QCI-NABET scheme for accreditation of EIA consultants organizations vide certificate number: NABET/EIA/1619/RA0058 on 28.06.2017 for Building and large construction projects and Townships & Area Development Projects, Thermal Power Plants, Metallurgical Industries (Ferrous only)-both primary & secondary, Industrial Estate Planning, Common Municipal Solid Waste Management, Highways, Railways, transport terminals, Cement Plants, MRTS, Building and large construction projects and Mining Projects (open cast only). Validity of the accreditation is extended till 22.02.2023 vide certificate no. **QCI/NABET/EIA/2023/SA0155** (Copy enclosed as **Annex 12.1**).

- **ACCREDITED LABORATORY**

The analytical tests for GCPL are conducted by M/s EEPL, Kolkata which was accredited by MOEF&CC. GCPL has signed MoU with M/s EEPL for specialized testing and analysis of samples from their laboratory enclosed as **Annexure-12.2**).

QUALITY COUNCIL OF INDIA
QCI Creating an Ecosystem for Quality

NABET

National Accreditation Board for Education and Training

NABET

Certificate of Accreditation

Greencindia Consulting Private Limited, Ghaziabad

605-611, Level-5, Sector-5, Shopprix Mall, Vaishali, Ghaziabad-201010

*The organization is accredited as **Category-A** under the QCI-NABET Scheme for Accreditation of EIA Consultant Organization, Version 3: for preparing EIA-EMP reports in the following Sectors –*

S. No	Sector Description	Sector (as per)		Cat.
		NABET	MoEFCC	
1.	Mining of minerals including opencast and underground mining both	1	1 (a) (i)	A
2.	River Valley projects	3	1 (c)	A
3.	Thermal power plants	4	1 (d)	A
4.	Coal washeries	6	2 (a)	A
5.	Metallurgical industries (ferrous & non-ferrous)	8	3 (a)	A
6.	Petroleum refining industry	10	4 (a)	A
7.	Petro-chemical complexes	18	5 (c)	A
8.	Petrochemical based processing	20	5 (e)	A
9.	Air ports	29	7 (a)	A
10.	Industrial estates/ parks/ complexes/areas, export processing Zones (EPZs), Special Economic Zones (SEZs), Biotech Parks, Leather Complexes	31	7 (c)	A
11.	Common hazardous waste treatment, storage and disposal facilities (TSDFs)	32	7 (d)	B
12.	Highways	34	7 (f)	A
13.	Common Effluent Treatment Plants (CETPs)	36	7 (h)	B
14.	Building and construction projects	38	8 (a)	B
15.	Townships and Area development projects	39	8 (b)	B

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in RAAC minutes dated July 18, 2023 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no QCI/NABET/ENV/ACO/23/2862 dated Aug 25, 2023. The accreditation needs to be renewed before the expiry date by Greencindia Consulting Private Limited, Ghaziabad following due process of assessment.

Sr. Director, NABET Dated: Aug 25, 2023	Certificate No. NABET/EIA/2326/RA 0297	Valid up to Feb 22, 2026

For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to the QCI-NABET website.

NABET Certificate

National Accreditation Board for
Testing and Calibration Laboratories

NABL

CERTIFICATE OF ACCREDITATION

LABORATORY DIVISION, ENVIROTECH EAST PRIVATE LIMITED

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2017

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

100, KALIKAPUR, KOLKATA, WEST BENGAL, INDIA

in the field of

TESTING

Certificate Number: TC-12649

Issue Date: 24/11/2023 Valid Until: 23/11/2025

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.
(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Name of Legal Entity: Envirotech East Private Limited

Signed for and on behalf of NABL

N. Venkateswaran
Chief Executive Officer

NABL Certificate