Annexure – XIV

M/s. STRATATECH MINERAL RESOURCES PRIVATE LIMITED

CUMULATIVE IMPACT ASSESMENT FOR DHIRAULI COAL BLOCK COMPRISING OF SULIYARI, DONGRITAL –II PHASE II, MARA II MAHAN, DONGRITAL –II PHASE II, MAHAN, CHHATRASAL, DONGRITAL, PATHPAHARIYA, SARAI EAST, BANDHA, BANDHA NORTH, GURBARA SOUTH, SARAI WEST, GURBARA CENTRAL, PACHAUR AT SINGRAULI COAL FIELDS, SINGRAULI

2023

PROJECT PROPONENT

M/S. STRATATECH MINERAL RESOURCES PRIVATE LIMITED

Adani Corporate House", Shantigram, Near Vaishno Devi Circle, S.G. Highway, Khodiyar Ahmedabad-382421,Gujarat, India

ENVIRONMENT CONSULTANT

VARDAN ENVIRONET

(QCI/NABET ACCREDITED NO. NABET/EIA/1922/RA0166)
PLOT NO.: 82 A, SECTOR-5, IMT MANESAR, GURUGRAM- 122052, HARYANA
E-mail: mining@vardanenvironet.com
Contact: +91 9899651342, +91 9810355569

Table of Contents

List of Tables

List of Figures

List of Annexure

CHAPTER-1
INTRODUCTION

1. INTRODUCTION

1.1 Introduction

Stratatech Mineral Resources Private Limited (SMRPL), a Private company wholly owned by the **Adani Enterprises Limited (AEL).** It has been planned to conduct mining operations through open cast mining with capacity of 5 MTPA and 1.5 MTPA through underground mining at Singrauli Coalfield, Singrauli District, Madhya Pradesh.

The **Dhirauli Coal Block** in Singrauli Coalfield, in the State of Madhya Pradesh has been allocated to M/s Stratatech Mineral Resource Private Limited (SMRPL) vide Letter No. NA-104/7/2020-NA dated 03.03.2021 by MoC, GoI. Copy of the allocation letters is enclosed as Annexure-1.

The ultimate target production capacity is estimated as 6.5 MTPA (OC-5 MTPA; UG-1.5 MTPA) from Dhirauli Coal Mine. The production build up has been planned in such a way that it will meet the requirement peak production of 5.0 MTPA of Opencast in the 3rd year of mine operation.
A buffer of 15 Km for the cluster i.e Dongrital, Dongrital –II phase 1, Dongrital –II phase 2, Pathpahariya, Suliyari, Dhirauli, Mara to Mahan, Mahan, Chatarsal, Bandha, Sarai East, Sindhrawal has been considerd as the study area for the proposed cumulative Study.

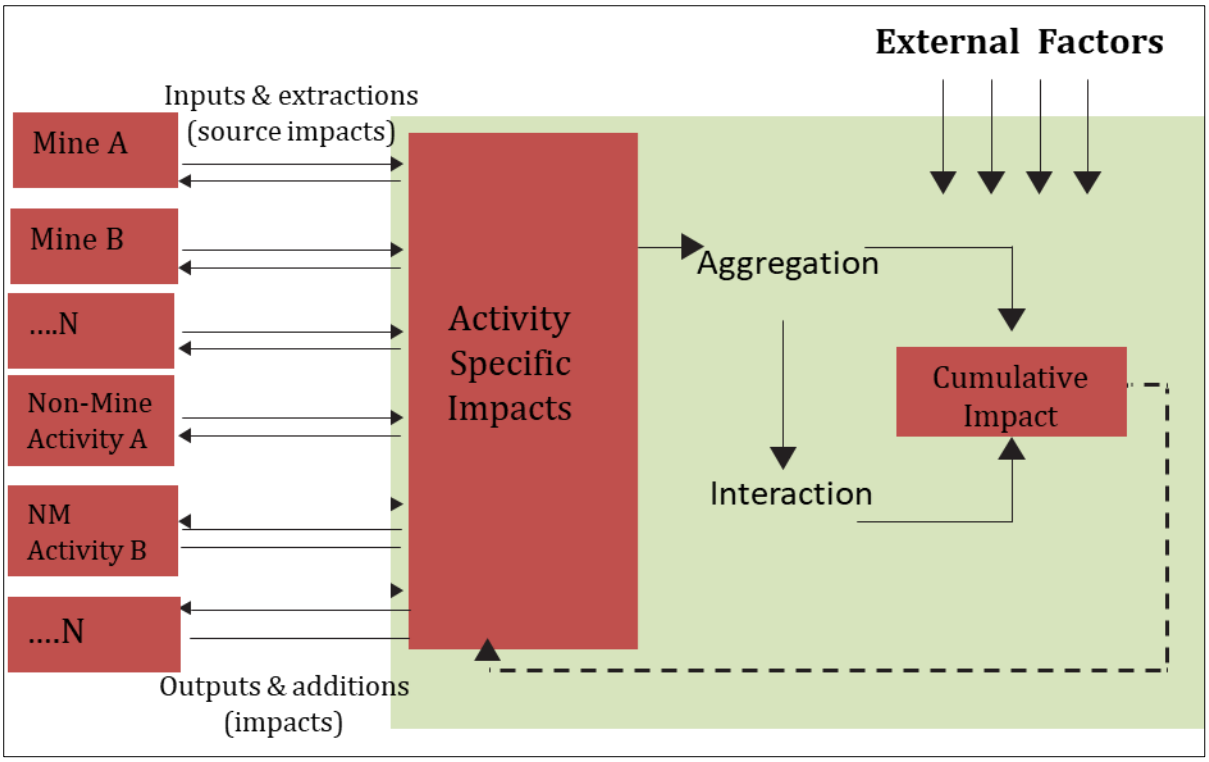
1.2 Purpose of the Report

Expert Appraisal Committee (Coal Mining) of Ministry of Environment & Forest in its 15th meeting held on 6th July 2021, recommended Terms of References for EIA/EMP Study of Dhirauli Coal Block of M/s Stratatech Mineral Resources Pvt. Ltd. (SMRPL) District Singrauli, (Madhya Pradesh. Subsequently, Ministry of Environment, Forest & Climate Change (MoEF&CC) issued Terms of References (ToR) for conducting EIA Study vide letter no. J-11015/49/2021-IA.II (M) dated 3rd August 2021 (Copy enclosed as Annexure-2).

As per condition no. 4 (iv) of the Terms of References, Cumulative study has been mandated which is reproduced below;

"In addition to existing data already collected (if any), the Cumulative Impact Assessment Study, carrying capacity and ecosystem services study of the area shall be carried over by project proponent considering the project being in Singrauli, having ~ 1400 ha of forest land and presence of other coal mining activity and industries. PP shall collect one season baseline data of all environmental parameters and shall compare with the data of earlier data collected for cumulative assessment of area. Air pollution impact prediction shall be conducted by considering the maximum values."

Environment cumulative effects assessment is to systematically analyze and assess the cumulative effects of ecology and environment resulted from coal exploitation, including cumulative sources, cumulative process, cumulative effect investigation, analysis, identification, description and explanation, the cumulative effect caused by the past, existing and planned development activities, the evaluation and prediction of impacts on society economy development, suggestions of development scale, speed and mode which is in accord with the sustainable development requires. Single factor assessment and comprehensive assessment are involved in the cumulative effect assessment, compared with general environment assessment, the traditional coal mining environment impacts assessment (EIA) usually aims at the individual development project assessment, while the cumulative impacts assessment (CIA) includes a wide range of mining environmental problems. EIA only considers the impact of individual project, while CIA not only includes impacts from a number of projects or behaviors, the direct and indirect effects of each item should be taken into account.



1.3 Characteristics approaches to cumulative impact assessment

The approach is to consider the combined effects of all elements of a single project on multiple environmental values:

Aspect	Cumulative driven approaches
Description	Assessment of single, multiple projects or multi-component activities
Regulatory characteristics	Single or multiple proponents
Trigger	Cumulative effects of project actions on specified environmental values in the project locations, or cumulative effects of multiple projects on a region or regional environmental values
Spatial bounds	Site specific, focused on direct on-site and off-site impacts
Environmental objective	Generally, to ensure effects are within acceptable levels

1.4 Study Area and Size of the Project

Cumulative study has been carried out, considering the impact on the environment due to operation of the Twelve mining block which are in a single Cluster i.e. (Dongrital, Dongrital –II phase 1, Dongrital –II phase 2, Pathpahariya, Suliyari, Dhirauli, Mara II Mahan, Mahan, Chatarsal, Bandha, Sarai East, Sindhrawal). Entire study area has been considered as single environmental unit owing to similar climatic factors for further study **(Figure 1.1, 1.2, 1.3).**

A buffer of 15 Km from the cluster i.e (Dongrital, Dongrital –II phase 1, Dongrital –II phase 2, Pathpahariya, Suliyari, Dhirauli, Mara II Mahan, Mahan, Chatarsal, Bandha, Sarai East, Sindhrawal) has been considerd as the study area for the proposed cumulative Study report. Total cluster area of mines Brief about the all mine is as below and also described in **Table No 1.1.**

Dhirauli opencast coal mine covers an area of 2672 Ha and located in eight villages Dhirauli, Phatpani, Sirswah, Amdand, Jhalari, Amraikhoh, Bansibridha, and Belwar, lies within the latitude 23°03’04” N to23°56’07” N and longitude 82°19’04” E to 82°24’21” E. The proposed project is a mechanized opencast and underground coal mine. The production capacity of the project is 6.5 MTPA (5 MTPA Opencastt and 1.5 MTPA underground).

Annexure-1: Allotment Letter for Dhirauli Coal Block
Annexure-2: Terms of References Issued by MoEF&CC
Annexure-3: Lab Reports (March to may 2021 and October to Dec 2021)

Table 1.1: Description of Other Coal Blocks in the Study Area

Mine	Area (in Ha)	Rated Production capacity	Distance from Mine
Suliyari	1298	5.0 MTPA	Adjacent, SW
Dongrital –II phase II	3027	Explored	Adjacent, W
Mara II Mahan	5364	Partially explored	Adjacent,SE
Dongrital –II phase 1	1392	Explored	3.22 KM, W
Mahan	937	Partially explored but not alloted	3.8 KM, N
Chhatrasal	971	Explored but not alloted Yet	6.8 KM,NE
Dongrital	2366	Partially explored but not alloted	7.9 KM, SW
Pathpahariya	1349	Partially explored	8.7 KM,SW
Sarai East	1889	Mine is under exploration	8.9 KM, W
Bandha	1850	5.0 MTPA (Submitted for EC)	9.41 KM, N
Bandha North	1490	Mine is under exploration	12.8 KM,N

Gurbara South	29.43	Mine is regionally explored	12.8 KM, NW
Sarai West	1505	Mine is under exploration	12.9 KM,W
Gurbara Central	2604	Mine is regionally explored	14.09 KM,NW
Pachaur	10.12	Mine is under exploration	14.6 KM,N

Source: Parivesh, CMPDI Website (https://oldsite.cmpdi.co.in/OCBIS/dashboard.php)

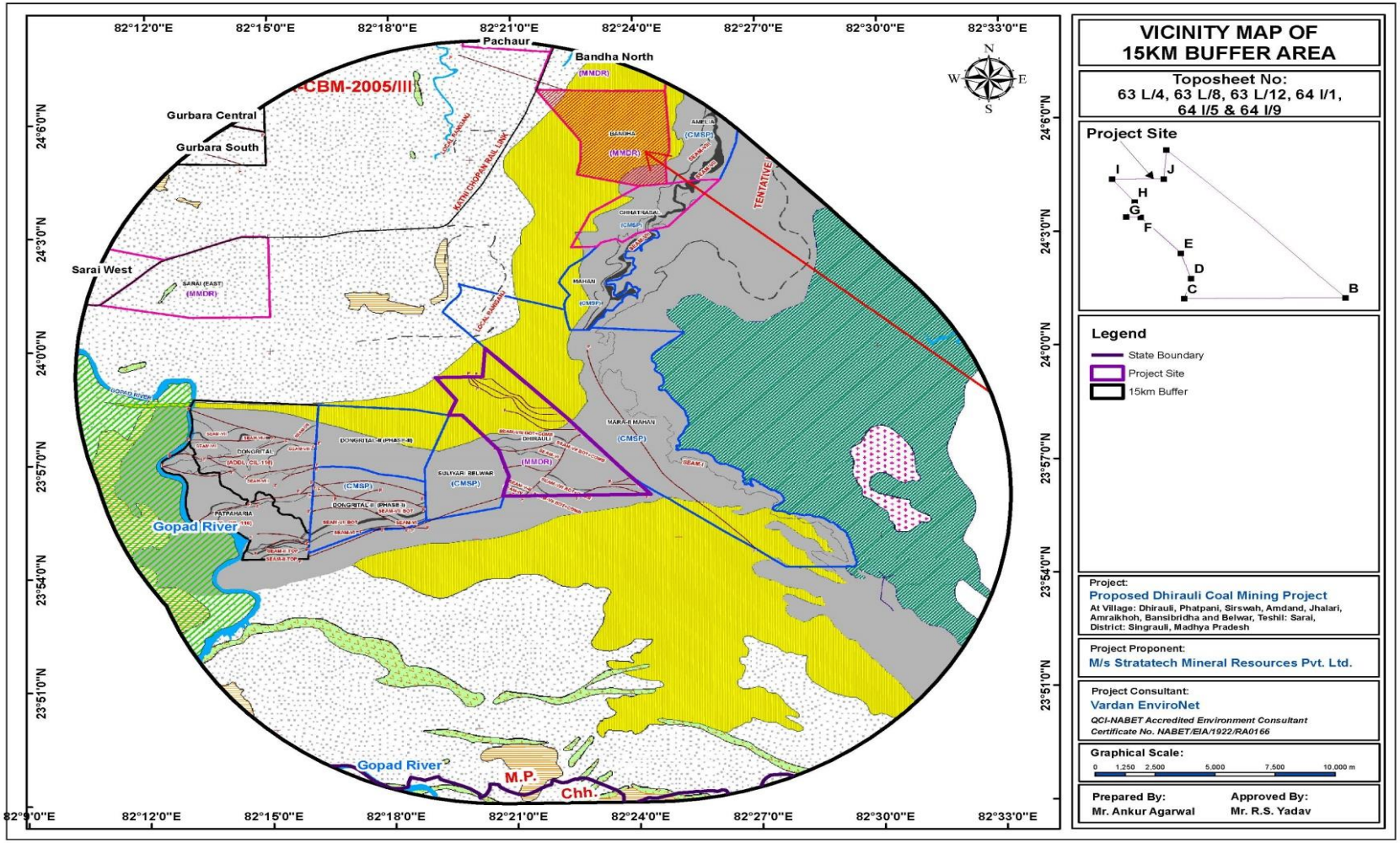


Figure 1.1: Map Showing the Mines in 15 KM vicinity

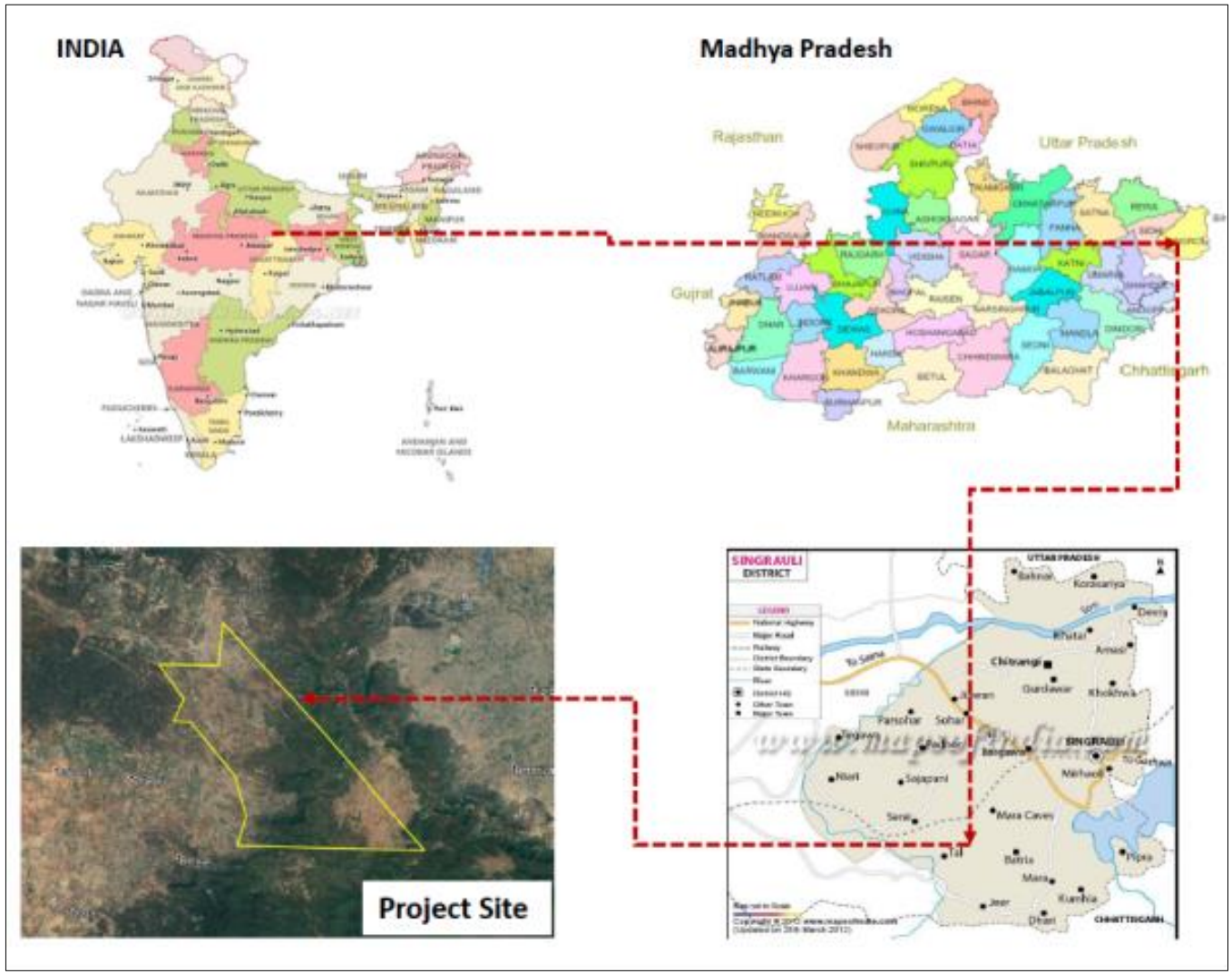


Figure 1.2: Geographical Location of the Study Area

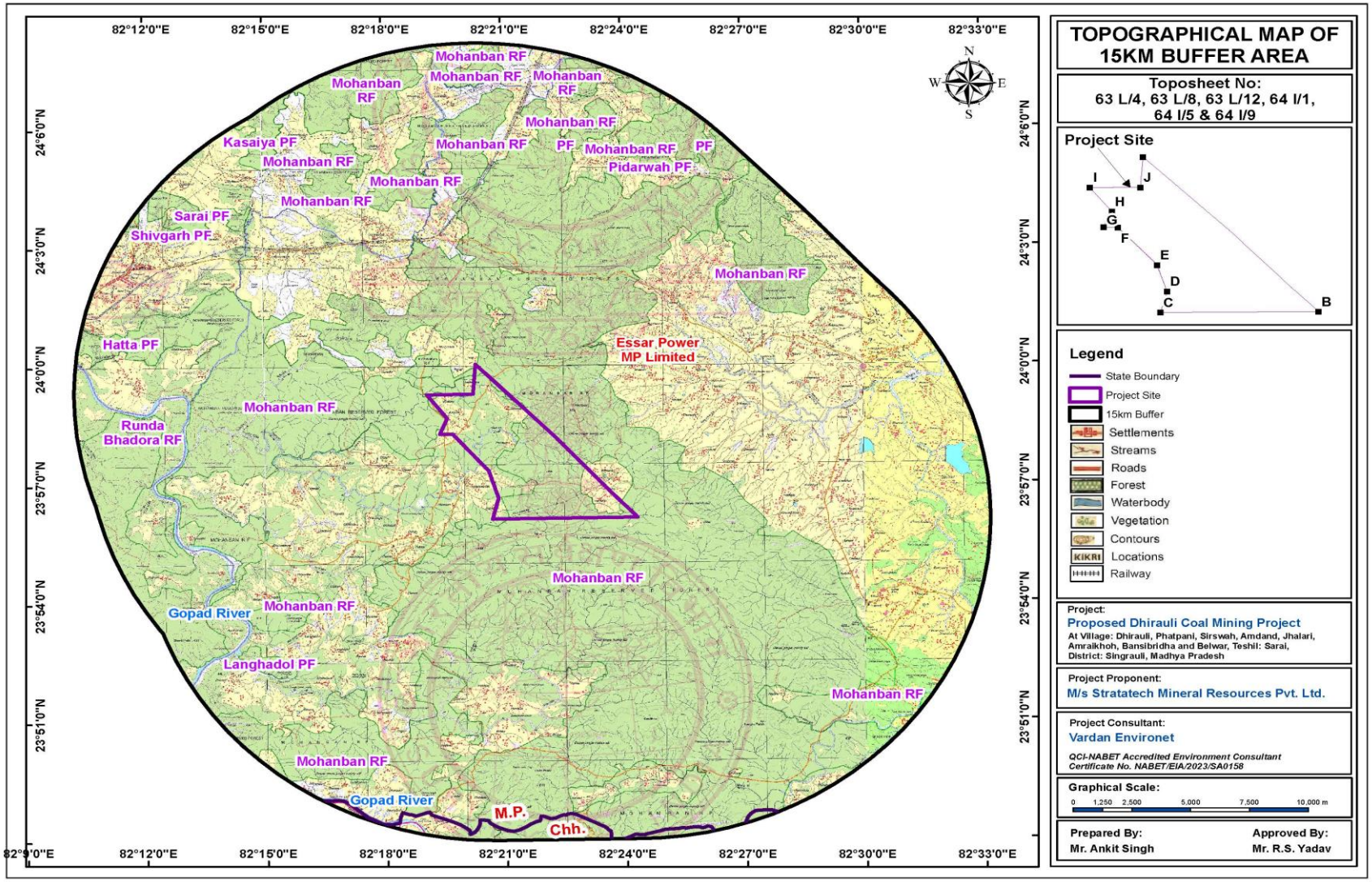


Figure 1.3: Geographical Location of the Study Area

1.4.1 Accessibility of Dirauli Coal Block

The block is located at about 70 km south-west of Singrauli township, whereas, it is around 50 km south-west of Waidhan township, the District Headquarter of Singrauli District. All blocks are well contacted with the tehsil and districts headquarter through Major district road followed by NH-75 at 23 Km in N. A metalled road from Parsona to Mara is located further east of the block. An un-metaled road branching out of this at Rajmelan culminates at Sarai. From this road to the west of River Mahan, a north-south running road leads to Langadda via Bhalyatola, Suliyari & Jhalri. The block is also accessible by an all weather metalled road from Singrauli as well as from Waidhan. The distance of Sarai-Gram, the nearest major railway bstation on Chopan-Singrauli-Katni line of central railway is about 18 km from the block. The nearest Airport is Varanasi which is at a distance of about 250 km from Waidhan. Shakti Nagar is an important industrial town in the vicinity of Singrauli and Waidhan townships. The other very important industrial township & railway station Renukoot is at a distance of 70 km from Waidhan on Chopan-Garwah Road section of eastern railway. Block is traversed by number of fair weathered and forest roads. The important villages in and around the block are Suliyari & Dhirauli villages located within the block, while village Jhalri & Majhalipath are located outside, west of the block.

Table 1.2: Infrastructure Details of Near Project Area

Parameters	Description	Distance (km) from Lease Area	Direction from Lease Area
Nearest Railway Station	Sarai Gram	18	North-West
Nearest Airport	Varanasi	250	North East
Nearest Highway	Waidhan-Sidhi State Highway	20 Km	North
Nearest Major Settlement	8 villages within the mine	-	-
Nearest Water Body	Hurdul Nala	0.0	Flows from east to west

Source: (i) Satellite Imagery of Study Area; (ii) Open Series Map (SOI) Sheet No. 63 L/4, 63L/8, 64 I/1 & 64 I/5; (iii) Google Earth Inc

1.4.2 Topography & Drainage

Western part of Dhirauli block is characterized by almost plain topography, while, north-eastern and south-central part are highly undulating and have rugged topography as evident from the topographical plan. The northeastern and south central part of the block have forest cover and is occupied by hillocks of elevation up to a maximum of 638 m above MSL. In general elevation of ground varies from 459.23m as observed near borehole MSD-102 to 603.45 m near borehole MDP-19 located in the south-western and south-eastern corner of the block respectively.

Drainage of the block is mainly controlled by westerly flowing Hurdul Nala which traverses the block and passes almost through central part of the block. Many small seasonal nallas originating from elevated topography of north eastern and south-central part of the block drain its water into HurdulNala. The minor nallas and tributaries present in the block shows dendritic to sub-dendritic drainage pattern.

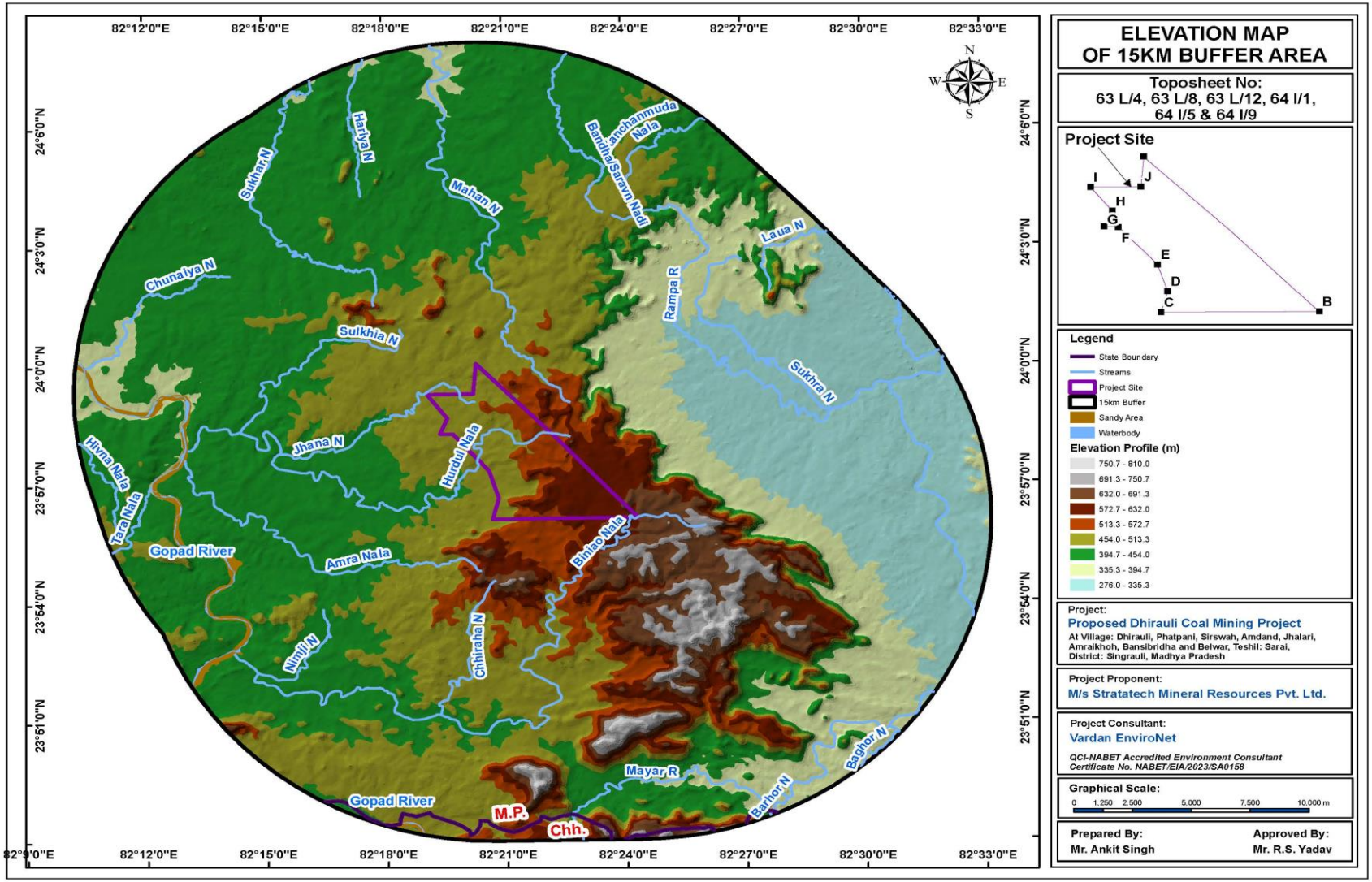


Figure 1.4: Elevation Map of the Study Area

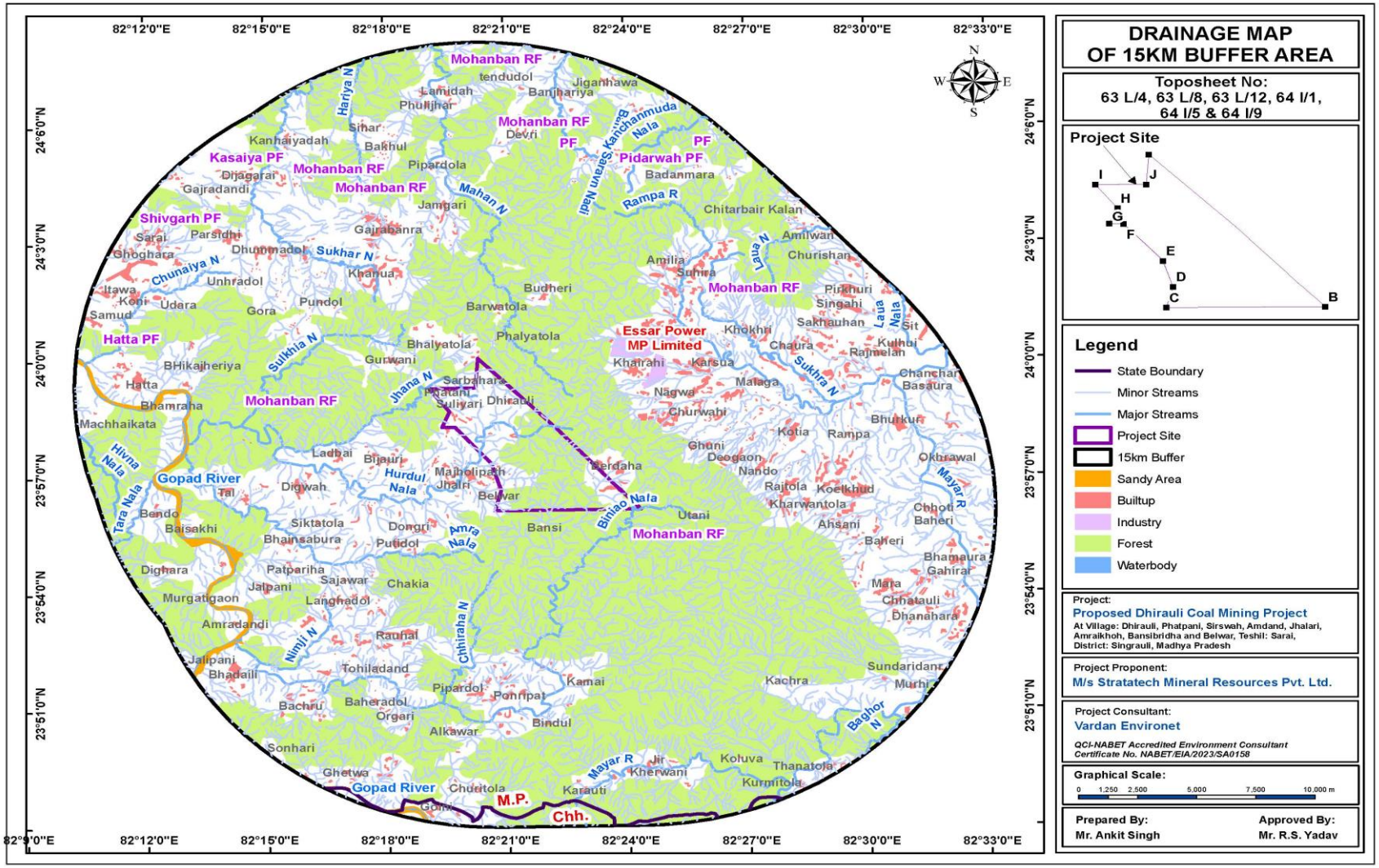


Figure 1.5: Drainage Map of Study

CHAPTER-2
APPROACH & METHODOLOGYOF THE STUDY

2. APPROACH & METHODOLOGY OF THE STUDY

The cumulative study of the mines has been taken into account for assessment the cumulative impact of the eco-system. This cumulative impact assessment has been undertaken on the basis of the following steps:

Review of the impact assessments within the cluster area , which provide a concise list of potential Project impacts in isolation to other proposed projects.
Identify projects that are either proposed or recently approved but not yet operational and located within general vicinity of the Project Area
Determine those impacts of the Project (Mine) that may overlap with impacts from other identified projects.

Identify the significance of the cumulative impact upon the existing environment on the basis of Impect matrix

As per the direction of EAC "In addition to existing data already collected (March to May 2021). PP has collected one season additional baseline data (October to December 2021) compairing the baseline data with the earlier data collected cumulative impact assessment of area has been done.

The baseline environmental quality has been assessed through field studies within the impact zone for various components of the environment, viz. air, noise, water, micro-meteorology, land, and eco-biodiversity, socio-economy. The main objectives of the study are:

To Assess Present Environmental Quality and the Environmental Impacts;
To Identify Environmentally Significant Factors That Could Preclude Project Development;
To achieve these objectives, a team of functional area experts monitored the environmental parameters within the core zone and buffer in accordance with the Guidelines issued by the Ministry of Environment, Forests & Climate Change (MoEF&CC), Govt. of India.

For the present study, the cumulative site is considered as core zone and the area lying within 15 km radius from the boundary of cluster is considered as buffer zone.

Secondary data has been collected from various source such as EIA/EMP Study Reports of Singruli coal field, Wildlife Conservation Plans, Mining Plans etc to study the physical and biological environment as well as demography of the area in order to determine Mine management & Allied Activities (Operation, Dump management, technology adopted in operational mine, Transportation, Reclamation etc. proposed or operational) for cluster block.

Primary data has also been collected from the core area and the buffer area for the Pre monsoon season i.e March to May 2021 and post monsoon season i.e October to December 2021. Methodology use for the study is given in the below **Table 2.1.**

Table 2.1: Methodology of the Study

Parameter	Methodology	Instrument Used	Data Collection	
			Secondary Data	Primary Data
Air Quality	Ambient air monitoring (24 hourly samples), twice a week for PM_{10}, $PM_{2.5}$, SO_2, NO2, CO. Meteorological Parameters, Wind Speed, Wind Direction, Relative Humidity, Temperature, Precipitation etc. Air Pollution Dispersion Models. IS-5182, (CPCB guidelines for measurement of Ambient Air Pollutants)	Respirable Dust Sampler with attachment for Gaseous Pollutant Envirotech Model APM460, Fine Particulate Matter (FPM) Sampler, Dry and Wet Bulb Thermometer, Micro Meteorological Station, Global Positioning System (GPS). AERMOD.	Historical data on climatologically parameters, CPCB, SPCB, IMD.	Site survey and Baseline data collected.
Water	Physiographic studies of the proposed coal mine area and its surroundings with the help of latest Google images, site visit, GPS survey etc. Standard limits: Surface water-IS:2296 Ground water-IS 10500:2015 Sampling Methodology-IS:3025, APHA	Resistivity meter, water level indicator, piezometer, GPS. PH meter, EC meter, BOD sampler, Hand-held open-mouth bottle sampler etc.	CGWB data, BHUVAN, WRIS.	Site survey and Baseline data collection.
Soil	Sampling	AGUER	District Soil	Site survey

Parameter	Methodology	Instrument Used	Data Collection	
			Secondary Data	Primary Data
	Methodology and Analysis- IS: 2720		health card	and Baseline data collection
Noise	IS:9989(Assessment of noise with respect to community response)	Sound level meter	CPCB/PCB	Site survey and Baseline data collection
Land	Use of Remote sensing technology to analysis the impact on land on the project area and study area using GPS survey, ground truthing, Reconnaissance survey etc.	GPS, DGPS, Total station, RKS, Drone etc.	Survey of India topo-sheet, administrative atlas, zoning atlas, master plan, zoning plan, ESZIS atlas, Soil Atlas, Hydro geology Atlas etc.	Satellite imagery through NRSC, BHUVAN, Google earth and site survey etc.
Social and economic	A judgmental and purposive sampling method. Questionnaire based pre-structured Feedback Surveys and Interviews.	-	Census 2011 records, District Statistical Handbook, Revenue data from Mine Department. Tehsil data	Site survey and Baseline data collection
Ecology and Biodiversity	Inventory Method, Quadrate Method, Pollard Walk' Point Sampling' etc.	Binocular GPS, Tree calliper measuring tap rope, Quadrates for herbs,	Forest Working plans.	Site survey and Baseline data collection

2.1 Methodology for Ambient Air Pollution

As per the scope of work, 10 monitoring stations were selected for monitoring of specific ambient air quality parameters during the study period. All the instruments (samplers) were installed between 1 to 4 m above ground level which was free from any obstructions. The sampling and analysis of the required parameters were carried out as per IS: 5182 methodology entitled "Methods of Measurement of Air Pollution" and

AWMA entitled "Methods of Air Sampling and Analysis." Following are the parameters monitored during the study period:

Particulate Matter (PM_{10} and $PM_{2.5}$)

Sulphur Dioxide (SO_2)

Nitrogen Dioxide (NO_2)

Carbon Monoxide (CO)

Table 2.2: Techniques Adopted/Protocols for Ambient Air Quality Monitoring

S. No.	Parameters	Techniques	Technical Protocol
1	Sulphur Dioxide (SO2)	West & Gaeke	IS:5182 (P2)
2	Nitrogen Dioxide (NO2)	Jacob & Hochheiser	IS:5182 (P6)
3	ParticulateMatter (PM10)	Gravimetric	IS:5182 (P23)
4	ParticulateMatter (PM2.5)	Gravimetric	IS:5182 (P24)
5	Carbon-monoxide (CO)	NDIR	IS:5182 (P-10)

The design of air quality monitoring network in the surveillance program was based on the following considerations.

Meteorological conditions on synoptic scale

Topography of the study area

Representation of regional background levels

Representation of project site

Representation of cross sectional distribution in the downward direction

Influence of the existing sources if any, are to be kept at minimum

Inclusion of major distinct villages to collect the baseline status

2.2 Methodology for Air Quality

The Gaussian Dispersion Modeling (GDM) is used for prediction of dispersion of air emission and the computation of Ground Level Concentration (GLC) up to a specified distance from source. The fundamental equation of GDM is given below:

$$c(x,y,z) = \frac{Q}{2\pi\sigma_y\sigma_z u}\exp\left(\frac{-y^2}{2\sigma_y^2}\right)\left(\exp\left(\frac{-(z-h)^2}{2\sigma_z^2}\right)+\exp\left(\frac{-(z+h)^2}{2\sigma_z^2}\right)\right)$$

Where,
c is a concentration at a given position;
Q is the source term;

x is the downwind;
y is the crosswind;
z is the vertical direction;
u is the wind speed at the h height of the release;
σy, σz deviations describe the crosswind and vertical mixing of the pollutant;
The above equation describes a mixing process that results in a Gaussian concentration distribution both in crosswind and in vertical direction, centered at the line downwind from the source. Gravitational settling and chemical or radioactive decays are neglected.

The model computes the pollutant concentration dispersed in microgram per cubic meter for any point source with the location coordinated at x, y and z.

The "Gaussian Dispersion Model" version formed the basic frame work of the computer model used for the computations of concentration of pollutants at ground level.

2.3 Methodology for Water

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

Drainage pattern;
Location of industries/residential areas; and
Likely areas, which can represent baseline conditions

Eight Ground water samples consisting of bore wells and dug wells and Five surface water sources covering 15 km radial distance from the mine lease boundary were examined for physio-chemical, heavy metals and bacteriological parameters in order to assess the effect of operations from mine and other activities on surface and ground water quality. 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).

Samples for chemical analysis were collected in polyethylene carbons. Samples collected for metal content were acidified with 1ml HNO3. Samples for bacteriological analysis were collected in sterilized glass bottles. Selected physio- chemical and bacteriological parameters have been analyzed for projecting the existing water quality status in the study area. Parameters like temperature, Dissolved Oxygen (DO) and pH were analyzed at the time of sample collection.

2.4 Methodology for Hydrogeology

Following methodology has been adopted to conduct hydro-geological investigation in the area:

- Physiographic studies of the coal mine area and its surroundings with the help of latest Google images, site visit, GPS survey etc. which helps in determining physiographic gradient.
- Secondary data collection i.e. climate and rainfall, soil and topography, geology, drainage etc. for interpretation.
- Drainage pattern of the study area within the watershed – The study envelopes identification of drainage pattern and its density based on the Topo-sheet and satellite imageries.
- Hydrology of the study area - Details about existing water bodies like Pond, Lake, River, Nala, Streams in the proposed project site as well as surrounding area. Surface water flow estimation and surface water data collection from the nearest source to identify a probable intake location.
- Utilization of satellite image for identification of fissures/fault and ground water signature as observed in the images.
- Detailed hydro-geological survey in core and buffer zone including geology, types of aquifer and their hydraulic parameters governing the groundwater regime of the area, depth to water level, groundwater quality, water abstraction structures and their discharge, surface water bodies, drainage pattern, major irrigation sources and their potential etc.
- Groundwater resources evaluation based on the norms recommended by Groundwater Estimation Committee (GEC), 2009.
- Evaluation of present groundwater scenario as well as future course of action for protecting the natural environment
- Scope of Rainwater Harvesting from runoff generated in open area of coal mine depending upon average annual rainfall and its intensity, recharge capacity of the aquifers & the design considerations.

2.5 Methodology of Soil

Soil sampling was carried out at samples were collected from 15 locations to understand the soil quality. locations in and around the mine lease area were selected for soil sampling. At each location, soil samples were collected from 0 to 30 cm, below the surface and are homogenized. This is in line with IS: 2720 and Methods of Soil Analysis, Part- 1, 2nd edition, 1986 of (American Society for Agronomy and Soil Science Society of America). The homogenized samples were analyzed for physical and chemical characteristics. The soil samples were collected during post-monsoon season.

Parameter	Method (ASTM Number)
Grain size distribution	Sieve analysis (D 422 – 63)
Textural classification	Chart developed by Public Roads Administration
Bulk density	Sand replacement, core cutter
Sodium absorption ratio	Flame photometric (D 1428-82)
pH	pH meter (D 1293-84)
Electrical conductivity	Conductivity meter (D 1125-82)
Nitrogen	Kjeldahl distillation (D 3590-84)
Phosphorus	Molybdenum blue, colourimetric (D 515-82)
Potassium	Flame photometric (D 1428-82)
Iron	AAS (D 1068-84)
Zinc	AAS (D 1691-84)
Boron	Surcumin, colourimetric (D 3082-79)
Chlorides	Argentometric (D 512-81 Rev 85)

2.6 Methodology of Noise

For noise measurement was done using calibrated integrated Sound Level Meter (SLM) manufactured by Lutron (SL-4001). SLM was mounted on a tripod as per the standard methodology for noise measurements. Special care was taken for not making noises while observing the meter during the measurement and ensuring the least amount of reflective surface is exposed from our body to meter.

Noise levels were recorded at locations by Sound Level Meter in dB (A). Noise levels were recorded as per IS: 9989 entitled “Assessment of noise with respect to community response” methodology. Noise levels were recorded at approximately 1.5 meter above the ground level and 3m away from walls, buildings or other sound reflecting sources and 1m away from the edge of the roads. The work-zone noise measurements were carried out 1m away from the sources. In order to reduce the disturbances from standing waves, the noise level measurements were averaged over +0.5 meter each of at least three positions. The mean values were taken for reporting. Ambient noise levels were compared with Noise Pollution (Regulation & Control) Rules, 2000 in respect of noise.

Equivalent Sound Pressure Level (L_{eq}) of Day and Night

The L_{eq} is the equivalent continuous sound level, which is equivalent to the same sound energy as the actual fluctuating sound measured in the same period. This is necessary because sound from noise source often fluctuates widely during a given period of time.

L_{day} is defined as the equivalent noise level measured over a period of time during day (6 am to 10 pm). L_{night} is defined as the equivalent noise level measured over a period of time during night (10 pm to 6 am).

This is calculated from the following equation

$$L_{eq} = L_{50} + (L_{10} - L_{90})^2/60$$

Hourly noise recorded data and Lday (16 hour), Lnight (8 hour) and Ldn (24hour) are computed and tabulated.

2.7 Methodology for Land Use Study

2.7.1 Tools and Resources

The Land use Land cover study will be carried out using Digital Image Processing and Digital Image Interpretation techniques. The Image Processing and Geographical Information Systems software will be used for the Spatial Analysis. In order to meet the project requirements, Vardan EnviroNet will acquire the high-resolution satellite data of the study area from National Remote Sensing Centre (NRSC). Basic Details of the Purchased data are as follows:

Satellite: IRS Resourcesat-2A

Sensor: LISS III

Spatial Resolution: 23.5m

No. of Bands = 3

UTM Zone No = 44

The bands used as input data for the current study have these following features:

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 3 may exhibit more contrast than bands 1 and 2 because the effect of the atmosphere is reduced. The 0.69 m cut-off represents the beginning of a spectral region from 0.68 to 0.75 m where

vegetation reflectance crossovers occur that can reduce the accuracy of vegetation studies.

Band 4: 0.77 - 0.86 µm (Near Infrared): For reasons discussed above, the lower cut-off for this band was placed above 0.75 m. This band is especially responsive to the amount of vegetation biomass present in a scene. It is useful for identification of vegetation types, and emphasizes soil-crop and land-water contrasts.

2.7.2 Pre-processing of Satellite Data

In the present study geo-coded Ortho-rectified IRS P-6 LISS-III satellite image having a resolution 23.5 m spatial resolution and a swath of 141 km.

All the processing will be done on ERDAS Imagine and Arc GIS software. A hybrid classification approach will be adopted for the purpose. Supervised classification will be performed on the imagery to delineate land use/land cover classes.

The IRS P-6 LISS-III data geometrically corrected with respect to Survey of India topo-sheets. To carry out the geo-referencing, ground control points (GCPs) have been identified on the maps and raw satellite data. The coefficients for two co-ordinate transformation equations have been computed based on polynomial regression between GCPs on map and satellite data. Alternate GCPs was generated till the Root Mean Square (RMS) error become less than 0.5 pixels. Methodology Flow Chart is given in **Figure 2.1.**

2.7.3 Visual Interpretation and Land Use Mapping

Fundamental characteristics seen on the images have aided in the visual interpretation of satellite imagery. These are tone/color, size, shape, texture, pattern, location, association, resolution and season. Visual interpretation is subjective and differs from person to person and also upon the season, scale, spectral bands, spatial resolution, overall image contrast & quality of the data. Several parameters like terrain, climatic conditions, socio-economic trends, and environmental influences etc. play a vital role in the existence of various land use categories.

2.7.4 Land Use / Land Cover Classification

Digital image processing was carried out to delineate various land use / land cover categories in the lease area viz. built-up area, forests, scrub land and water bodies etc. by assigning necessary training sets, which was identified based on tone, texture, size, shape pattern and location information. Necessary care was taken to identify proper land use class, where there is conflict between the signatures of various classes. The interpreted map was verified on ground at limited points and final land use / land cover map was prepared. The buffer zone was broadly classified in to forest areas, built-up areas, agriculture areas and other land with or without scrubs.

The limitations of Remote Sensing, Image Processing, Geographical Information Systems, Cartography and GPS are mentioned below:

One season data sometimes give same spectral response of different objects creates confusion in image analysis and sub classification.

Sometimes one season or one-time data is unable to show sub-classification in the study area.

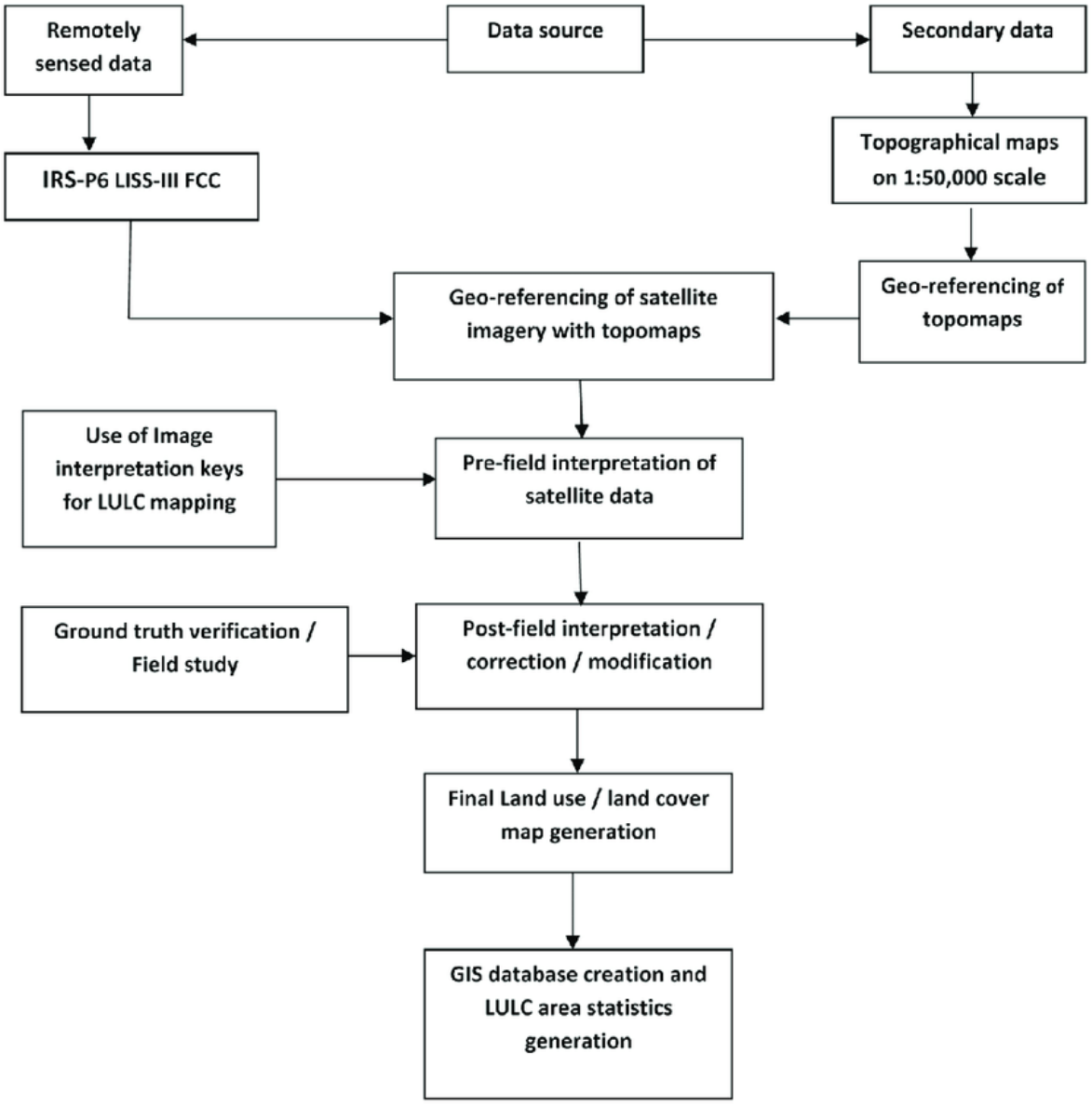


Figure 2.1: Methodology Flow Chart

2.8 Socio Economic Aspects (Methodology and Approach)

2.8.1 Sampling Method

A judgmental and purposive sampling method was used for choosing respondents of various sections of the society Judgmental and purposive sampling method includes the right cases from the total population that helps to fulfill the purpose of study.

For the study, both qualitative and quantitative methods were adopted. Data regarding the field area were collected both from primary as well as secondary sources.

- Primary sources include data collected through direct field sampling, observations based on schedules, questionnaires etc.
- Secondary source includes Census 2011 records, District Statistical Handbook literatures, documents from district etc.
- Data regarding mining, revenue generated by mining practices etc will be collected from the Mine Department

2.8.2 Primary Data Collection

- The Socio-economic survey was carried out in the nearby human inhabitations (villages) of mining sites in order to study the existing resources of the area, land use, social structure of the community, employment patterns, income generation activities, dependency on forests and species preferred by the local people along with information on other related environmental and socioeconomic aspects.
- Detailed information on demography, labor allocation and employment, dependence on forest products, health and perceptions of change in the local environment was elicited through the interviews.
- The study was performed in mining areas by using Questionnaire based pre-structured Feedback Surveys and Interviews
- Economic status levels and forest dependency was also studied. The Questionnaire used for survey contained the questions covering environmental and socio-economic aspects of mining, forest and forestry related issues.

2.8.3 Data Collection Techniques Used for Socio Economic Survey

- The sample frame of this study consists of communities within the 15 km of mining sites.
- Quantitative and qualitative data collection techniques namely Participatory Rural Appraisal (PRA) tools, direct observations through questionnaire based survey through villagers meetings were employed.

Participatory Rural Appraisal: Face-to-face interview conducted with the villagers to obtain information regarding household heads, live stocks, income, dependency on

forest, impacts of mining, choice of species for reclamation from nearby communities in the study area.

Direct Observation: Direct observations were used throughout the pre-structured questionnaire-based survey.

2.8.4 Secondary Data Collection

Preparation of Work Plan including information collected from secondary sources, profile of the study site, criteria for assessment etc.

Secondary data obtained from the sources was verified during the primary survey carried out in the study area.

2.9 Methodology for Ecology and Biodiversity

The floral assessment for the project affected area and its buffer zone was based on field survey of the area.

Inventory Method: Forest inventory methodology was adopted to evaluate the floral diversity of core and buffer zone. A forest inventory is ***"an attempt to describe the quantity and quality of forest trees and many of the characteristics of the land area upon which the trees are grown."*** The objective this floral inventory of the study area, is to provide complete checklist of floristic structure in the study area for formulating effective management and conservation measures.

Quadrate Method: The study was aimed at enumeration of the available plant resources and obtaining a broad representation of the existing floristic variations in the project affected area and surrounding buffer areas. Enumeration of the plant wealth was done by surveying the area through walking followed by collection and identification of plant specimens. A Phyto-sociological aspect of the study was carried out by perambulating and sampling through quadrates method. Sample plots will be selected in such a way to get maximum representation of different types of vegetation and plots will be laid out in different parts of the areas within the project affected area and surrounding buffer area.

Selection of sites for vegetation data has been done by random sampling procedure. Accordingly, equal number of quadrates of 10 m x 10 m for the study of tree layer in the project affected area and surrounding buffer area was laid. Within these sample plots, sub-plots of 3 m x 3 m will be laid out randomly for studying the shrub layer and regeneration of tree species. For information on ground layer including herbaceous species, quadrates of 1 m x 1 m size was laid out within the tree quadrate.

All species encountered during the transect walk has been recorded and their herbarium specimens prepared for identification and future use. The girth at breast height (gbh) of all individuals in each quadrate was measured for all species of trees and

woody climbers. All individuals with gbh > 10 cm was considered and recorded as trees (Parthasarathy and Karthikeyan, 1997). Individuals below 10 cm gbh will be considered as saplings and shrubs. This concept will be tested further during the fieldwork. Basal area of plants will be measured following Philips (1959).

The primary data recorded on number of individuals in a species and girths was utilized to derive secondary attributes like density and frequency following standard phyto-sociological methods of Misra (1968). Relative values were calculated following Philips (1959). Important Value Index (IVI) will be calculated by adding up relative frequency, relative density and relative dominance (Curtis, 1959). In the case of shrubs, herbs and saplings; IVI has been calculated based only on relative values, i.e., relative frequency and relative density. Formulae used for various calculations are:

$$\text{Density} = \frac{\text{Total number of individuals of a species in all the Quadrates}}{\text{Total number of quadrats studied}}$$

$$\text{Frequency (\%)} = \frac{\text{Total number of Quadrats in which species occurred}}{\text{Total number of Quadrats studied}} \times 100$$

$$\text{Abundance} = \frac{\text{Total number of individuals of a species in all Quadrates}}{\text{Total number of Quadrats in which species occurred}}$$

$$\text{Mean Basal Area} = \frac{C2}{4\pi} \quad (C = \text{Mean of the circumference})$$

$$\text{Total Basal Area} = \text{Mean basal area} \times \text{Density}$$

$$\text{Mean of the Circumference (C)} = \frac{\text{Sum of all cbh of a species}}{\text{Total number of individuals of a species}}$$

$$\text{Relative Density} = \frac{\text{Density of a species}}{\text{Total density of all species}} \times 100$$

$$\text{Relative Frequency} = \frac{\text{The frequency of a species}}{\text{Total frequency of all species}} \times 100$$

$$\text{Relative Dominance} = \frac{\text{Total basal cover of a species}}{\text{Total basal cover of all species}} \times 100$$

Importance Value Index (IVI) = Relative Density + Relative Frequency + Relative Dominance

The Shannon–Wiener Index or species diversity (Whitt, when properly manipulated, always results in a diversity value (H´) ranging between 0, indicating a low community complexity and 4 and above indicating high community complexity. **Species diversity (H)** was computed following the Shannon and Weiner (1963) information index as follows:

$$H = \sum \frac{n_i}{N} \log_n \frac{n_i}{N}$$

2.9.1 Methodology for Faunal Diversity Assessment

A linear transect of 1.0 km each was chosen for sampling at each site. Each transect was trekked for 1.5 hr for the sampling of faunal diversity through following methods for different categories. For the sampling of butterflies, the standard '**Pollard Walk**' method was employed and all the species recorded daily. Voucher specimens of the species that could not be identified in the field have been collected using a butterfly net besides photographing them.

For bird's sampling, '**Point Sampling'** along the fixed transect (Foot trails) will be carried out. All the species of birds was observed through a binocular and identified with the help of field guide book and photographs.

For the sampling of mammals, direct count on open width (20m) transect was used. In addition, information on recent sightings/records of mammals by the villagers/locals was collected. For carnivores, indirect sampling will be carried out and the mammals was identified by foot marks, faeces and other marks/sign created by them. In case of reptiles mainly lizards will be sampled by direct count on open width transects.

The study of fauna takes substantial amount of time to understand the specific faunal characteristic of area. The assessment of fauna was done by extensive field survey of the area. During survey, the presence of wildlife was also be inhabitants depending on animal sightings and the frequency of their visits in the project area was confirmed from forest department, Wildlife Department etc.

2.9.2 Methodology for Aquatic Diversity Assessment

The fauna and flora of the ponds and rivers were regularly and carefully recorded during the period of visit. The floral samples were collected and brought to the lab and identified using standard keys. In the case of fauna, fishes and crustaceans were collected using dragnets or cast nets, fixed in 10% formalin, brought to the laboratory and identified using Fauna of British India. The occurrence of different fauna and flora during the period of study was tabulated and presented.

CHAPTER-3
EXISTING ENVIRONMENT OF THE AREA

3. EXISTING ENVIRONMENT OF THE AREA

3.1 Baseline Environment Status

Baseline Environmental status of the cluster mine depicts the existing quality of Air, Noise, Water, Soil, Ecology & Biodiversity and Socio-Economic environment. The impact identification always commences with the collection of baseline data such as Ambient Air Quality, Micro-Meteorology, Ground and Surface Water Quality, Noise levels, Soil Quality, Land Use pattern, Biological Environment and Socio-Economic Aspects, Geology and Hydrology within the study zone of 15 km radius.

3.2 Study Period

The baseline environmental study has been done for the period of March to May 2021 by M/s Vimta Labs Limited and one season additional data from i.e October to December by Vardan Enviro LAB NABL Accredited Lab, Secondary data also collected from different sources as already discussed in **Table 2.1.**

Ambient air quality monitoring is done to determine the general background concentration levels. The prime objective of the ambient air quality study is to assess the existing air quality of study area and to establish the existing ambient air quality within the study area and its conformity to NAAQS.

3.3 Ambient Air Environment

3.3.1 Metrological Condition of the Area

Secondary data Data (Yearly data)

Micro-meteorological data of the project site during the air quality survey period is an indispensable part of air pollution study. The mico-meteorology data has been collect from both secondary and primary sources:

3.3.2 Secondary Data

Historical data on meteorological parameters also plays an important role in identifying the general meteorological status of the region. The data generated in the field is compared with the historical data in order to identify changes, which may have taken place during the course of time.

The latest and updated secondary data for 30 years (1981-2010) has been procured from the IMD, Sidhi for observing parameters like Temperature, Relative Humidity, Rainfall, Wind Speed and Wind direction in the Sidhi district of Madhya pradesh. The IMD data for Sidhi is given in **Table 3.1.**

3.3.2.1 Temperature

The pre-monsoon season starts from March and continues till the end of May. Both the night and day temperatures increase rapidly during the onset of the pre-monsoon season from March to May 2021. During pre-monsoon season, the mean maximum temperature (May) was observed to be 41.9°C with the mean minimum temperature at 16.1°C (March). The mean maximum temperature in the monsoon season was observed to be 39.1 °C in the month of June whereas the mean minimum temperature was observed to be 24.2°C in the month of September. By the end of September with the onset of post-monsoon, day temperature decreases slightly with height. Maximum temperature 33°C was observed in October and the lowest minimum temperature was observed 13.8°C during November. In winter season (December to February), the mean monthly maximum temperature at 27.9 °C in February and the mean monthly minimum temperature at 8.8 °C in January. The monthly variations of temperature are presented in **Table-3.1.**

3.3.2.2 Relative Humidity

The air is generally humid in this region during the entire year when the relative humidity at 08:30 hr was observed with maximum at 83% and a minimum at 21%, at 17:30 hr. Relative humidity is presented in **Table-3.1.**

Table 3.1: Climatological Data Station: IMD Sidhi

Month	Atmospheric Pressure (mb)		Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)
			Mean Max	Mean Min			
January	985.9	982.6	24.6	8.8	76	46	20.5
February	983.7	980.3	27.9	11.5	67	38	22.7
March	980.9	977	33.5	16.1	50	26	11.4
April	977	972.7	39.2	21.9	38	21	7.3
May	972.9	968.8	41.9	26.3	42	26	13.8
June	969.3	965.6	39.1	27.6	58	47	117.2
July	969.3	966.4	33.5	25.7	79	71	340.3
August	971	968	32.3	25.2	83	75	316.8
September	974.7	971.5	32.6	24.2	81	71	244.1
October	980.4	977	33	19.9	74	52	35.2
November	984.5	981	29.9	13.8	71	47	6.9
December	986.6	983	26.4	9.1	73	50	7.1

Month	Atmospheric Pressure (mb)	Temperature (^{0}C)		Relative Humidity (%)	Rainfall (mm)
		Mean Max	Mean Min		
Total					1143.3

Source: IMD Climatological Normals 1981-2010

3.3.2.3 Atmospheric Pressure

The maximum pressure observed were 986.6 mb at 08:30 hr. in the months of December. The minimum pressure observed were 965.6 mb at 08:30 hr during the month of June in monsoon season. The pressure levels are found to be fairly consistent over the region. The monthly variations in the pressure levels are presented in **Table 3.1.**

3.3.2.4 Rainfall

The average annual rainfall based on the 30 years of IMD data, was observed to be 1143.9 mm. The monsoon sets in the month of June and continues till October. The maximum amount of rainfall (340.3 mm) occurring in the month of July. Monthly variations in the rainfall for past 30 years are given in **Table 3.1.**

3.3.2.5 Wind Speed/Direction

Generally, light to moderate winds prevail throughout the year. The seasonal wind roses are presented in Figure 3.1. The summary of wind pattern at IMD, Sidhi is given in **Table-3.2.**

Table 3.2: Summary of Wind Pattern: IMD Sidhi

Months	First Predominant Winds	Average Wind Speed (m/s)	Calm Condition (%)
March	W (32%)	1.4	81
April	W (33%)	1.2	72
May	W (27%)	1.3	62

Source: IMD Climatological Normals 1981-2010

3.3.3 Primary data for premonsoon season (March to May 2021)

3.3.3.1 Temperature

Maximum temperature 40.6^{o}C and minimum temperature of 10.8^{0}C was recorded during the study period. Maximum temperature was observed in April month and the minimum temperature was observed during March in the study period.

3.3.3.2 Relative Humidity

During the period of observation, the relative Humidity recorded ranged from 93% to 3%. Maximum humidity was observed during the month of March.

Table 3.3: Summary of the Meteorological Data Monitored at Site (Primary Data)

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	Atmospheric Pressure (mb)	
	Max.	Min.	Max.	Min.		Max.	Min.
March	39.3	10.8	70	3	0	690	679
April	40.6	14.1	51	3	0	963	952
May	40.1	20.3	93	8	0	959	949

Source: Primary On-site Data Collected by VimtaLab

3.3.3.3 Pressure

The maximum pressure observed were 963mb in the months of April and the minimum pressure were observed 679mb in the month of March. The pressure levels are found to be fairly consistent over the region.

3.3.3.4 Rainfall

During the period of observation, Maximum rainfall was observed during the month of baseline month was 0 mm

3.3.3.5 Wind Speed/Direction

The wind roses for the study period representing winter season is shown in Figure-3.2. A review of the wind rose diagram shows that predominant winds direction from W-E.

3.3.4 Interpretation

The India Meteorological Department (IMD) records the data at two times a day viz. 08:30 hr and 17:30 hr while the site specific data has been recorded at an hourly interval. On comparison of site specific data generated for study period vis-à-vis the IMD data, slight variations were found. The following observations are brought out:

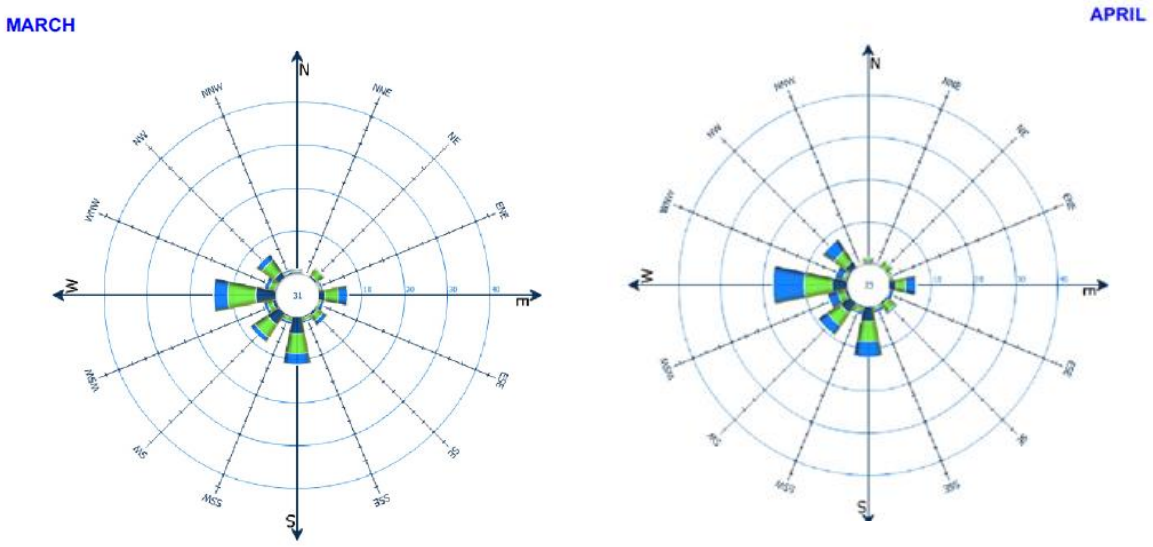
The temperature recorded on site when compared vis-à-vis the IMD data, slight variations was found. The maximum and minimum temperatures recorded at site during study period were 40.6°C and 10.8°C, whereas the maximum and minimum temperature recorded at IMD, Sidhi for the same season are 41.9°Cand 16.1°C respectively;

The relative humidity was observed to range from 93% to 3% during the study period whereas according to IMD, Sidhi data the relative humidity in the same season was observed to range from 50% to 21 %. The variation could be because of the fact that the RH values considered for the site are actual values while the range of IMD, Sidhi data represents the average values for 30 year period.

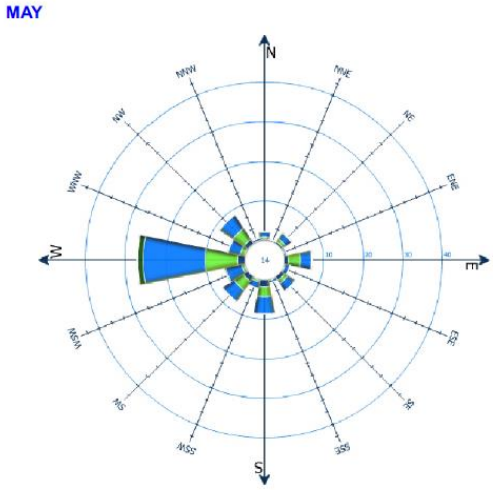
During the study period was observed that the predominant direction in W-E followed. The variation could be because of the fact that the values considered for the site are

actual values while the range of IMD, Sidhi data represents the average values for 30 year period.

The data obtained when compared with IMD data are found to be fairly consistent The data generated at continuous monitoring station at mine site when compared with the data recorded at IMD, it can be observed that the data generated at the site is broadly compatible with regional meteorology, except minor variations as described above.



March **April**



May

Figure 3.1: Secondary Data Wind Rose

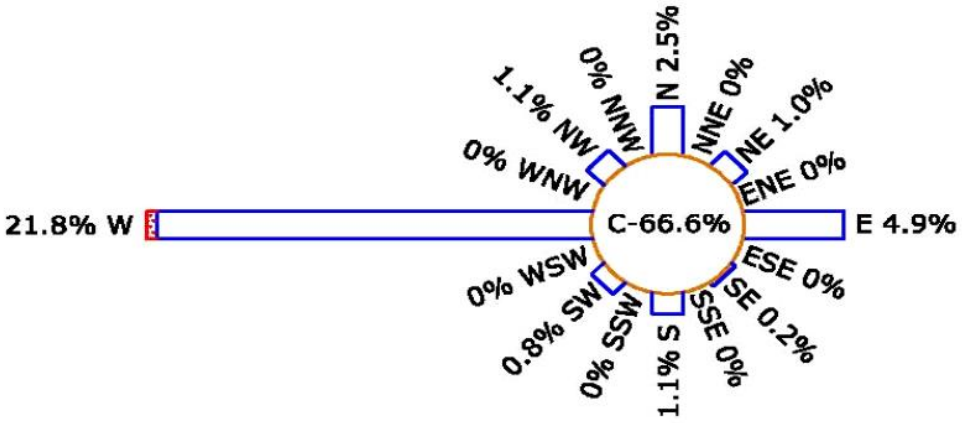


Figure 3.2: Windrose Diagram of Study Period (March to May 2021)

3.3.5 Primary data for Post monsoon season (October to Dec 2021)

3.3.5.1 Temperature

Maximum temperature 32.5^{0}C and minimum temperature of 3.3^{0}C was recorded during the study period. Maximum temperature was observed in october month and the minimum temperature was observed during December in the study period.

3.3.5.2 Relative Humidity

During the period of observation, the relative Humidity recorded ranged from 96% to 16%. Maximum humidity was observed during the month of October.

Table 3.4: Summary of the Meteorological Data Monitored at Site (Primary Data)

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	Atmospheric Pressure (mb)	
	Max.	Min.	Max.	Min.		Max.	Min.
October	32.5	14.5	96	21	0	963	953
November	30.1	8.5	89	16	0	969	961
December	28	3.3	87	17	0	969	962

Source: Primary On-site Data Collected by VimtaLab

3.3.5.3 Pressure

The maximum pressures observed were 969 mb in the months of November & December and the minimum pressure were observed 953 mb in the month of October. The pressure levels are found to be fairly consistent over the region.

3.3.5.4 Rainfall

During the period of observation, Maximum rainfall was observed during the month of baseline month was 0 mm.

3.3.5.5 Wind Speed/Direction

The wind roses for the study period representing winter season is shown in Figure-3.3. A review of the wind rose diagram shows that predominant winds direction from WNW.

3.3.6 Interpretation

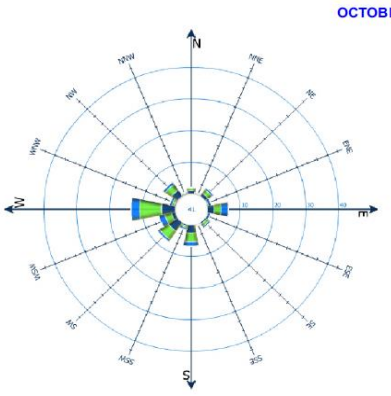
The India Meteorological Department (IMD) records the data at two times a day viz. 08:30 hr and 17:30 hr while the site specific data has been recorded at an hourly interval. On comparison of site specific data generated for study period vis-à-vis the IMD data, slight variations were found. The following observations are brought out:

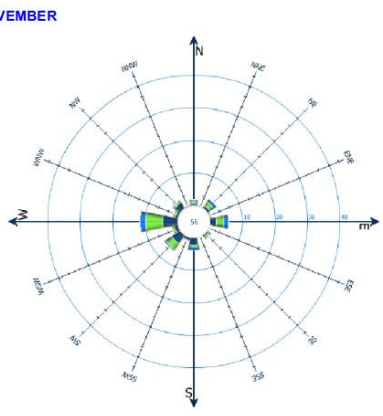
The temperature recorded on site when compared vis-à-vis the IMD data, slight variations was found. The maximum and minimum temperatures recorded at site during study period were 32.5^{0}C and 3.3^{0}C, whereas the maximum and minimum temperature recorded at IMD, Sidhi for the same season are 35.5^{0}Cand 6^{o}C respectively;

The relative humidity was observed to range from 96% to 16% during the study period whereas according to IMD, Sidhi data the relative humidity in the same season was observed to range from 73% to 44%. The variation could be because of the fact that the RH values considered for the site are actual values while the range of IMD, Sidhi data represents the average values for 30 year period.

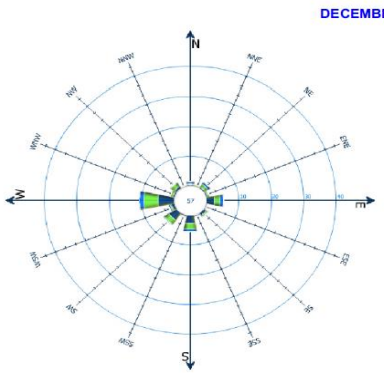
During the study period was observed that the predominant direction in WNW. The variation could be because of the fact that the values considered for the site are actual values while the range of IMD, Sidhi data represents the average values for 30 year period.

The data obtained when compared with IMD data are found to be fairly consistent The data generated at continuous monitoring station at mine site when compared with the data recorded at IMD, it can be observed that the data generated at the site is broadly compatible with regional meteorology, except minor variations as described above.





October **November**



December

Figure 3.3: Secondary Data Wind Rose

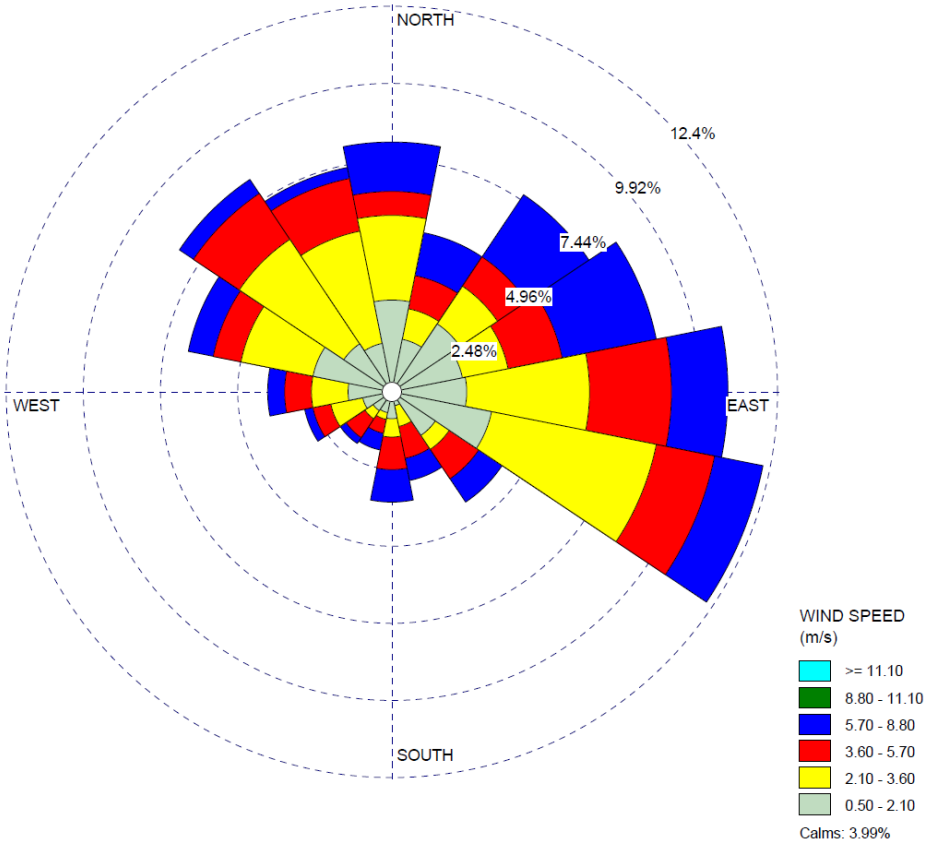


Figure 3.4: Windrose Diagram of Study Period (October to December)

3.3.7 Selection of Sampling Locations for Air

The sources of air pollution in the region are mining activity emissions, vehicular traffic, dust arising from unpaved roads and domestic fuel burning.

Due consideration during the selection of sampling locations has been given to the likely affected zones during mining activity. The location of human habitation and other sensitive areas within the study area were also considered in selection of ambient air quality monitoring locations. 10 numbers of monitoring stations are set up to assess the existing air quality of the study area. Two stations are located inside the proposed project site (core zone) and the eight others are outside (buffer zone) the proposed project site.

The locations of the monitoring stations are also based on the meteorological conditions of the study area like likeliness of pollution dispersion in areas located towards predominant wind directions. Locations are also based on sensitive receptors in the study area like densely populated areas, forest area, river bodies, etc. Logistic considerations as ready accessibility, security, availability of reliable power supply, etc were examined while finalizing the monitoring locations. The Ambient Air Quality Monitoring locations have been presented in **Figure 3.5.**

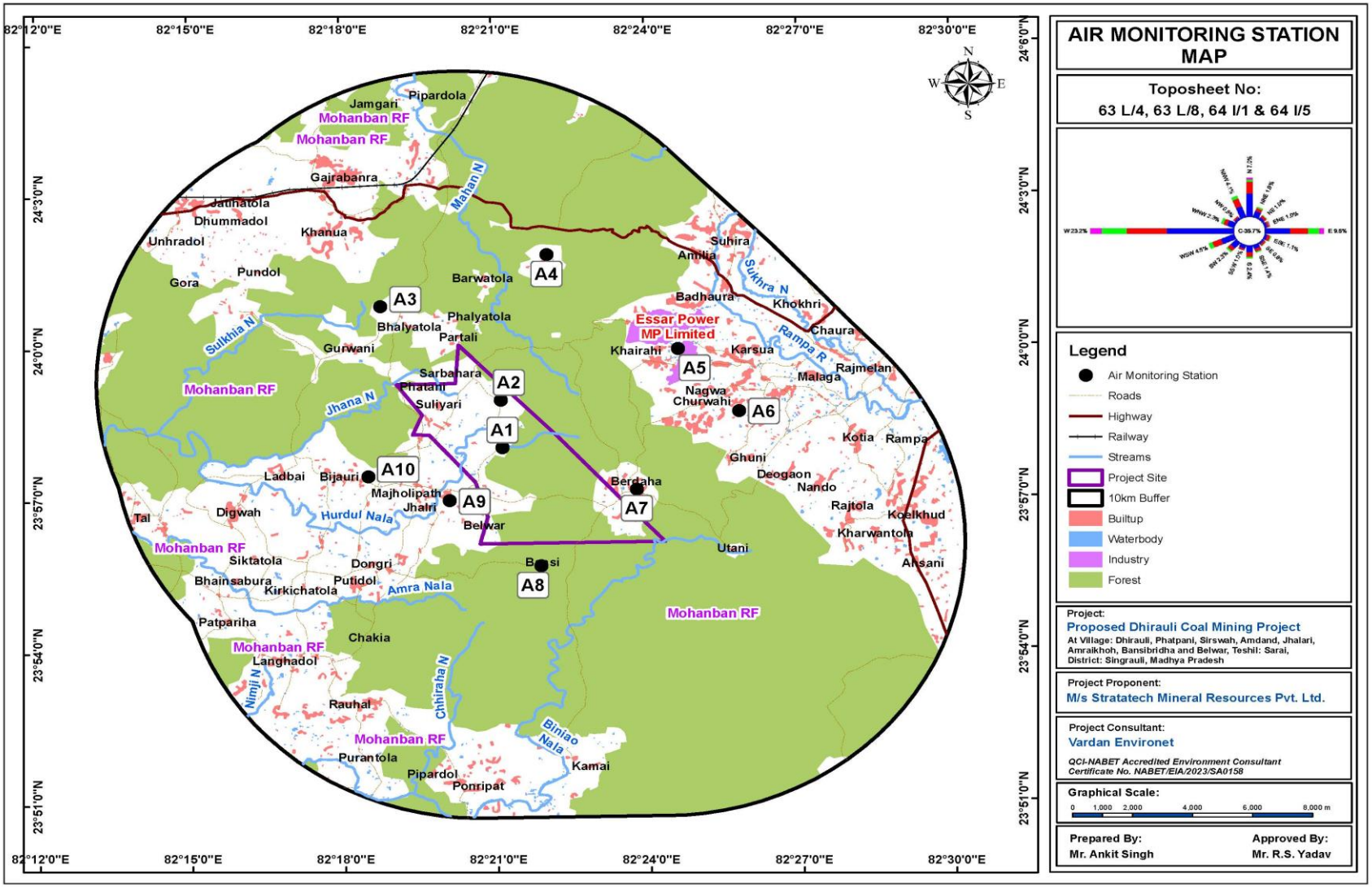


Figure 3.5: Ambient Air Quality Monitoring Locations (March to May 2021)

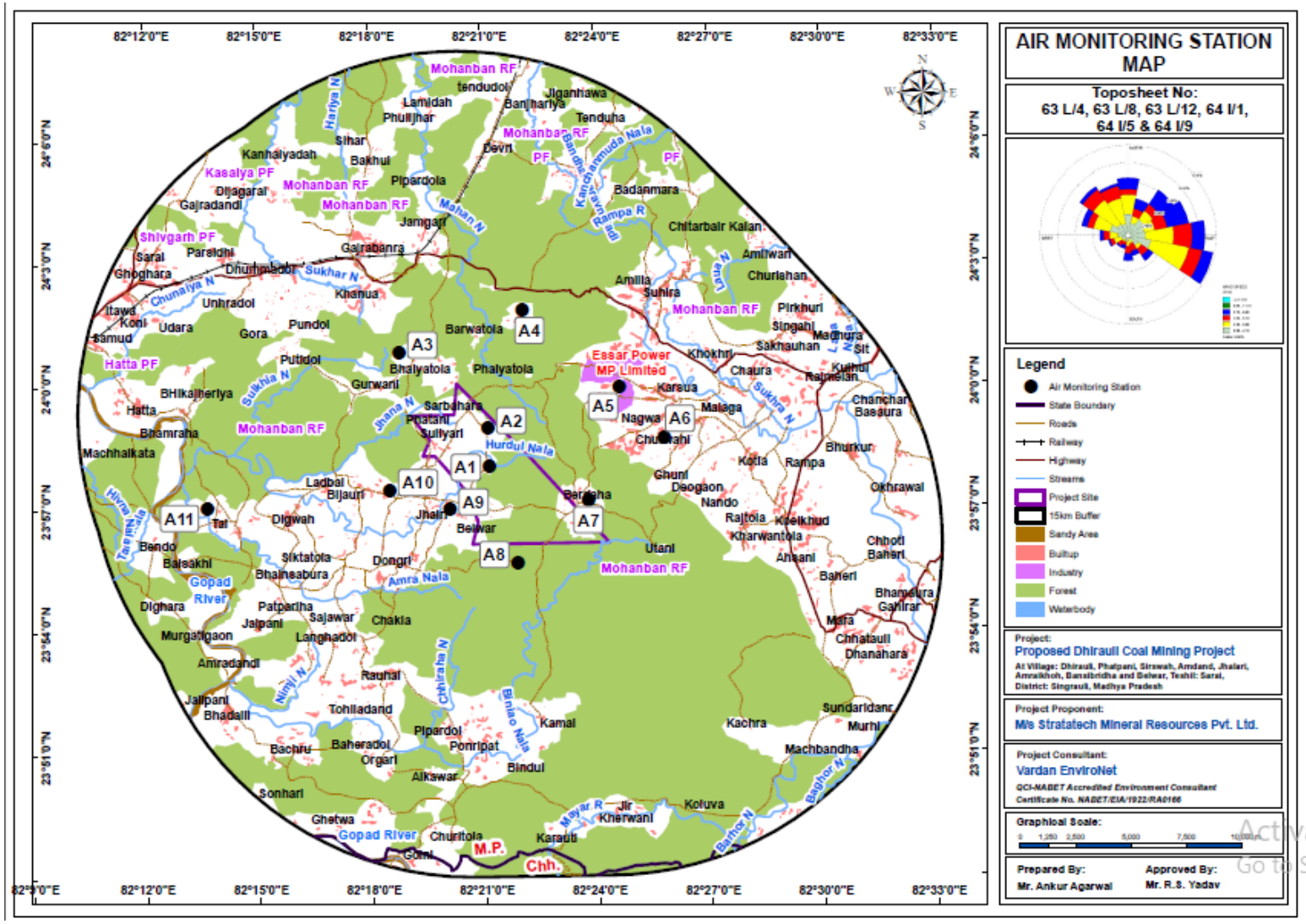


Figure 3.6: Ambient Air Quality Monitoring Locations (October to December 2021)

Table 3.5: Ambient Air Quality Monitoring Stations (March to May 2021)

Stations	Name	Latitude	Longitude	Distance (km)	Direction	Selection Criteria
A1	Mine Area (Dhirauli South)	23°58'01.35"N	82°21'08.15"E	ML Area		Proposed Mine Site
A2	Mine Area (Dhirauli North)	23°58'56.40"N	82°21'07.79"E	ML Area		Proposed Mine Site
A3	Mine Area (Dhirauli North)	24°00'50.31"N	82°18'46.65"E	2.0	NNW	Cross wind direction of first predominant
A4	Budheri	24°01'48.81"N	82°22'02.98"E	3.9	N	Cross wind direction of first predominant
A5	Khairahi	23°59'58.17"N	82°24'37.23"E	4.5	NE	Up wind direction of second predominant and located near to industrial area
A6	Churwani	23°58'41.81"N	82°25'49.42"E	4.6	E	Downwind direction of first predominant
A7	Berdaha	23°57'11.77"N	82°23'45.81"E	0.5	ESE	Cross wind direction of first predominant
A8	Bansi	23°55'40.74"N	82°21'53.48"E	0.8	S	Downwind direction of second predominant and forest area
A9	Majholipath	23°56'59.11"N	82°20'04.80"E	0.8	SW	Cross wind direction of first Second predominent
A10	Bijauri	23°57'29.18"N	82°18'29.63"E	2.6	W	Up wind direction of first predominant

Source: Primary On-site Data Collected by Vimta Lab

Table 3.6: Ambient Air Quality Monitoring Stations (October to December 2021)

Stations	Name	Latitude	Longitude	Distance (km)	Direction	Selection Criteria
A1	Mine Area (Dhirauli South)	23°58'01.35"N	82°21'08.15"E	ML Area		Proposed Mine Site
A2	Mine Area (Dhirauli North)	23°58'56.40"N	82°21'07.79"E	ML Area		Proposed Mine Site
A3	Mine Area (Dhirauli North)	24°00'50.31"N	82°18'46.65"E	2.0	NNW	Cross wind direction of first predominant
A4	Budheri	24°01'48.81"N	82°22'02.98"E	3.9	N	Cross wind direction of first predominant
A5	Khairahi	23°59'58.17"N	82°24'37.23"E	4.5	NE	Up wind direction of second predominant and located near to industrial area
A6	Churwani	23°58'41.81"N	82°25'49.42"E	4.6	E	Downwind direction of first predominant
A7	Berdaha	23°57'11.77"N	82°23'45.81"E	0.5	ESE	Cross wind direction of first predominant
A8	Bansi	23°55'40.74"N	82°21'53.48"E	0.8	S	Downwind direction of second predominant and forest area
A9	Majholipath	23°56'59.11"N	82°20'04.80"E	0.8	SW	Cross wind direction of first Second predominent
A10	Bijauri	23°57'29.18"N	82°18'29.63"E	2.6	W	Up wind direction of first predominant
A11	Tal Near Sanjay National Park	23°57'02.6"N	82°13'36.6"E	10	W	Near sensitive area

Source: Primary On-site Data Collected by Vardn Envirolab

3.3.8 Data Analysis

The Ambient Air Quality survey has been carried out at 10 locations within 10 km radius around the cluster site. Measurement of Particulate matter (PM_{10}& $PM_{2.5}$), SO_2, NO_X and CO levels helps to understand the existing environmental scenario. The results of PM_{10}, $PM_{2.5}$, SO_2, NO_X are expressed in $\mu g/m^3$ whereas the results of CO are expressed in $\mu g/m^3$. The results of all the locations were further computed for statistical parameters like 98 Percentile and Arithmetic mean (AM). The results are shown in **Table 3.7.** The graphical representations of the results are depicted in Figure **3.7, 3.8,3.9 & 3.10**. Lab Reports are enclosed as Aneexure-6.

Table 3.7: Comparision of Baseline Result for the Air Monitoring Stations (March to May 2021 and October to December 2021)

	Premonsoon Season (March to May 2021) by Vimta Lab					Winter Season (October to December 2021) By Vardan Enviro Lab					
Pollutant	**Location Codes**	**Max.**	**Min.**	**Avg.**	**98 Percentile**	**Location Codes**	**Max.**	**Min.**	**Avg.**	**98 Percentile**	**NAAQS**
PM_{10} (µg/m³)	A-1	49.50	34.80	43.20	49.30	A-1	51.60	36.70	43.48	51.05	100
	A-2	52.30	35.90	43.70	51.80	A-2	54.30	37.80	45.87	54.10	
	A-3	49.30	35.10	42.90	49.30	A-3	51.30	37.20	45.03	50.90	
	A-4	48.90	33.80	41.50	48.90	A-4	50.30	35.70	42.92	49.58	
	A-5	58.60	38.90	46.90	58.50	A-5	63.80	41.60	55.90	63.30	
	A-6	61.30	39.70	47.90	60.00	A-6	61.70	40.80	53.17	61.20	
	A-7	51.30	37.50	43.40	51.10	A-7	53.40	39.40	46.85	53.05	
	A-8	44.60	26.50	36.80	44.40	A-8	46.80	34.70	41.14	46.70	
	A-9	51.80	35.00	42.50	51.20	A-9	53.80	37.00	45.54	52.55	
	A-10	48.90	28.90	39.30	48.90	A-10	50.90	30.80	41.90	50.12	
						A-11	52.20	34.80	32.73	48.87	
$PM_{2.5}$ (µg/m³)	A-1	29.2	17.1	22.6	28.7	A-1	39.40	27.10	34.05	39.15	60
	A-2	30.3	17.6	23.3	29.9	A-2	40.20	27.60	33.50	39.75	
	A-3	27.9	16.9	21.4	26.1	A-3	37.90	26.90	32.83	37.40	
	A-4	26.7	16.6	21.7	26.6	A-4	37.10	26.60	31.49	36.91	
	A-5	33.6	21.8	27.1	33.1	A-5	50.40	36.20	44.69	50.00	
	A-6	40.2	23.1	29.7	40.0	A-6	43.70	31.80	38.30	43.40	
	A-7	39.2	22.9	29.2	39.0	A-7	49.20	32.90	39.08	46.45	
	A-8	28.2	15.8	21.6	28.0	A-8	38.30	25.50	33.35	38.25	

	Premonsoon Season (March to May 2021) by Vimta Lab					Winter Season (October to December 2021) By Vardan Enviro Lab					
Pollutant	**Location Codes**	**Max.**	**Min.**	**Avg.**	**98 Percentile**	**Location Codes**	**Max.**	**Min.**	**Avg.**	**98 Percentile**	**NAAQS**
	A-9	32.5	17.9	24.3	31.2	A-9	42.50	27.90	35.08	40.99	
	A-10	27.8	16.8	21.8	27.8	A-10	37.70	24.60	31.27	37.13	
						A-11	37.50	25.50	32.73	37.40	
NO_X ($\mu g/m^3$)	A-1	23.6	17.4	19.7	23.3	A-1	17.30	14.20	15.52	17.15	80
	A-2	23.9	17.9	19.8	23.2	A-2	17.90	13.40	15.87	17.75	
	A-3	25.4	16.5	21.2	25.3	A-3	16.80	13.70	14.94	16.75	
	A-4	25.5	18.0	21.6	25.3	A-4	22.60	14.80	16.25	20.63	
	A-5	34.2	22.6	26.2	33.9	A-5	20.30	13.40	15.85	19.80	
	A-6	32.2	21.0	25.6	31.7	A-6	26.30	18.70	22.20	26.25	
	A-7	30.9	20.6	27.5	30.8	A-7	23.80	16.20	19.40	23.75	
	A-8	29.1	20.5	26.0	28.9	A-8	21.10	14.90	17.76	21.10	
	A-9	31.5	21.3	26.0	31.3	A-9	24.60	15.80	20.08	24.50	
	A-10	24.9	16.4	20.6	24.8	A-10	18.00	12.30	15.61	17.58	
						A-11	20.40	14.20	17.05	20.40	
SO_2 ($\mu g/m^3$)	A-1	16.3	13.2	14.7	16.2	A-1	24.70	18.50	21.58	24.40	80
	A-2	17.1	13.5	15.0	17.0	A-2	24.80	17.50	21.23	24.70	
	A-3	15.9	12.8	14.2	15.6	A-3	26.50	17.40	20.60	26.20	
	A-4	21.6	13.9	17.2	21.5	A-4	26.60	19.10	21.46	25.64	
	A-5	25.1	17.8	21.0	24.7	A-5	33.30	22.00	25.99	32.45	

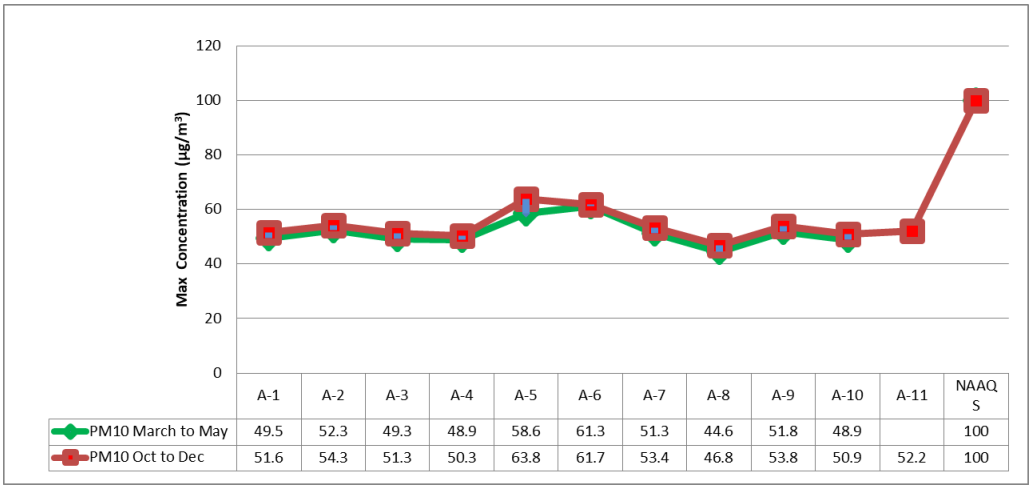
	Premonsoon Season (March to May 2021) by Vimta Lab					Winter Season (October to December 2021) By Vardan Enviro Lab					
Pollutant	**Location Codes**	**Max.**	**Min.**	**Avg.**	**98 Percentile**	**Location Codes**	**Max.**	**Min.**	**Avg.**	**98 Percentile**	**NAAQS**
	A-6	23.8	17.3	20.4	23.7	A-6	35.10	23.70	29.43	35.00	
	A-7	22.8	15.6	18.8	22.5	A-7	31.80	21.70	25.92	31.70	
	A-8	20.7	13.1	16.3	20.1	A-8	30.20	20.20	24.66	30.20	
	A-9	23.4	14.2	18.1	22.9	A-9	32.80	22.70	26.89	32.70	
	A-10	15.9	12.5	14.2	15.6	A-10	25.70	17.50	22.30	25.08	
						A-11	29.20	20.40	24.42	29.20	
							mg/m³				
CO (mg/m³)	A-1	0.418	0.316	0.382	0.417	A-1	0.51	0.33	0.45	0.51	2
	A-2	0.419	0.314	0.381	0.415	A-2	0.52	0.42	0.46	0.52	
	A-3	0.439	0.350	0.384	0.431	A-3	0.54	0.36	0.48	0.54	
	A-4	0.378	0.317	0.333	0.358	A-4	0.48	0.42	0.45	0.48	
	A-5	0.487	0.381	0.406	0.473	A-5	0.57	0.47	0.54	0.59	
	A-6	0.472	0.373	0.391	0.458	A-6	0.59	0.49	0.54	0.59	
	A-7	0.415	0.325	0.354	0.391	A-7	0.52	0.43	0.47	0.52	
	A-8	0.335	0.305	0.319	0.327	A-8	0.44	0.41	0.43	0.44	
	A-9	0.437	0.353	0.366	0.399	A-9	0.53	0.45	0.48	0.52	
	A-10	0.342	0.312	0.319	0.327	A-10	0.47	0.41	0.44	0.46	
						A-11	0.45	0.40	0.42	0.44	
O_3 (µg/m³)	A-1	8.3	4.3	6.1	8.2	A-1	10.40	6.30	8.44	1.30	100
	A-2	8.9	4.8	6.7	8.4	A-2	10.80	6.10	8.74	10.75	

	Premonsoon Season (March to May 2021) by Vimta Lab					Winter Season (October to December 2021) By Vardan Enviro Lab					
Pollutant	Location Codes	Max.	Min.	Avg.	98 Percentile	Location Codes	Max.	Min.	Avg.	98 Percentile	NAAQS
	A-3	7.9	4.2	5.6	7.4	A-3	9.80	6.20	7.82	9.60	
	A-4	8.6	4.4	6.1	8.0	A-4	10.60	6.40	8.88	10.55	
	A-5	9.6	4.9	7.1	9.0	A-5	11.60	7.00	9.78	11.55	
	A-6	9.8	4.8	7.1	9.7	A-6	11.80	7.20	9.30	11.75	
	A-7	9.4	4.1	6.1	9.1	A-7	18.80	9.00	13.57	18.35	
	A-8	7.9	3.7	5.5	7.6	A-8	9.90	5.60	7.42	9.80	
	A-9	8.9	4.3	6.5	8.6	A-9	10.90	6.50	8.75	10.85	
	A-10	8.2	4.0	5.8	7.9	A-10	10.20	6.00	8.15	10.15	
						A-11	9.10	5.40	7.07	9.05	

Source: Primary On-site Data Collected by Vimta Lab and Vardn EnviroLab

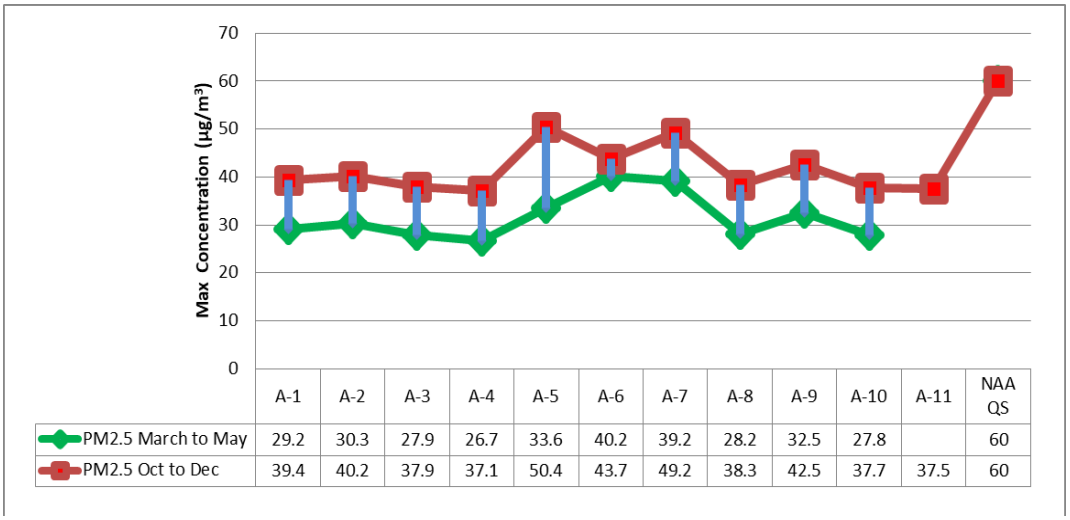
Location	Premonsoon Season (March to May 2021) by Vimta Lab						Winter Season (October to December 2021) By Vardan Enviro Lab						Standards
	NH3 (µg/m3)	C6H6 (µg/m3)	BaP (ng/m3)	As (ng/m3)	Ni (ng/m3)	Pb (µg/m3)	NH3 (µg/m3)	C6H6 (µg/m3)	BaP (ng/m3)	As (ng/m3)	Ni (ng/m3)	Pb (µg/m3)	
A-1	<20.0	<1.0	<0.1	<1.0	<1.0	<0.1	15.80	*BDL(**DL-0.5)	*BDL(**DL-0.5)	*BDL(**DL-0.1)	<0.5	0.05	400
A-2	<20.0	<1.0	<0.1	<1.0	<1.0	<0.1	17.50	*BDL(**DL-0.5)	*BDL(**DL-0.5)	*BDL(**DL-0.1)	<0.5	0.09	5
A-3	<20.0	<1.0	<0.1	<1.0	<1.0	<0.1	15.30	*BDL(**DL-0.5)	*BDL(**DL-0.5)	*BDL(**DL-0.1)	<0.5	0.03	1
A-4	<20.0	<1.0	<0.1	<1.0	<1.0	<0.1	13.70	*BDL(**	*BDL(**	*BDL(**	<0.5	0.04	-

								DL-0.5)	DL-0.5)	DL-0.1)			
A-5	<20.0	<1.0	<0.1	<1.0	<1.0	<0.1	18.30	*BDL(** DL-0.5)	*BDL(** DL-0.5)	*BDL(** DL-0.1)	<0.5	0.03	-
A-6	<20.0	<1.0	<0.1	<1.0	<1.0	<0.1	18.80	*BDL(** DL-0.5)	*BDL(** DL-0.5)	*BDL(** DL-0.1)	<0.5	0.08	-
A-7	<20.0	<1.0	<0.1	<1.0	<1.0	<0.1	16.20	*BDL(** DL-0.5)	*BDL(** DL-0.5)	*BDL(** DL-0.1)	<0.5	0.05	-
A-8	<20.0	<1.0	<0.1	<1.0	<1.0	<0.1	13.10	*BDL(** DL-0.5)	*BDL(** DL-0.5)	*BDL(** DL-0.1)	<0.5	0.08	-
A-9	<20.0	<1.0	<0.1	<1.0	<1.0	<0.1	17.10	*BDL(** DL-0.5)	*BDL(** DL-0.5)	*BDL(** DL-0.1)	<0.5	0.09	-
A-10	<20.0	<1.0	<0.1	<1.0	<1.0	<0.1	14.90	*BDL(** DL-0.5)	*BDL(** DL-0.5)	*BDL(** DL-0.1)	<0.5	0.10	-
A-11							12.50	*BDL(** DL-0.5)	*BDL(** DL-0.5)	*BDL(** DL-0.1)	<0.5	0.04	



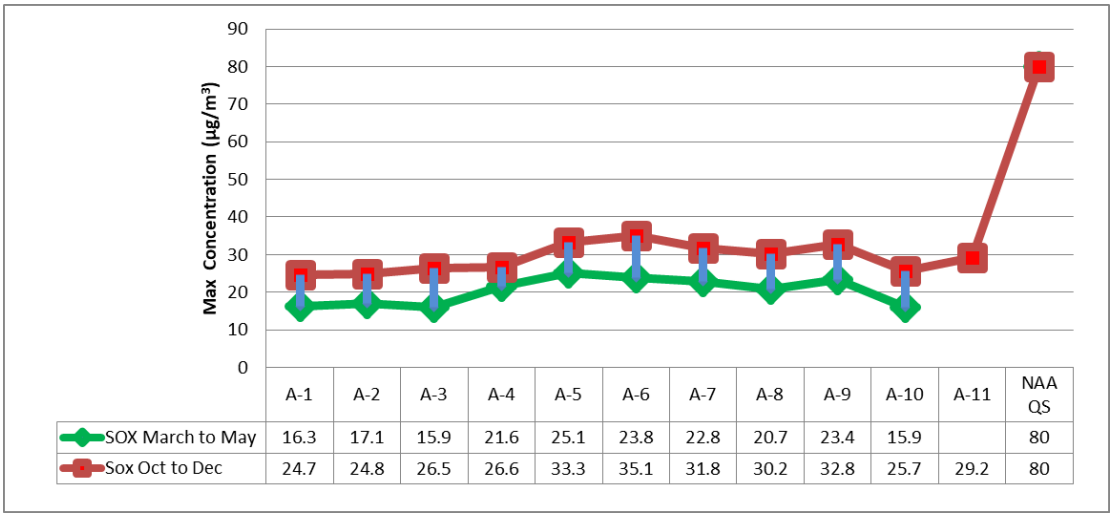
	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10	A-11	NAAQS
PM10 March to May	49.5	52.3	49.3	48.9	58.6	61.3	51.3	44.6	51.8	48.9		100
PM10 Oct to Dec	51.6	54.3	51.3	50.3	63.8	61.7	53.4	46.8	53.8	50.9	52.2	100

Figure 3.7: Two Season (March to May and Oct to Dec 2021) Comparision data for Particulate Pollutants (PM_{10})



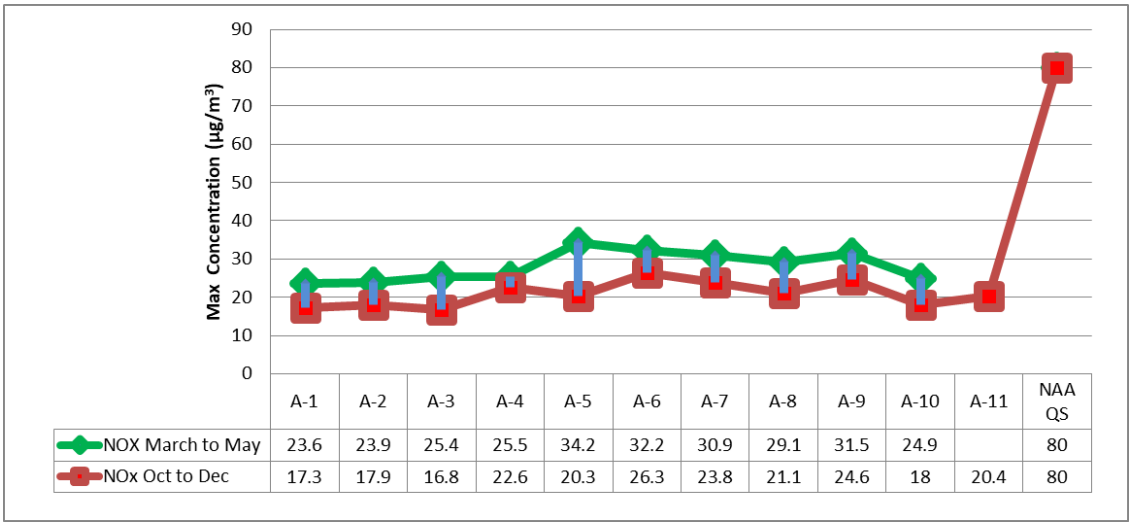
	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10	A-11	NAAQS
PM2.5 March to May	29.2	30.3	27.9	26.7	33.6	40.2	39.2	28.2	32.5	27.8		60
PM2.5 Oct to Dec	39.4	40.2	37.9	37.1	50.4	43.7	49.2	38.3	42.5	37.7	37.5	60

Figure 3.8: Two Season (March to May and Oct to Dec 2021) Comparision data for Particulate Pollutants ($PM_{2.5}$)



	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10	A-11	NAAQS
SOX March to May	16.3	17.1	15.9	21.6	25.1	23.8	22.8	20.7	23.4	15.9		80
Sox Oct to Dec	24.7	24.8	26.5	26.6	33.3	35.1	31.8	30.2	32.8	25.7	29.2	80

Figure 3.9: Two Season (March to May and Oct to Dec 2021) Comparision data for Sox



	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10	A-11	NAAQS
NOX March to May	23.6	23.9	25.4	25.5	34.2	32.2	30.9	29.1	31.5	24.9		80
NOx Oct to Dec	17.3	17.9	16.8	22.6	20.3	26.3	23.8	21.1	24.6	18	20.4	80

Figure 3.10: Two Season (March to May and Oct to Dec 2021) Comparision data for NOx

3.3.9 Air Quality Index

An air quality index (AQI) is a number used by government agencies to communicate to the public how polluted the air currently is or how polluted it is forecast to become. As the AQI increases, an increasingly large percentage of the population is likely to experience increasingly severe adverse health effects.

There are six AQI categories, namely Good, Satisfactory, Moderately polluted, Poor, Very Poor, and Severe. The AQI for proposed project is considering five pollutants (PM_{10}, $PM_{2.5}$, NO_2, SO_2 and CO) for which short-term (up to 24-hourly averaging period) National Ambient Air Quality Standards are prescribed. Based on the measured ambient concentrations, corresponding standards and likely health impact, a sub-index is calculated for each of these pollutants. The worst sub-index reflects overall AQI.

AQI has been be calculated by using the following formula.

$$I = [I_{high} - I_{low} / C_{high} - C_{low}] (C - C_{low}) + I_{low}$$

Where,

I - The Air Quality Index

C - The pollutant concentration

C_{low} - The concentration breakpoint that is ≤ C

C_{high} - The concentration breakpoint that is ≥ C

I_{low} - The index breakpoint corresponding to C_{low}

I_{high} - The index breakpoint corresponding to C_{high}

The AQI values and corresponding ambient concentrations (health breakpoints) as well as associated likely health impacts for the identified eight pollutants are as follows

Table 3.8: AQI Category Based on Pollutants Concentration

AQI	Associated Health Impacts
Good (0-50)	Minimal Impact
Satisfactory (51-100)	May cause minor breathing discomfort to sensitive people.
Moderate (101-200)	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults.
Poor (201-300)	May cause breathing discomfort to people on prolonged exposure, and discomfort to people with heart disease
Very Poor (301-400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases.
Severe (401-500)	May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts may be experienced even during light physical activity.

(Ref: Associated Health Effects taken by the MoEF&CC.)

In the present study only 5 parameters are taken such as PM_{10}, $PM_{2.5}$, SO_2, NO_2 and CO. By considering the above 5 pollutants the calculated AQI at 16 locations are given.

Table 3.9: Sub-Index Values for each Air Pollutant at Selected Sites

	March to May 2021						October to Dec 2021				
Site	**Conc.**	**Sub-Index**	**Category**	**Color**	**Health Impact**		**Conc.**	**Sub-Index**	**Category**	**Color**	**Health Impact**
Name of the pollutant: PM_{10} (µg/m³)											
A1	49.50	50	Good	Green	Minimal Impact	A1	51.60	52	Satisfactory	Light green	May cause discomfort to sensitive people
A2	52.30	52	Satisfactory	Light green	May cause discomfort to sensitive people	A2	54.30	54	Satisfactory	Light green	May cause discomfort to sensitive people
A3	49.30	49	Good	Green	Minimal Impact	A3	51.30	51	Satisfactory	Light green	May cause discomfort to sensitive people
A4	48.90	49	Good	Green	Minimal Impact	A4	50.30	50	Satisfactory	Light green	May cause discomfort to sensitive people
A5	58.60	59	Satisfactory	Light green	May cause discomfort to sensitive people	A5	63.80	64	Satisfactory	Light green	May cause discomfort to sensitive people
A6	61.30	61	Satisfactory	Light green	May cause discomfort to sensitive people	A6	61.70	62	Satisfactory	Light green	May cause discomfort to sensitive people
A7	51.30	51	Satisfactory	Light green	May cause discomfort to sensitive people	A7	53.40	53	Satisfactory	Light green	May cause discomfort to sensitive people
A8	44.60	45	Good	Green	Minimal Impact	A8	46.80	47	Good	Green	Minimal Impact
A9	51.80	52	Satisfactory	Light green	May cause discomfort to sensitive people	A9	53.80	54	Satisfactory	Light green	May cause discomfort to sensitive people
A10	48.90	49	Good	Green	Minimal Impact	A10	50.90	51	Satisfactory	Light green	May cause discomfort to sensitive people
						A11	52.20	52	Satisfactory	Light green	May cause discomfort to sensitive people
Name of the pollutant: $PM_{2.5}$ (µg/m³)											
A1	29.2	49	Good	Green	Minimal Impact	A1	39.40	66	Satisfactory	Light	May cause discomfort to

	March to May 2021						October to Dec 2021				
Site	Conc.	Sub-Index	Category	Color	Health Impact		Conc.	Sub-Index	Category	Color	Health Impact
										green	sensitive people
A2	30.3	51	Satisfactory	Light green	May cause discomfort to sensitive people	A2	40.20	67	Satisfactory	Light green	May cause discomfort to sensitive people
A3	27.9	47	Good	Green	Minimal Impact	A3	37.90	63	Satisfactory	Light green	May cause discomfort to sensitive people
A4	26.7	45	Good	Green	Minimal Impact	A4	37.10	62	Satisfactory	Light green	May cause discomfort to sensitive people
A5	33.6	56	Satisfactory	Light green	May cause discomfort to sensitive people	A5	50.40	84	Satisfactory	Light green	May cause discomfort to sensitive people
A6	40.2	67	Satisfactory	Light green	May cause discomfort to sensitive people	A6	43.70	73	Satisfactory	Light green	May cause discomfort to sensitive people
A7	39.2	65	Satisfactory	Light green	May cause discomfort to sensitive people	A7	49.20	82	Satisfactory	Light green	May cause discomfort to sensitive people
A8	28.2	47	Good	Green	Minimal Impact	A8	38.30	64	Satisfactory	Light green	May cause discomfort to sensitive people
A9	32.5	54	Satisfactory	Light green	May cause discomfort to sensitive people	A9	42.50	71	Satisfactory	Light green	May cause discomfort to sensitive people
A10	27.8	46	Good	Green	Minimal Impact	A10	37.70	63	Satisfactory	Light green	May cause discomfort to sensitive people
						A11	37.50	63	Satisfactory	Light green	May cause discomfort to sensitive people
Name of the pollutant: SO_2 (µg/m³)											
A1	16.3	20	Good	Green	Minimal Impact	A1	24.70	31	Good	Green	Minimal Impact
A2	17.1	21	Good	Green	Minimal Impact	A2	24.80	31	Good	Green	Minimal Impact
A3	15.9	20	Good	Green	Minimal Impact	A3	26.50	33	Good	Green	Minimal Impact
A4	21.6	27	Good	Green	Minimal Impact	A4	26.60	33	Good	Green	Minimal Impact
A5	25.1	31	Good	Green	Minimal Impact	A5	33.30	42	Good	Green	Minimal Impact
A6	23.8	30	Good	Green	Minimal Impact	A6	35.10	44	Good	Green	Minimal Impact

	March to May 2021						October to Dec 2021				
Site	**Conc.**	**Sub-Index**	**Category**	**Color**	**Health Impact**		**Conc.**	**Sub-Index**	**Category**	**Color**	**Health Impact**
A7	22.8	28	Good	Green	Minimal Impact	A7	31.80	40	Good	Green	Minimal Impact
A8	20.7	26	Good	Green	Minimal Impact	A8	30.20	38	Good	Green	Minimal Impact
A9	23.4	29	Good	Green	Minimal Impact	A9	32.80	41	Good	Green	Minimal Impact
A10	15.9	20	Good	Green	Minimal Impact	A10	25.70	32	Good	Green	Minimal Impact
						A11	29.20	37	Good	Green	Minimal Impact
Name of the pollutant: NO_2 (µg/m³)											
A1	23.6	30	Good	Green	Minimal Impact	A1	17.30	22	Good	Green	Minimal Impact
A2	23.9	30	Good	Green	Minimal Impact	A2	17.90	22	Good	Green	Minimal Impact
A3	25.4	32	Good	Green	Minimal Impact	A3	16.80	21	Good	Green	Minimal Impact
A4	25.5	32	Good	Green	Minimal Impact	A4	22.60	28	Good	Green	Minimal Impact
A5	34.2	43	Good	Green	Minimal Impact	A5	20.30	25	Good	Green	Minimal Impact
A6	32.2	40	Good	Green	Minimal Impact	A6	26.30	33	Good	Green	Minimal Impact
A7	30.9	39	Good	Green	Minimal Impact	A7	23.80	30	Good	Green	Minimal Impact
A8	29.1	36	Good	Green	Minimal Impact	A8	21.10	26	Good	Green	Minimal Impact
A9	31.5	39	Good	Green	Minimal Impact	A9	24.60	31	Good	Green	Minimal Impact
A10	24.9	31	Good	Green	Minimal Impact	A10	18.00	23	Good	Green	Minimal Impact
						A11	20.40	26	Good	Green	Minimal Impact
Name of the pollutant: CO (mg/m³)											
A1	418	21	Good	Green	Minimal Impact	A1	0.51	26	Good	Green	Minimal Impact
A2	419	21	Good	Green	Minimal Impact	A2	0.52	26	Good	Green	Minimal Impact
A3	439	22	Good	Green	Minimal Impact	A3	0.54	27	Good	Green	Minimal Impact
A4	378	19	Good	Green	Minimal Impact	A4	0.48	24	Good	Green	Minimal Impact
A5	487	24	Good	Green	Minimal Impact	A5	0.57	29	Good	Green	Minimal Impact
A6	472	24	Good	Green	Minimal Impact	A6	0.59	30	Good	Green	Minimal Impact
A7	415	21	Good	Green	Minimal Impact	A7	0.52	26	Good	Green	Minimal Impact
A8	335	17	Good	Green	Minimal Impact	A8	0.44	22	Good	Green	Minimal Impact

	March to May 2021						October to Dec 2021				
Site	Conc.	Sub-Index	Category	Color	Health Impact		Conc.	Sub-Index	Category	Color	Health Impact
A9	437	22	Good	Green	Minimal Impact	A9	0.53	27	Good	Green	Minimal Impact
A10	418	21	Good	Green	Minimal Impact	A10	0.47	24	Good	Green	Minimal Impact
						A11	0.45	23	Good	Green	Minimal Impact
Name of the pollutant: O3 (µg /m³)											
A1	8.3	8	Good	Green	Minimal Impact	A1	10.40	10	Good	Green	Minimal Impact
A2	8.9	9	Good	Green	Minimal Impact	A2	10.80	11	Good	Green	Minimal Impact
A3	7.9	8	Good	Green	Minimal Impact	A3	9.80	10	Good	Green	Minimal Impact
A4	8.6	9	Good	Green	Minimal Impact	A4	10.60	11	Good	Green	Minimal Impact
A5	9.6	10	Good	Green	Minimal Impact	A5	11.60	12	Good	Green	Minimal Impact
A6	9.8	10	Good	Green	Minimal Impact	A6	11.80	12	Good	Green	Minimal Impact
A7	9.4	9	Good	Green	Minimal Impact	A7	18.80	19	Good	Green	Minimal Impact
A8	7.9	8	Good	Green	Minimal Impact	A8	9.90	10	Good	Green	Minimal Impact
A9	8.9	9	Good	Green	Minimal Impact	A9	10.90	11	Good	Green	Minimal Impact
A10	8.2	8	Good	Green	Minimal Impact	A10	10.20	10	Good	Green	Minimal Impact
						A11	9.10	9	Good	Green	Minimal Impact

Source: Primary On-site Data Collected by Vimta Lab

Table 3.10: AQI Values for each Air Pollutant at Selected Sites (Oct to dec 2021)

Site	Conc.	AQI value	Category	Color	Health Impact
A1	Baseline	66	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	106.72	Moderate	Pink	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults
A2	Baseline	67	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	91.33	Satisfactory	Light green	May cause Discomfort to sensitive people

A3	Baseline	63	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	68.62	Satisfactory	Light green	May cause Discomfort to sensitive people
A4	Baseline	62	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	64.21	Satisfactory	Light green	May cause Discomfort to sensitive people
A5	Baseline	84	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	76.22	Satisfactory	Light green	May cause Discomfort to sensitive people
A6	Baseline	73	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	75.08	Satisfactory	Light green	May cause Discomfort to sensitive people
A7	Baseline	82	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	82.53	Satisfactory	Light green	May cause Discomfort to sensitive people
A8	Baseline	64	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	65.77	Satisfactory	Light green	May cause Discomfort to sensitive people
A9	Baseline	71	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	79.25	Satisfactory	Light green	May cause Discomfort to sensitive people
A10	Baseline	63	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	73.08	Satisfactory	Light green	May cause Discomfort to sensitive people
A11	Baseline	63	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	61.38	Satisfactory	Light green	May cause Discomfort to sensitive people

AQI for March to May study period

From the above interpretation of Air Quality Index for study area responsible parameter for pollution is PM_{10}, $PM_{2.5}$, SO_X, NO_X and CO. The AQI of study area falls under good to satisfactory categorization as per the data obtained during March to May baseline studies. The health impact due to this AQI is very less and it may only cause discomfort to sensitive people.

AQI for October to December study period

From the above interpretation of Air Quality Index for study area responsible parameter for pollution is PM_{10}, $PM_{2.5}$, SO_X, NO_X and CO. The AQI of study area falls under good to satisfactory categorization as per the data obtained during October to December baseline studies. The health impact due to this AQI is very less and it may only cause discomfort to sensitive people.

3.3.10 Air Quality Modeling

Considerable amount of air pollution will be generated at various stages of mining operations of cluster Coal Block such as drilling, blasting, excavation, dozing, loading, crushing, transportation of material and wind erosion of dumps. Particulate Matter less than 10 microns (PM_{10}) and less than 2.5 microns ($PM_{2.5}$) are the main source of pollution due to the mining activities operations. Most of the dust is generated from drilling, blasting, excavation, crushing and transportation operations. Large quantities of dust get air borne and is carried away from coal stocks overburden dumps induced by wind blow.

3.3.10.1 Emission Estimate from Mining area

The emissions from the mining operations can be estimated either by sampling or direct measurement or using emission factors. Emission factors are being widely used for estimation of emissions from the Dhirauli Mining Operations. An emission factor is a representative value that attempts to relate the quantity of pollutant released in the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance or duration of the activity emitting the pollutant. The parameters that are most likely to influence the particle emissions are measure of source activity, properties of the material being disturbed and climatic parameters.

United States Environmental Protection Agency (USEPA) has developed emission factors for coal mining operation was published through AP- 42 (1998), based on these emission factors, National Pollution Inventory (NPI), Australian Government also developed emission factors for Suspended Particulate Matter (TSP) and Particulate Matter (PM_{10}) and published the Emission Estimation Technique Manual (EET Manual) for mining and the version 3.1 is updated in January 2012.

3.3.10.2 Emission Sources and Strength

The emissions are estimated using the USEPA, AP- 42 Emission factors and NPI emission factors for different mining operations such as drilling, blasting, dozing, loading, dumping, transportation, loading on to the trains, scarping, grading, CHP and wind erosion of dumps for both coal and OB operations separately.

As per the New National Ambient Air Quality standards notified vide GSR 826 (E), dated November 2009, the monitoring parameters for Particulate Matters for Ambient Air Quality were prescribed as PM_{10} and $PM_{2.5.}$

Hence, the emission estimation for PM_{10} is carried with equation of USEPA and NPI. Emission Factor Equations used for calculation PM_{10} from Drilling, Blasting, Excavation, Loading, CHP, Transportation, Dumping, Grading, Wind Erosion, etc. for both coal and OB is discussed below:

3.3.10.3 Drilling in Coal

Emissions from the drilling are relatively minor component of the overall emission from the opencast mining. The variables like, depth of hole, diameter of the hole, moisture content of the material being drilled, type of the drilling, wind current at the drilling site will influence the rate of emission. USEPA (1998) has derived emission factor for TSPM is 0.59 Kg / hole taking into consideration of all the parameters. USEPA (1998) does not provide any emission factor for PM_{10} component. However, the NPI EET Manual (2012) states that the mean fraction of PM_{10}/TSP was 0.52. Hence the best estimation of the emission factor for drilling for PM_{10} is = 0.59*0.52= 0.31 Kg/hole.

EF PM10 = 0.31 Kg/Hole
Where, EF PM10 = Emission Factor for PM10.

3.3.10.4 Blasting Operation in Coal

The emissions from the blasting operations mainly depend on the area of the blasting, moisture content of the blasted material, depth of the blast hole, explosives being used, mode of detonation, blasting pattern, etc. NPI EET Manual (2012) provided emission factor for blasting for PM10 is as follows:
EFPM10 = 0.000114*A1.5 Kg/blast
Where,
EFPM10 = Emission factor for PM10 in Kg/blast
A = Area of blasting in m2

3.3.10.5 Blasting Operation in OB

As per the USEPA and NPI, the emission factor for coal is also suitable for OB. As such,
EFTSP = (344*A0.8)/(M1.9*D1.8) Kg/blast
Where,
EFTSP = Emission factor for TSP in Kg/blast

A = Area of blasting in m2 (OB)
M =Moisture content in OB, %
D = Depth of the hole, m
For PM10 fraction, USEPA (1998) estimated that, it will be 52% of TSP (Ref: NPI EET Manual, 2012). Hence,
EFPM10 = EFTSP x 0.52

3.3.10.6 Excavation in Coal

The emission during the excavation i.e. loading of coal on to the trucks is mainly depending on the moisture content. As per the USEPA (1998) and NPI EET Manual, 2012 the emission factor is:
$EFPM10 = k*0.0596/(M)^{0.9}$
Where,
EFPM10 = emission factor for PM10 in Kg / ton
k = 0.75 for PM10 concentration
M = Moisture content in (%)

3.3.10.7 Excavation in OB

The emission during the excavation i.e. loading of OB on to the dumpers / trucks is mainly depending on the moisture content of OB and mean wind speed.
EFPM10 = k*0.0016*(U/2.2)1.3/(M/2)1.4
Where,
EFPM10 = emission factor for PM10 in Kg / ton
k = 0.35 for PM10
U = Mean wind speed in m/s
M = Moisture content in %

3.3.10.8 Bulldozing in Coal

The emission during the bulldozing operation in the coal is mainly depending on the moisture content and silt content of the material. As per the USEPA (1998) and NPI EET Manual, 2012 the emission factor is:
EFPM10 = 6.33(s)1.5/(M)1.4
Where,
EFPM10 = emission factor for PM10 in Kg/h
s = Silt content in (%),
M = Moisture content in (%)

3.3.10.9 Bulldozing in OB

As per the USEPA (1998) and NPI EET Manual, 2012 the emission factor is;
EFPM10 = 0.34(s)1.5/(M)1.4
EFPM10 = emission factor for PM10 in Kg/h
s = Silt content in (%),
M = Moisture content in (%)

3.3.10.10 Transportation of Coal

When a vehicle travels an unpaved road, the force of the wheels on the road surfaces causes pulverization of the surface material, particles are lifted and dropped from the rolling wheels and the road surface is exposed to strong air currents in turbulent shear, with turbulent wake behind the vehicle continue to act on the road surface after the vehicle has passed. Various types of road surfaces and vehicle characteristics are likely to have an impact on the particulate emission from unpaved roads. The particulate emission is mainly depending on the weight of the vehicle and silt content on the road surface.

As per the USEPA (1998) and NPI EET Manual 2012 the emission factor for PM_{10} is:

$EFPM10 = k*(s/12)^{0.8*}(W/3)^{0.4}/(M/0.2)^{0.3}$

Where,
EF_{PM10}=emission factor in Kg per vehicle per km (Kg/VKT)
k = 0.733 for PM10
s = Silt content of road surface %
W = Vehicle gross mass in tonnes
M = Moisture content, %

3.3.10.11 Transportation of OB

As per the USEPA (1998) and NPI EET Manual 2012 the emission factor for PM_{10} for OB is also same as coal:

EFPM10 = k*(s/12)0.8*(W/3)0.4/(M/0.2)0.3

Where,
s = silt content of road surface
W = Vehicle gross mass in tonnes
M = Moisture content, %

3.3.10.12 Dumping of Coal

As per the NPI EET Manual 2012 the emission factor for PM_{10} for dumping coal is,

EFPM10 = 0.0042 kg/ton

3.3.10.13 Dumping of OB

The USEPA uses the same equation for unloading overburden as it does for loading OB

EF = 0.000644 Kg/ton

3.3.10.14 Grading in Coal and OB

Grading of haul roads is required to carryout to sweep the loose material pilfered from the loaded dumpers, flying fragments during blasting, etc. As per the USEPA (1998) and NPI EET Manual 2012, the emission factor for PM_{10} for grading in coal & OB is:

EF= 0.0034*(S)2 kg/VKT

Where,

S= Mean Vehicle Speed in Kmph

3.3.10.15 Wind Erosion of Coal Dump (Stock Yard)

Dumping of coal in the coal stock yard is required to be carried as an alternate arrangement at the surface, when the bunker / pre-weigh bin is full of its capacity. Wind provides the mechanical energy for particle entrainment. A certain minimum wind velocity, often called threshold wind velocity is responsible for air borne of the dust from the dumps. For long term emission estimations, average soil moisture content or the number of rainy days, silt content of the dumping material, wind speed are influencing parameters. As per USEPA (1998) and NPI EET Manual 2012, emission factor for PM_{10} for wind erosion of dump is as given below.

EFTSP = 1.9*(s/1.5)*365*((365-p)/235)*(f/15)

3.3.10.16 Wind Erosion of OB Dumps

As per the USEPA (1998) and NPI EET Manual 2012 the emission factor for PM_{10} for wind erosion of dump is:

EFTSP = 1.9*(s/1.5)*365*((365-p)/235)*(f/15)

Taking,

EFPM10 = 50% of EFTSP

EF = emission factor for TSPM kg/ha/Year

s = silt content in exposed area of the coal heap, %

p = number of days when rain fall > 0.25 mm

f = % of time that wind speed is > 5.40 m/sec at the mean height of the dump

3.3.10.17 Coal Handling Plant

As per the USEPA (1998) the emission factor for Coal Handling Plant is,

EF = ((100-M) / M)) 0.4 x (a2 x s / (100-s)) 0.3 x (u / 160+ 3.7u)

Where,

M= Moisture Content, %

A= area, m^2

S= silt content, %

u= mean wind speed, m/s

3.3.11 AERMOD Results for study period March to May

The quarry area has been taken as a poly area source for all the dust emitting sources from all different mining activities. Appropriate emission factors, programme control

parameters such as land use, UTM zone, Albedo, Bowen Ratio, Surface roughness, surrounding surface features, etc. and micrometeorological data was taken. The emission reduction by implementation of proposed control measures was also considered. The ground level concentrations are computed for high 1st high 24-hr concentration values for all the baseline air quality monitoring stations by selecting them as discrete Cartesian receptors in the modeling area so that 16 receptors points taken for computation 24 -HR. Average concentrations of particulate matter and the predicted incremental concentration of PM_{10} and $PM_{2.5}$ at receptors for peak production capacities of the project are depicted in the **Figure No. 5.1 and 5.10.**

PM10: Max Incremental GLC will be 63.397 µg/m3 and maximum cumulative GLC will be 112.897 µg/m3 at Mine Site (Dhirauli South) A1 location, this is due to the major mining activity in this area.

PM2.5: Max Incremental GLC will be 38.038 µg/m3 and maximum cumulative GLC will be 67.238 µg/m3 at Mine Site (Dhirauli South) A1 location, this is also due to the major mining activity in the nearby area.

Sox : Max Incremental GLC will be 0.05718 µg/m3 and maximum cumulative GLC will be 25.10317µg/m3 at (Khairahi) A5 location, this is due to the Industrial area.

Nox: Max Incremental GLC will be 0.00953 µg/m3 and maximum cumulative GLC will be 34.20053 µg/m3 at (Khairahi) A5 location, this is due to the Industrial area.

CO: Max Incremental GLC will be 0.0000076 µg/m3 and maximum cumulative GLC will be 0.48700042 µg/m3 at (Khairahi) A5 location.

3.3.12 AERMOD Results for study period October to Dec 2021

The quarry area has been taken as a poly area source for all the dust emitting sources from all different mining activities. Appropriate emission factors, programme control parameters such as land use, UTM zone, Albedo, Bowen Ratio, Surface roughness, surrounding surface features, etc. and micrometeorological data was taken. The emission reduction by implementation of proposed control measures was also considered. The ground level concentrations are computed for high 1st high 24-hr concentration values for all the baseline air quality monitoring stations by selecting them as discrete Cartesian receptors in the modeling area so that 16 receptors points taken for computation 24 -HR. Average concentrations of particulate matter and the predicted incremental concentration of PM_{10} and $PM_{2.5}$ at receptors for peak production capacities of the project are depicted in the **Figure No. 5.1 and 5.10.**

PM_{10}: Max Incremental GLC will be 55.12933 µg/m^3 and maximum cumulative GLC will be 106.7293µg/m^3 at Mine Site (Dhirauli South) A1 location, this is due to the major mining activity in this area.

$PM_{2.5}$: Max Incremental GLC will be 38.038 µg/m^3 and maximum cumulative GLC will

be 72.06923 µg/m^3 at Mine Site (Dhirauli South) A1 location, this is also due to the major mining activity in the nearby area.

Sox : Max Incremental GLC will be 0.0459 µg/m^3 and maximum cumulative GLC will be 35.10 µg/m^3 at (Churwani) A6 location, this is due to the Industrial area.

Nox: Max Incremental GLC will be 0.00765 µg/m^3 and maximum cumulative GLC will be 26.30073µg/m^3 at (Churwani) A6 location, this is due to the Industrial area.

CO: Max Incremental GLC will be 0.00000149 µg/m^3 and maximum cumulative GLC will be 0.59000580 µg/m^3 at (Churwani) A6 location.

3.4 Water Environment

Water of high quality is essential to human life, and water of acceptable quality is essential for agricultural, industrial, domestic and commercial uses; in addition, most recreation is water based; therefore, major activities having potential effects on surface water are certain to be of appreciable concern to the consumers.

The hydrological environment is composed of two interrelated phases; ground water and surface water. Impacts initiated in one phase eventually affect the other. For example, a ground water system may charge one surface water system and later be recharged by another surface water system. The complete assessment of an impact dictates consideration of both ground water and surface water. Thus, pollution at one point in the system can be passed throughout, and consideration of only one phase does not characterize the entire problem.

3.4.1 Selection of Monitoring Location

Water Samples were collected from 24 locations out of which 10 for surface and 14 for ground water (Figure 3.7). Samples were collected as per IS: 3025 (Part-1) methodology. Necessary precautions were taken while collecting, preserving and transporting. Lab Reports are enclosed as Aneexure-3.

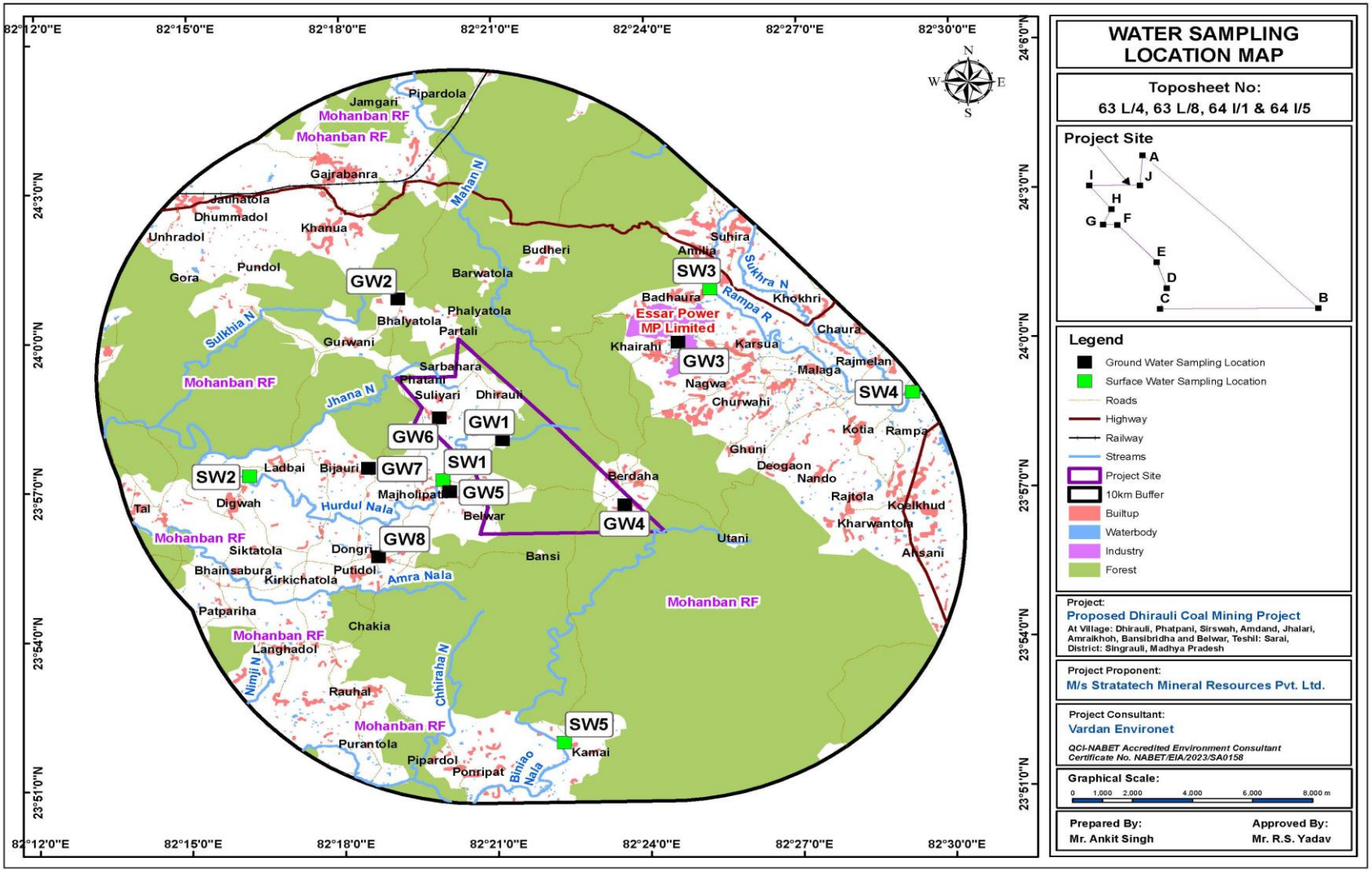


Figure 3.11: Water Sampling Location Map (March to May 2021)_

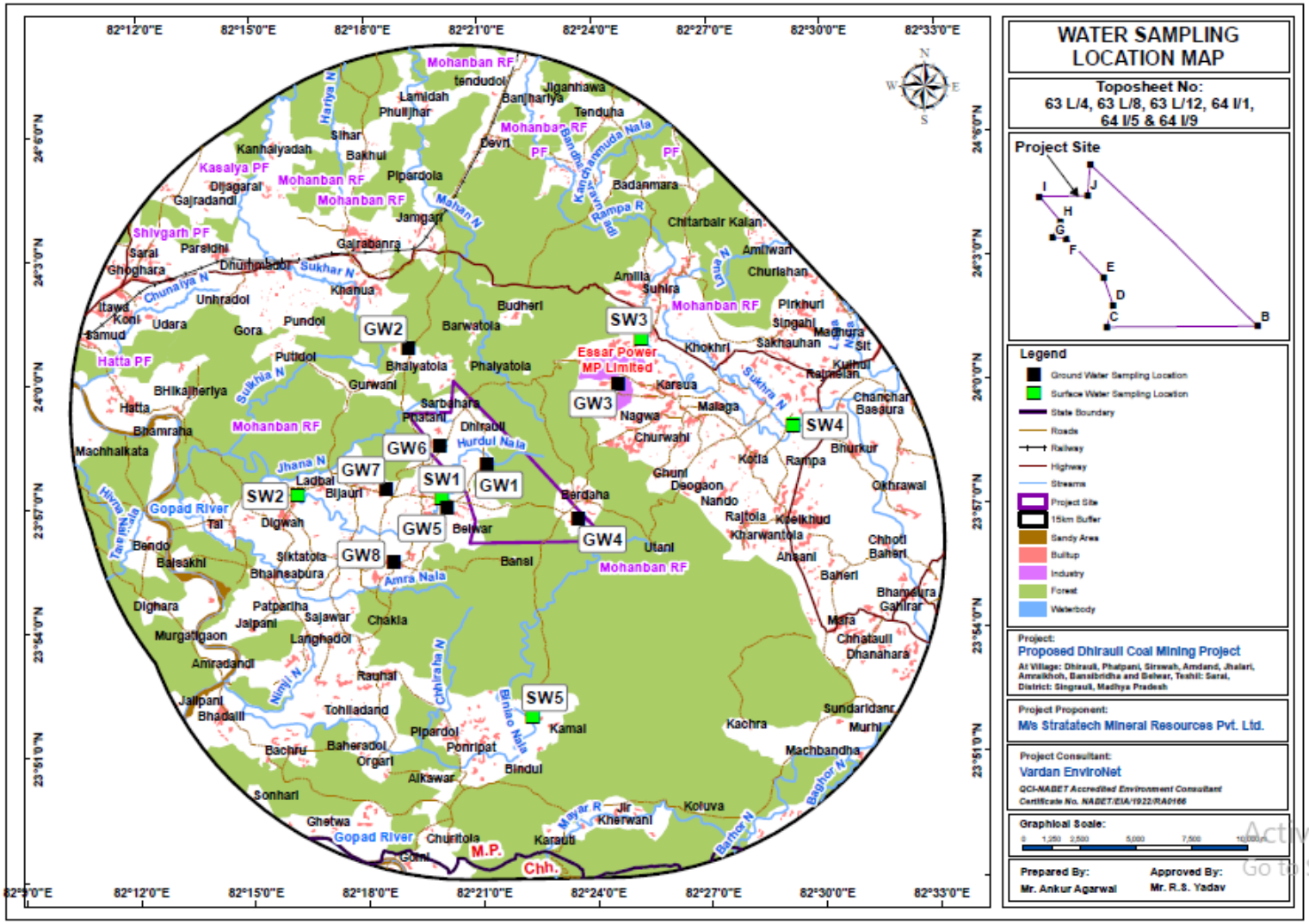


Figure 3.12: Water Sampling Location Map (October to Dec 2021)

Table 3.11: Water Sampling Location (March to May 2021 & October to December 2021)

Location	Name	Latitude	Longitude	Distance (km)/ Direction	Selection Criteria
SW1	Hurdul Nala near Majholipath (U/S)	23°57'16.01"N	82°19'56.96"E	0.7/SW	Nala
SW2	Hurdul Nala near Digwah (D/S)	23°57'19.24"N	82°16'08.14"E	6.9/W	Nala
SW3	Rampa River near Badhaura (U/S)	24°00'58.94"N	82°25'15.30"E	7.4/NE	River
SW4	Rampa River near Rampa (D/S)	23°58'54.15"N	82°29'09.83"E	9.6/E	River
SW5	Biniao Nala near Kamai (U/S)	23°51'54.80"N	82°22'15.37"E	7.5/S	Nala
GW1	M.L. Area – Dhirauli South	23°58'00.76"N	82°21'08.33"E	ML Area	Bore well
GW2	Bhalyatola	24°00'52.78"N	82°19'06.05"E	2.0	Bore well
GW3	Khairahi	23°59'56.10"N	82°24'34.35"E	4.5	Bore well
GW4	ML Area - Berdaha	23°56'40.98"N	82°23'32.56"E	ML Area	Bore well
GW5	Majholipath	23°56'58.93"N	82°20'06.85"E	0.8	Bore well
GW6	ML Area near Suliyari	23°58'27.19"N	82°19'56.05"E	ML Area	Bore well
GW7	Bijauri	23°57'27.73"N	82°18'28.86"E	2.6	Bore well
GW8	Dongri	23°55'40.09"N	82°18'42.98"E	2.9	Bore well

Source: Primary On-site Data Collected by Vimta

Table 3.12: Ground Water Sampling Result (March to May 2021)

Sr. No	Parameters	UOM	IS: 10500 Limits	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8
1	pH	-	6.5 – 8.5 (NR)	6.86	6.61	7.49	7.12	7.1	7.54	6.89	6.78
2	Colour	Hazen	5(25)	1	1	1	1	1	1	1	1
3	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
5	Conductivity	µS/cm	$	305	260	717	435	392	600	336	367
6	Turbidity	NTU	1(5)	2	2	3	3	3	4	2	2
7	TDS	mg/l	500(2000)	178	162	389	267	239	360	210	225
8	Total Hardness	mg/l	200(600)	90.9	77.9	263.4	147.6	118.0	173.6	95.2	102.3
9	Alkalinity	mg/l	200(600)	95	65	265	125	110	165	74	95
10	Calcium as Ca	mg/l	75(200)	17.6	15.7	61.4	32.2	23.5	41.8	19.4	22.4
11	Magnesium as Mg	mg/l	30(100)	11.4	9.4	26.7	16.3	14.4	16.8	9.5	11.2
12	Residual Chlorine	mg/l	0.2 Min	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
13	Boron as B	mg/l	0.5 (.4)	0.06	0.05	0.11	0.09	0.12	0.09	0.14	0.11

14	Chlorides as Cl	mg/l	250(1000)	27.4	32.8	46.9	52.2	44.5	66.4	28.6	32.5
15	Sulphates as SO4	mg/l	200(400)	9.6	10.3	14.8	8.7	11.5	32.6	12.9	10.2
16	Fluorides as F	mg/l	1.0(1.5)	0.2	0.3	0.2	0.4	0.3	0.5	0.2	0.3
17	Nitrates as NO3	mg/l	45(NR)	7.8	9.2	14.5	11.8	13.6	10.5	9.7	12.5
18	Sodium as Na	mg/l	$	26.7	23.5	41.7	29.6	32.4	57.5	25.2	28.3
19	Potassium as K	mg/l	$	1.5	1.0	2.3	5.2	6.4	3.7	2.4	4.8
20	Phenolic Compou	n mg/l	0.001(0.002)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
21	Cyanides as CN	mg/l	0.05 (NR)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
22	Anionic Detergent	mg/l	0.2 (1.0)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
23	Mineral Oil	mg/l	0.01 (0.03)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
24	Cadmium as Cd	mg/l	0.003 (NR)	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
25	Arsenic as As	mg/l	0.01 (NR)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Copper as Cu	mg/l	0.05 (1.5)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
27	Lead as Pb	mg/l	0.01 (NR)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
28	Manganese as Mn	mg/l	0.1 (0.3)	0.02	0.01	0.03	0.02	0.01	0.02	0.01	0.01

29	Iron as Fe	mg/l	0.3(1.0)	0.11	0.09	0.12	0.14	0.09	0.12	0.07	0.05
30	Chromium as Cr+	mg/l	0.05(NR)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
31	Selenium as Se	mg/l	0.01(NR)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
32	Zinc as Zn	mg/l	5(15)	0.08	0.05	0.07	0.09	0.07	0.05	0.09	0.04
33	Aluminium as Al	mg/l	0.03(0.2)	0.03	0.02	0.04	0.02	0.02	0.04	0.01	0.03
34	Mercury as Hg	mg/l	0.001(NR)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
35	Pesticides	mg/l	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
36	E. Coil	-	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
37	Total Coliforms	MPN	10	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Source: Primary On-site Data Collected by Vimta

Table 3.13: Surface Water Quality Data (March to May 2021)

Sr.No.	Parameters	Unit	SW1	SW2	SW3	SW4	SW5
1	pH	-	7.34	7.43	7.55	7.67	7.49
2	Colour	Hazen	3	4	3	4	4
3	Conductivity	µS/cm	188	160	235	192	260
4	TDS	mg/l	120	97	141	110	152
5	TSS	mg/l	11	12	16	19	14
6	Turbidity	NTU	5	7	4	6	5
7	DO	mg/l	5.2	5.4	5.7	5.3	5.1
8	BOD	mg/l	<3	<3	<3	<3	<3
9	COD	mg/l	<5	<5	<5	<5	<5
10	Total Hardness as CaCO3	mg/l	58.8	48.1	59.3	77.7	93.1
11	Total Alkalinity as CaCO3	mg/l	60	56	80	76	84
12	Calcium as Ca	mg/l	12.5	10.7	11.2	17.1	18.3
13	Magnesium as Mg	mg/l	6.7	5.2	7.6	8.5	11.5

14	Chlorides as Cl	mg/l	14.1	13.6	19.8	7.8	23.1
15	Residual free chlorine	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1
16	Phosphates as PO4	mg/l	0.07	0.05	0.08	0.06	0.09
17	Sulphates as SO4	mg/l	6.7	3.4	5.3	5.7	9.8
18	Fluorides as F	mg/l	0.4	0.3	0.2	0.3	0.4
19	Nitrates as NO3	mg/l	6.8	2.9	4.8	5.2	3.1
20	Sodium as Na	mg/l	13.4	14	22.3	7.83	15.2
21	Potassium as K	mg/l	4.2	2.52	7.9	2.45	3.4
22	Total Boron as B	mg/l	0.09	0.21	0.08	0.14	0.12
23	Phenolic Compounds	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
24	Cyanides	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02
25	Oil & grease	mg/l	<1.0	<1.0	<1.0	<1.0	<1.0
26	Cadmium as Cd	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003
27	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
28	Copper as Cu	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01

29	Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
30	Iron as Fe	mg/l	0.11	0.08	0.09	0.05	0.14
31	Chromium as Cr+6	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05
32	Selenium as Se	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01
33	Zinc as Zn	mg/l	0.09	0.04	0.08	0.06	0.05
34	Aluminum as Al	mg/l	0.03	0.04	0.02	0.03	0.02
35	Mercury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001
36	SAR	-	0.76	0.88	1.26	0.39	0.69
37	Pesecticides	mg/l	Absent	Absent	Absent	Absent	Absent
38	Anionic detergents as MBAS	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02
39	Total Coliforms	MPN/100	1120	1030	1180	1340	1160

Source: Primary On-site Data Collected by Vimta

Table 3.14: Ground Water Sampling Result (October to December 2021)

Sr. No	Parameters	UOM	Limits of IS:10500 -2012		GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8
			Requirement (Acceptable) Limit	Permissible limit in the Absence of Alternate								
1	pH (at 25 0C)	--	6.5 to 8.5	No Relaxation	7.56	7.48	7.54	7.38	7.61	7.42	7.58	7.32
2	Colour	Hazen	5	15	1.0	1.0	1.0	*BDL (**DL 1.0 Hazen)	1.0	*BDL (**DL 1.0	1.0	1.0
4	Odour	--	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
5	Taste	--	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
6	Total Hardness as	mg/l	200	600	301.00	289.36	320.23	215.63	325.12	195.45	286.33	170.12
7	Calcium as Ca	mg/l	75	200	78.55	69.33	84.26	58.26	89.54	59.63	67.58	45.36
8	Alkalinity as CaCO3	mg/l	200	600	264.00	259.00	352.00	230.00	279.00	224.00	252.00	196.00
9	Chloride as Cl	mg/l	250	1000	81.53	63.25	46.89	93.21	60.21	50.26	59.9	62.47
11	Magnesium as Mg	mg/l	30	100	25.52	28.19	26.73	17.08	24.72	11.34	28.61	13.84
12	Total Dissolved	mg/l	500	2000	466.00	428.00	471.00	473.00	477.00	396.00	425.00	376.00
13	Sulphate as SO4	mg/l	200	400	35.21	32.69	21.53	45.85	53.54	38.96	40.54	37.24

14	Fluoride as F	mg/l	1.0	1.5	0.35	0.26	0.42	0.32	0.45	0.32	0.41	0.30
15	Nitrate as NO3	mg/l	45	No Relaxation	26.89	29.56	18.55	24.56	30.79	29.41	27.21	23.31
16	Iron as Fe	mg/l	1.0#	No relaxation	0.16	0.12	0.16	0.15	0.35	0.11	0.17	0.14
20	Conductivity (at 25ºC)	µS/cm	--	--	717	659	725	728	734	609	654	578
24	Zinc as Zn	mg/l	5	15	1.05	1.26	1.17	1.21	1.19	1.06	1.18	1.10
25	Copper as Cu	mg/l	0.05	1.5	0.07	0.08	0.10	0.12	0.14	0.07	0.11	0.09
32	Total Coliform	MPN/100ml	Shall not be detectable in any		<2	<2	<2	<2	<2	<2	<2	<2
33	E. Coli	MPN/100ml	Shall not be detectable in any		Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Note: - Turbidity, Cyanide as CN, Aluminium as Al, Boron. Chromium as Cr, Phenolic Compounds, Mineral Oil, Anionic Detergents as MBAS, Manganese as Mn, Cadmium as Cd, Lead as Pb, Selenium as Se, Arsenic as As, Mercury as Hg *BDL-Below Detection Limit, **DL- Detection Limit												

Source: Primary On-site Data Collected by Vardan Environet

Table 3.15: Surface Water Quality Data (October to December 2021)

Sr.No.	Parameters	Unit	SW1	SW2	SW3	SW4	SW5
1	pH (at 25 0C)	--	7.45	7.49	7.59	7.64	7.52
2	Colour	Hazen	5.0	7.0	11.0	9.0	8.0

3	Turbidity	NTU	20.00	25.00	28.00	41.00	31.00
4	Odour	--	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
5	Total Hardness as CaCO3	mg/l	336.25	350.69	421.00	436.89	361.00
6	Calcium as Ca	mg/l	121.32	129.47	138.56	142.88	131.52
7	Alkalinity as CaCO3	mg/l	389.00	390.00	393.00	409.21	396.52
8	Chloride as Cl	mg/l	210.53	216.47	215.56	231.56	227.58
11	Magnesium as Mg	mg/l	8.15	6.72	18.3	19.54	7.98
12	Total Dissolved Solids	mg/l	995.00	1017.00	1024.00	1078.00	1051.00
13	Total Suspended solids	mg/l	76.00	64.00	47.00	49.00	63.00
14	Dissolved Oxygen	mg/l	6.5	6.2	5.7	6.1	5.9
15	Sulphate as SO4	mg/l	142.00	146.00	155.00	161.00	150.00
16	Fluoride as F	mg/l	0.49	0.50	0.31	0.42	0.46
17	BOD (3 Days at 270C)	mg/l	10.00	13.00	11.00	12.00	11.00
18	COD	mg/l	36.00	44.00	32.00	46.00	38.00
19	Conductivity (at 25 0C)	mS/cm	1.53	1.56	1.57	1.65	1.62

20	Nitrate as NO3	mg/l	33.56	35.24	38.42	41.53	37.54
21	Sodium as Na	mg/l	231.00	228.00	202.00	215.00	236.00
22	Potassium as K	mg/l	16.5	21.12	19.9	20.53	22.14
23	Iron as Fe	mg/l	0.53	0.56	0.45	0.55	0.53
25	Boron	mg/l	0.41	0.44	0.32	0.42	0.41
30	Zinc as Zn	mg/l	1.23	2.36	2.05	2.13	2.22
31	Copper as Cu	mg/l	0.09	0.14	0.10	0.12	0.16
34	Total Coliform	MPN/100ml	1000	900	800	1000	800
35	Fecal Coliform	MPN/100ml	600	400	300	600	350
Note: Residual free Chlorine, #Cyanide as CN, Aluminium as Al, Chromium as Cr, Phenolic Compounds, #Mineral Oil, #Anionic Detergents as MBAS, Manganese as Mn, Cadmium as Cd, *BDL-Below Detection Limit, **DL- Detection Limit							

Source: Primary On-site Data Collected by Vardan Envirolab

3.5 Hydrogeology

3.5.1 Physiography of District

The district as a whole constitutes a hilly terrain most part of the district is covered by kaimur hilly ranges. The district is divided into three physiographic divisions: - (i) Kaimur hilly ranges (ii) The Central part hilly ranges and (iii) Southern hilly ranges. In the district three main river flows along with several tributaries rivers the major rivers are the Son, Gopal and Rihand. The Kaimur range stretching from NE and SW direction and covered most part of the district. The central part of the district forms a series of hill ranges. The Southern part of district the elevation of hills ranges varies between 365 and 488m above MSL. The general slope of the area is towards North east.

3.5.2 Physiography of the Project Site:

Western part of Dhirauli block is characterized by almost plain topography, while, north-eastern and south-central part are highly undulating and have rugged topography as evident from the topographical plan. The north-eastern and south-central part of the block have forest cover and is occupied by hillocks of elevation up to a maximum of 638 m above MSL. In general elevation of ground varies from 459.23m as observed near borehole MSD-102 to 603.45 m near borehole MDP-19 located in the south-western and south-eastern corner of the block respectively.

3.5.3 Geology

The geology of the district reveals that the Occurrence of various work formation as old as granites of Achaean age to the Alluvium of Recent age. The other important formations Outcropping in the district are Deccan trap of cretaceous – Eocene, Gondwanas of Paleozoic to Mesozoic Sandstone and other ranks of Vindhayans and Phyllites. Quartzites, Schist Gneisses and Granites of Archeans age. The Geology of the district is shown in the Hydrogeogical Map. The general Stratigraphical Succession obtained in the district is given as under:

Table 3.16: Geology of the Area

Period	Series/Stage	Lithology	
Recent Pleistocene	Alluvium	Allvium and soil cap comprising clay, sand gravel etc.	
Cretaceous to Eocene	Deccan Trap	Basaltic Lava flows	
Permian to Carboniferous	Gondwanas	Upper Gondwana formation Ranging formation Talchir formation	Sandstone Shale eval conglomerate and glauconite
Cambrian	Vindhyans	Kaimur Series	Porcellinite

		Semri Series	sandstone Orthoquartzite and conglometry
Pre-Cambrian	Archeans	Phyite, Quartzites, Granite, Schist, gneisses metabasic sedimentary and inhusives	

3.5.3.1 Geology of Singrauli Coal Field:

Singrauli coalfield forms the northern extremity of Son-Mahanadi master Gondwana basin, at the junction region of east-west trending Damodar-Koel-Tatapani garben and the NW-SE trending Son-Mahanadi rift zone; thus, reflecting the lithological and structural characteristics of both Damodar and Son valley Gondwana basins. The northern limit of the Singrauli coalfield is defined by a major east-west trending northern boundary fault, which is parallel to the Narmada-Son lineament. High standing Mahadeva hills are defining the southern boundary. Talchir beds rest un-conformably over Precambrian rocks and the Precambrian themselves are forming the eastern boundary whereas the western boundary is formed by the contact of Precambrian and Supra Barakar sediments.

3.5.3.2 Talchir Geology of Dhirauli Block:

The Dhirauli block is traversed by 11 normal gravity faults designated as F1-F1 to F11-F11. There are two sets of faults - one trending NW-SE and the other trending NE-SW. The magnitude of these faults varies from 5 m to 85 m within the block. The faults have been deciphered based on the floor level difference observed on either side of the fault planes and on the basis of borehole intersections. It is pertinent to mention here that the numbers of minor slips are also observed in boreholes causing insignificant reduction of parting and seam thickness. It is seen that, out of 11 faults interpreted, 10 faults are of low magnitude having throw between 5 m to 35 m except fault F9-F9 which is having maximum 85 m of throw. In general, the strike varies from NW-SW in the entire area of the block to almost E-W in the southern part of the block with gentle dip of 2° to 4° north-easterly to north and south-westerly to south at places. The net geological and mineable reserves estimated for both open cast and underground mining is 558.01 Mt and 313.79 Mt respectively

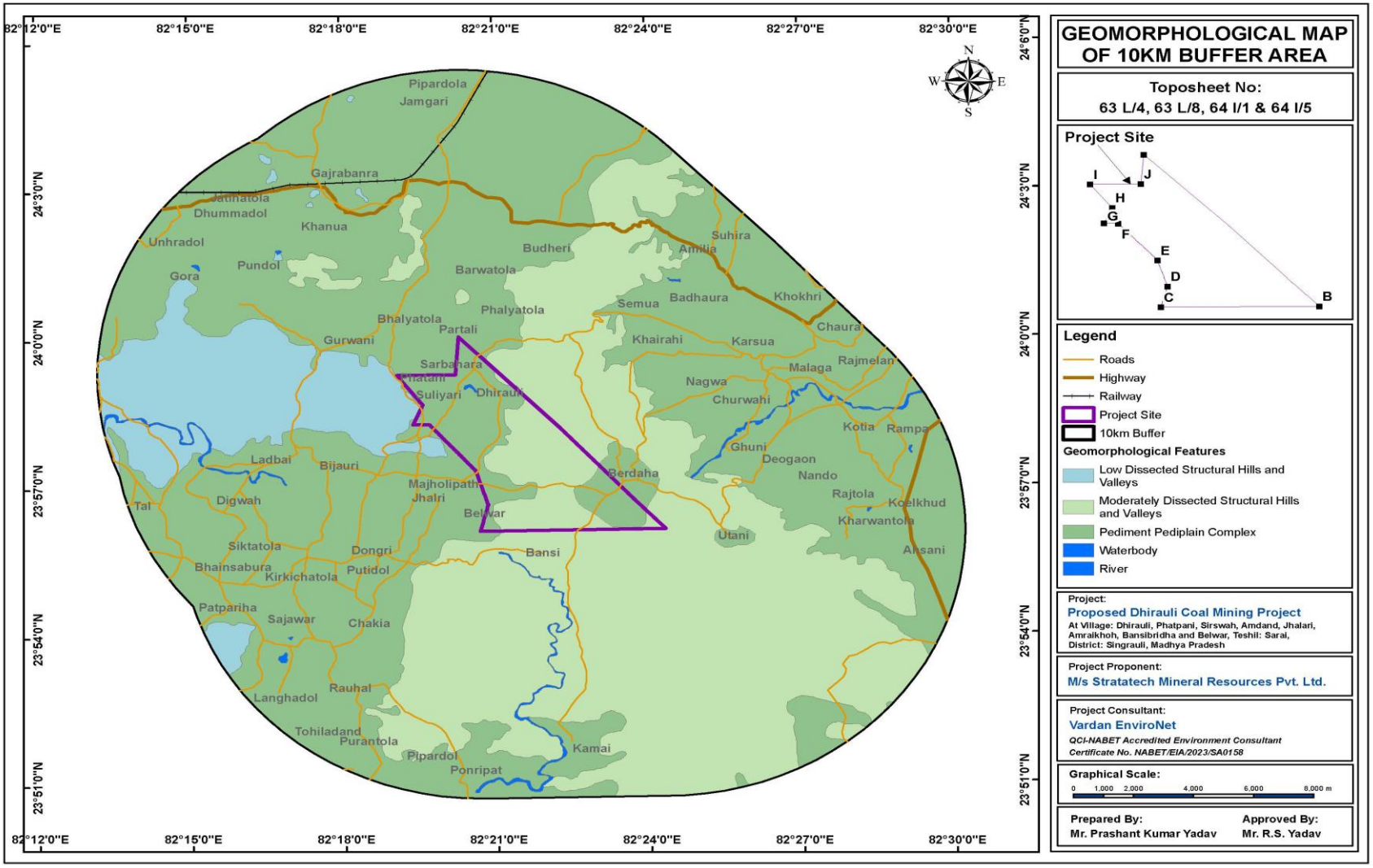


Figure 3.13: Geomorphological Map of the Study Area

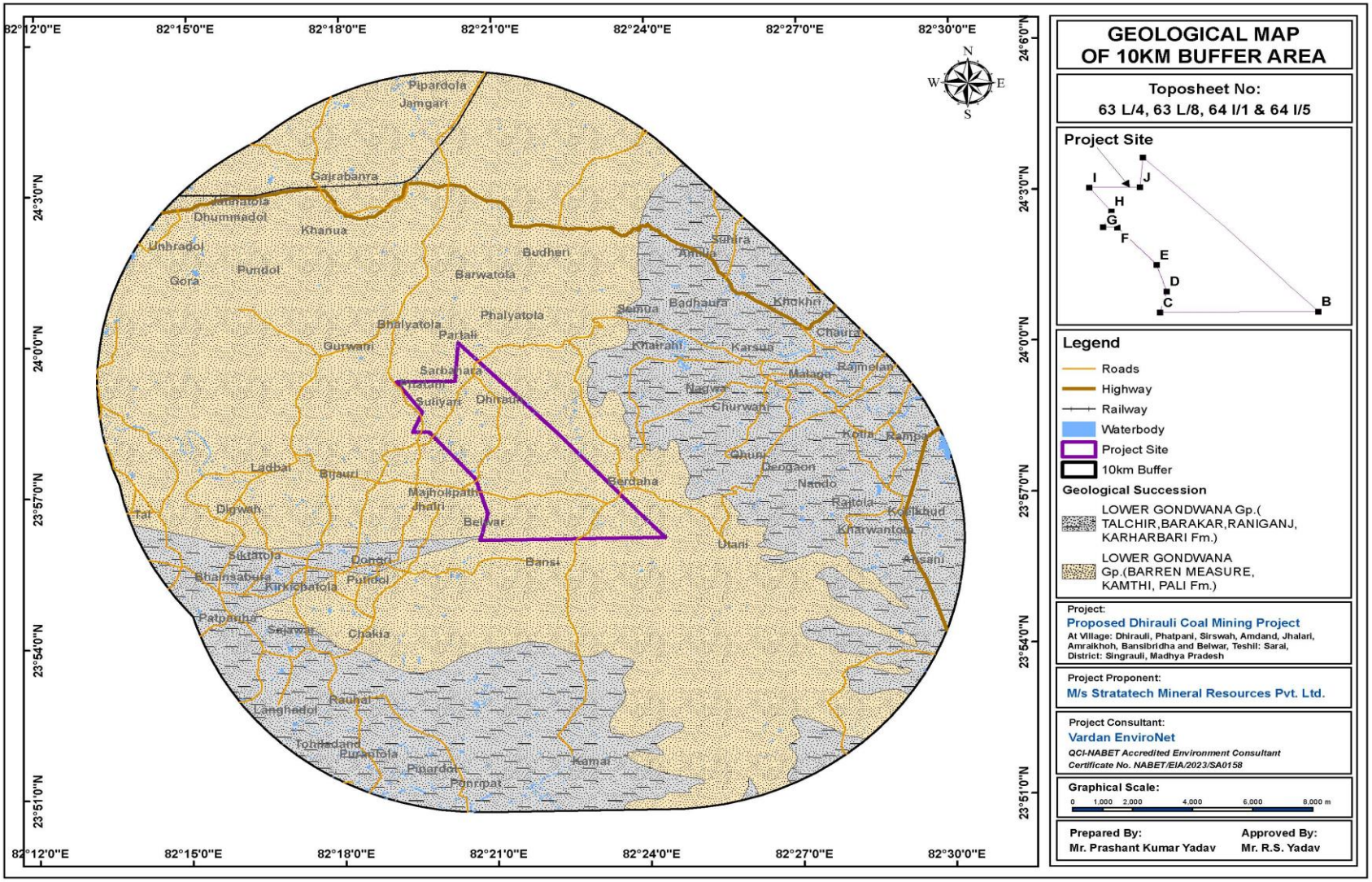


Figure 3.14: Geological Map of the Study Area

3.5.4 Hydrogeology

As per CGWA the project location comes under the non-Notified, safe zone.

The entire district drained by the above mentioned 3 major rivers and their tributaries for us the Ganges drainage System. The pattern of drainage is dendrite in hectare excepting the localized radial pattern in the hilly terrain.

Ground water is the principal source of irrigation in the district. The district area is underlain by hand rocks as well alluvium. The occurrence and movement of ground Water in different formations varies with rock type. The weathered and fractured zones occurring at shallow depths provide scope of ground water storage and movement. Ground water in Achaeans rocks occur in joints and fractures plane and in the weathered zones mostly under the water table conditions occurrence and movement of ground water is controlled by the extended size and interconnection of Joints and the degree of weathering which varies specially areas having a fairly high degree of fracturing and weathering and fracturing can sustain tube wells.

3.5.4.1 Aquifer Study

The area occupied by Achaean rocks comprising mostly granites schist's phyllites gneisses and guartizes where ground water occurs under phreatic conditions in the shallow weathered, Jointed and fractured zones of these rock types the thickness of weathered zone generally varies from 7 to 18 mbgl. The depth of the dug wells ranged between 3 to 21 mbgl with depth to water level varies from 2.41 to 16.70 mbgl.

The Vindhyan Sandstone and limestone, when occurring ocuring at lower elevations and having well developed joints, yield modulate quantities of ground water. The semri limestone has well developed and interconnected solution openings and ground water occurs under confined conditions. The depth to dug wells range between 6 to 24m bgl with depth to water level varying between 3.72 to 21.50m bgl Lower gondwana formations are represented by Talchir formation occupy in the northern part of the district wells located in topographic lows and piercing the Talchir Sandstones yield vary between 200 to 400m3 /day. The upper gondwana formations mainly consists of sandstones and clays and appear as hilly terrain in the southern part of the district the depth to water level in the upper gondwana formations verging between 3.15 to 11.32. The well discharge varies between 100 to 150m3 /day during summer months and can be developed by large diameter dug wells with diameter dug wells with diameter varying between 5 to 10m with 15 to 20m depth piercing the full thickness of weathered Jointed and fractured zones available in this formation.

3.5.4.2 Groundwater level monitoring

District Scenario:

Pre-Monsoon: The pre-monsoon depth to water level in the district ranges between 4.13 m bgl and 18.50m bgl. Major part of the district has water level in the range of 8-12m bgl during the pre-monsoon.

Post-Monsoon: During post-monsoon period, water level varies from 2.94m bgl to 15.17m bgl. In major part of the district, water level lies between 5 & 10 m bgl.

Ground water level at project location:

Ground water level near the project location varies from 5.00 to 15.00 mbgl **(Figure 3.15, 3.16 & 3.17).**

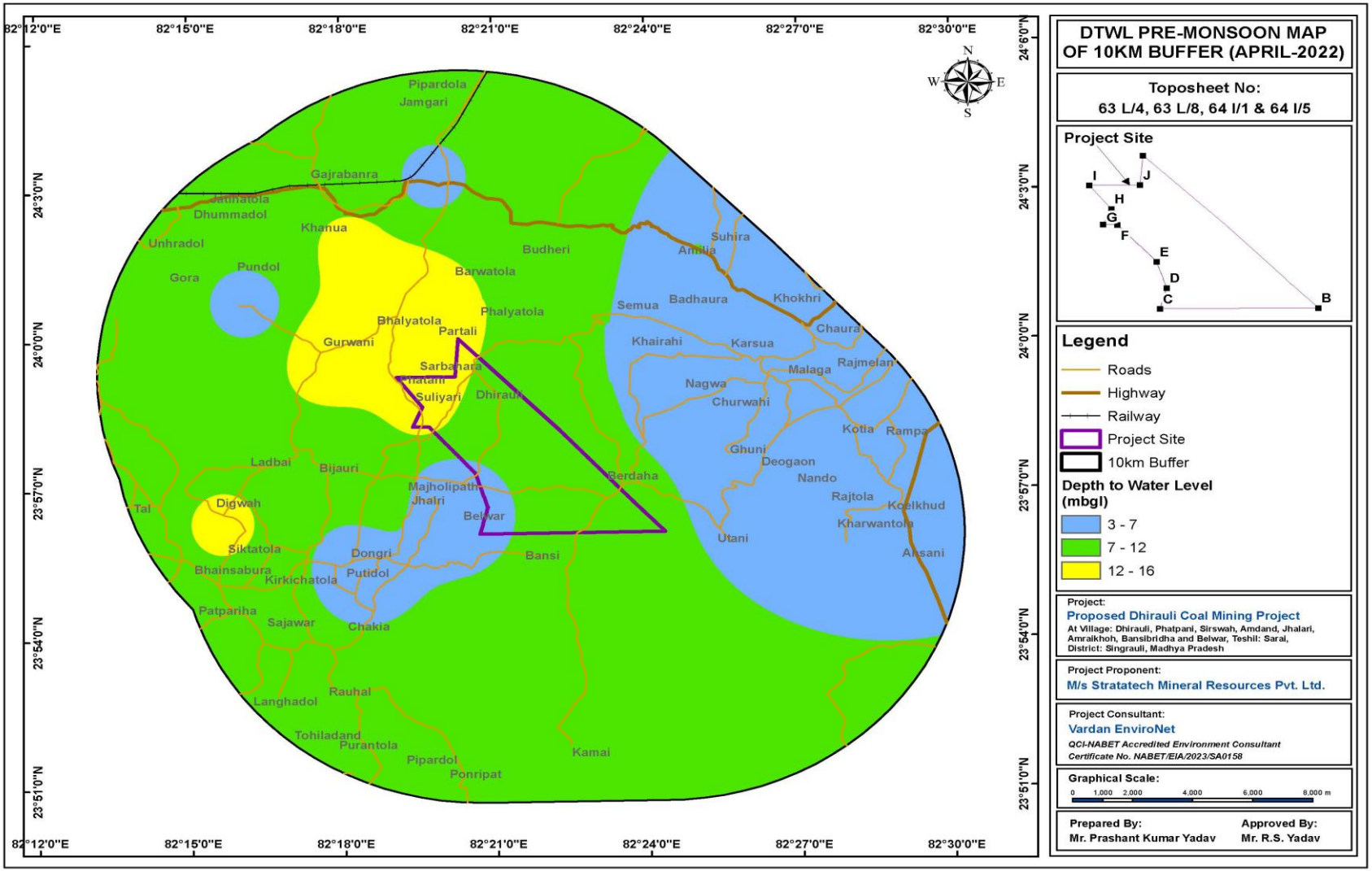


Figure 3.15: Pre –Monsoon Depth to Water Level Map

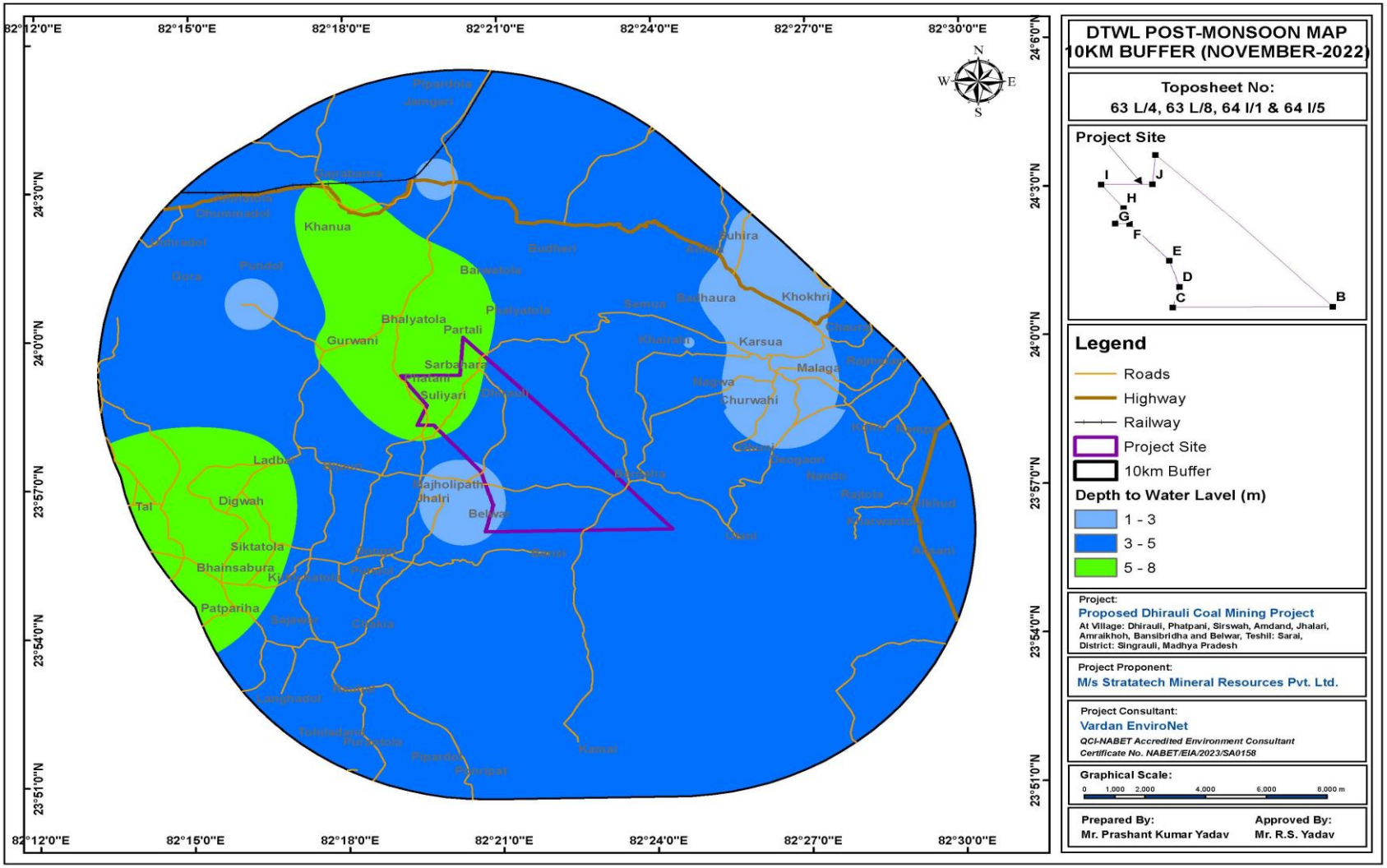


Figure 3.16: Post –Monsoon Depth to Water Level Map

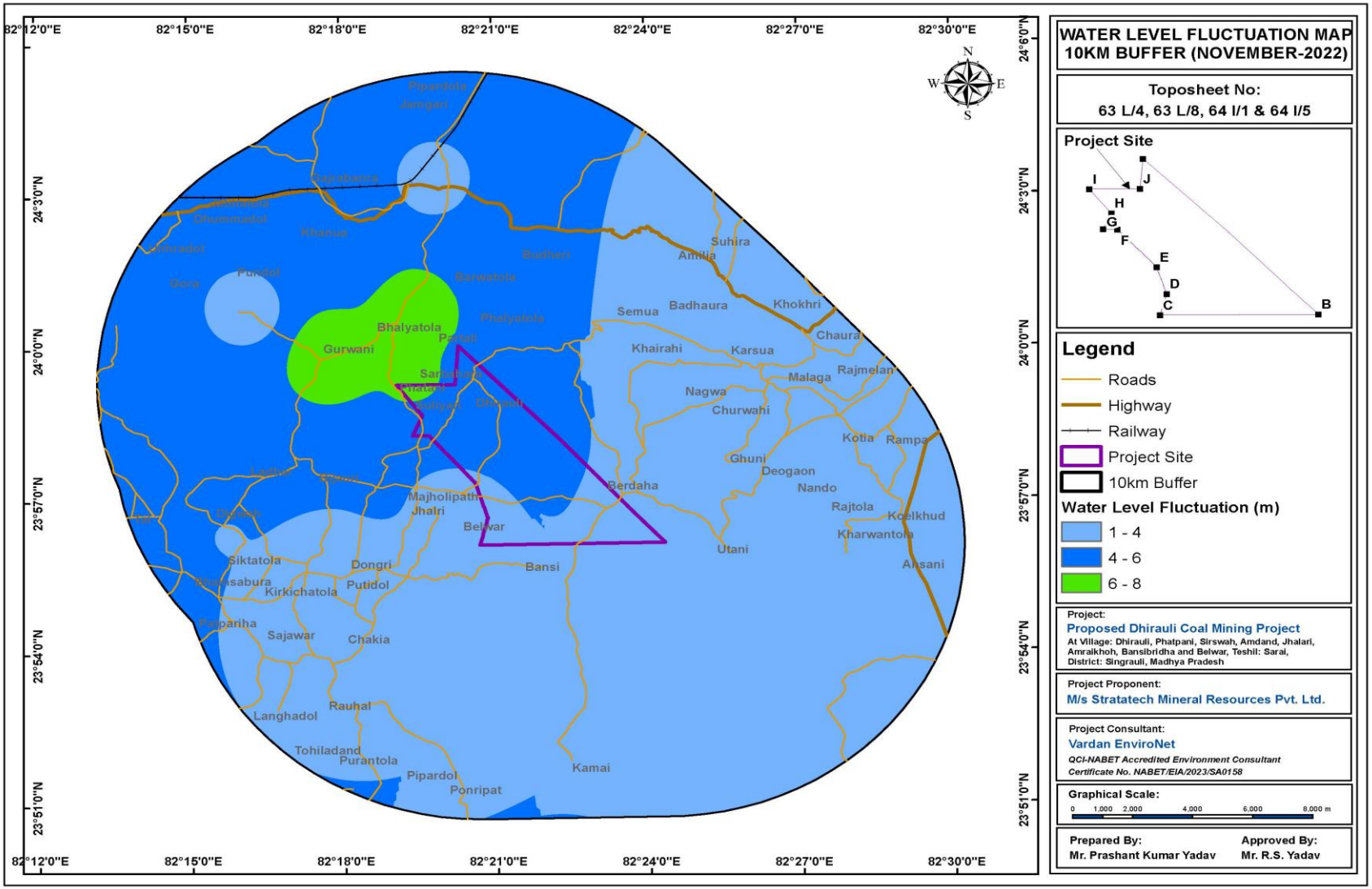


Figure 3.17: Fluctuation Water Level Map

3.5.5 Groundwater Resources Evaluation

Groundwater Resources of an area can be distinguished under two categories-

Dynamic Groundwater

Static Groundwater Resources

3.5.5.1 Dynamic Groundwater Resources

Dynamic groundwater is that amount of water, which is found in the natural zone of fluctuation in an aquifer due to ground water recharge. Total Groundwater Recharge (Rt) of the area can be estimated by assessing the various component of the following equation.

R_t	=	$R_r + R_s + R_i + S_r + R_c$
R_r	=	Recharge from Rainfall
R_s	=	Recharge from irrigation due to surface water
R_i	=	Recharge from irrigation due to groundwater
S_r	=	Recharge through surface water bodies
R_c	=	Recharge to confined aquifer

3.5.5.1.1 Groundwater Resources in Dhirauli Core Zone

The proposed coal mine covers about 2672 hectares (26.72 sq.km.). The main source of groundwater recharge is due to rainfall by direct percolation.

3.5.5.2 Recharge Due To Rainfall (For Dhirauli Block)

By Groundwater Table Fluctuation Method

In the core zone, dominant geological formations are Barakar Formation consisting of calcareous shale. Average specific yield can be taken as 3% for such formations while seasonal fluctuation is taken as 3 m. Recharge due to rainfall computed by specific yield and water table fluctuation method is as follows:-

R_{r1}	=	$A \times Sf \times Sy$
R_{r1}	=	Recharge
A	=	Area
Sf	=	Seasonal Fluctuation
Sy	=	Specific Yield

Here,

A	=	2672 Hectare
Sf	=	3.0 m

Sy	=	0.03%
R_{r1}	=	2672 Ha * 0.03 * 3 m
	=	26.72 sq. km. * 0.03 * 3
	=	2.40 Mcm/annum

By Rainfall infiltration Factor Method

In the area where groundwater level monitoring is not adequate in space and time, rainfall infiltration method may be adopted. The groundwater estimation committee, Govt. of India (2009) has suggested norms for recharge from rainfall under various hydro-geological conditions. Rainfall infiltration factor has been suggested as 3 to 10% for coal and shale formation as prevailing in Singrauli district. On an average, it can be taken as 8% for the core zone having well-developed drainage and comparatively more permeable strata.

R_{r2}	**=**	**Area x Rainfall x RI factor**
Rainfall	=	1.031mm (average annual rainfall, 2010-2019)
RI factor	=	8%
Area	=	2672 Hectare
R_{r2}	=	2672 Ha x 1.031 mm x 8%
	=	26.72 Sq. km. x 1.031 m x 0.08
	=	2.20 Mcm/annum

As per the recommendations of GEC, 2009, if the difference between the two, expressed as a percentage of rainfall infiltration method is greater than or equal to -20% or less than or equal to +20%, then the recharge is taken as the value estimated by the water table fluctuation method. If it is less than -20%, then it is taken as 0.8 times the value estimated by rainfall infiltration factor method. If it is greater than +20%, then recharge is taken as equal to 1.2 times the value estimated by rainfall infiltration factor method.

The difference between the two is 0.28 mcm/annum or 9%, thus the rainfall recharge for normal monsoon is to be taken as the value estimated by specific yield factor method i.e. 1.59 mcm/annum

It shows that R_r= 2.20 mcm/annum

3.5.5.3 Total Dynamic Reserves of Core Zone

Considering all above recharge components, total dynamic reserves in the investigated core area will be

R_r	=	1.59 Mcm/annum

3.5.5.4 GROUNDWATER DRAFT OF CORE ZONE

Groundwater draft in the area can be estimated by assessing the various components of the following equation-

$$D_t = D_i + D_d + D_{in} + D_w + D_{et} + D_o$$

Where,

D_t = Total Groundwater Draft

D_i = Groundwater Draft for irrigation in the area

D_d = Groundwater draft for domestic use

D_{in} = Groundwater Draft for industrial use

D_w = Groundwater Draft for irrigation and Domestic use

D_{et} = Groundwater Draft by way of evapo-transpiration

D_o = Groundwater Draft as out flow from Confined aquifer.

Here,

Total Groundwater Draft- Total water requirement for the mine activities including mine workshop, drinking and domestic purposes, dust suppression and green belt development etc. is about 1590 KLD. Evapo-transpiration losses are considered nil as already included while calculating recharge by specific yield and rainfall infiltration factor method.

$$D_t = 0.13 \text{ mcm/annum}$$

Net recharge of core zone is 1.59mcm/annum while net draft is coming around 0.0159mcm/annum. Groundwater development stage in the core zone shall be 8.17% only of the total groundwater recharge; hence it is coming under safe category.

3.5.6 Ground Water Resources for Buffer Zone

Area of buffer zone is coming about 59.69sq.km. (As per land use/land cover map). Rainfall is the principal source of groundwater but seepage from surface water bodies, canals, return flow from applied irrigation as well as infiltration factor also play a significant role in raising the groundwater level. Geographical area, specific yield and infiltration index are the parameters for determining the amount of water which is stored in the aquifer.

3.5.6.1 Recharge Due To Rainfall

By Groundwater Table Fluctuation Method

The buffer zone has Sandstone and Shale as main aquifer and groundwater recharge occurs due to this formation. It has been observed that average seasonal fluctuation of water table is varying between 6 to 10 m. At an average level, it can be taken as 4 m.

Specific yield is varying between 1 to 3% for coal and Shale formations and can be taken as 2.5% on an average. Recharge due to rainfall in the buffer zone computed by specific yield and water table fluctuation is given as::

$$\mathbf{R_{r1} = A \times Sf \times Sy}$$

$$= 59.63 \text{ sq.km} * 8 \text{ m} * 0.03$$

$$= 59.16 \times 8 \times 0.03$$

$$= 14.20 \text{ mcm/annum}$$

By Rainfall Infiltration Factor

The groundwater recharge can also be roughly estimated by rainfall infiltration method. For geological formations as prevailing in buffer zone i.e. coal and Shale, rainfall infiltration has been suggested as 7 to 10% (GEC, 2009). On an average, RI factor has been taken as 8% for buffer zone.

$$\mathbf{R_{r2} = Area \times Rainfall \times RI\ Factor}$$

$$= 59.16 \times 1.037 \text{ mm} \times 8\%$$

$$= 59.16 \times 1.037 \times 0.08$$

$$= 4.91 \text{ mcm/annum}$$

As per the recommendations of Groundwater Estimation Committee (GEC), 2017, if the difference between the two, expressed as a percentage of rainfall infiltration method is greater than or equal to -20% or less than or equal to +20%, then the recharge is taken as the value estimated by the water table fluctuation method. If it is less than -20%, then it is taken as 0.8 times the value estimated by rainfall infiltration factor method. If it is greater than +20%, then recharge is taken as equal to 1.2 times the value estimated by rainfall infiltration factor method.

The difference between the two is 2.25 mcm/annum or 65.42%, thus the rainfall recharge for normal monsoon is to be taken as 1.2 times, the value estimated by rainfall infiltration factor method i.e. 17.04mcm/annum.

3.5.6.2 Return Flow from Applied Irrigation

As suggested by the GEC committee, groundwater recharge from the return flow of irrigation water is normally taken as 30% of the total water applied for irrigation in an area consists of coal and Shale. Total groundwater applied for irrigation is 12.38 mcm/annum (kindly refer section 6.5.1). Groundwater recharge from the above factors is as under:

$$RiB = 12.38 \times 0.3$$

= 3.71 mcm/annum

3.5.6.3 Recharge Due to Surface Water Bodies

As per the land use pattern of the buffer zone, total area under surface water bodies and seasonal water bodies works out to be 1.92 Sq.km. As per the GEC, groundwater recharge through surface water bodies can be taken as 40% of the total water spread area. Hence, groundwater recharge from the above factors is as under

SrB = 1.92 sq.km. x 0.4

= 0.768 mcm/annum

3.5.6.4 Total Recharge of Buffer Zone

RB = 17.04+ 3.71 + 0.768

= 21.518 mcm/annum

3.5.6.5 Groundwater Draft of Buffer Zone

In the investigated area, ground water draft will occur mainly due to applied irrigation, domestic and industrial uses. Evapo-transpiration losses are considered nil as they are already taken into account while calculating recharge by water table fluctuation and rainfall infiltration factor method. Hence, groundwater draft can be computed by reducing the equation (B) to:

$$D_{tB} = D_{iB} + D_{dB} + D_{lB} + D_{inB}$$

3.5.6.6 Draft Due to Applied Irrigation (DiB)

The groundwater draft in the buffer zone takes place mainly by dug wells and shallow/deep bore wells used for irrigation. There are about 500 dug wells and 200 shallow/deep bore wells tapping the aquifer consist of coal and shale. These bore wells usually have an average discharge of 70 m3/day for shale and 120 m3/day for carb shale (on an average, discharge of 0.012 mcm). However, dug wells having a discharge of 50 m3/day for shale and 70 m3/day for shale (on an average, discharge of 0.005 mcm) (Source: CGWB). The annual draft has been calculated after considering that these structures generally operate for 4 months in a year. The annual groundwater withdrawal from these wells is calculated as-

Groundwater draft by dug wells = 500 x 120 days x 50 m^3/day

= 3000000

= 3.00 mcm/ annum

Groundwater draft by bore wells = 200 x 120 days x 80 m^3/day

= 19,20,000

= 1.92 mcm/ annum

Total groundwater draft due to applied irrigation= 3.00 + 1.92

= 4.92 mcm/annum

3.5.6.7 Draft Due to Domestic Use (DdB)

The total population in buffer zone area was around 49383 according to census figure for 2011 which has increased to 66346 in 2018 as per population growth rate of 34.65% per decade. Calculating as on present year (2020) population is assumed to be 70000 @ 5% increase. Considering 100 Liters (0.1 m3) as domestic use in rural and semi urban area (GEC, 1997), the total groundwater withdrawal for domestic use will be.

D_{dB} = 70000 x 0.1 x 365

= 2555000

= 2.555 mcm/ annum

3.5.6.8 Draft Due to Livestock Use (DlB)

The water consumption for livestock has been empirically considered as 5% of human consumption which is calculated as

D_{lB} = 2.555 x 0.05

= 0.13 mcm/annum

3.5.6.9 Draft Due to Industrial Use

There are basically few major coal mines within 10 km buffer zone which uses water including project/mining activities, dust suppression and green belt development, domestic purposes shall be met from surface reservoir/mined out reservoirs of existing mines apart from minor groundwater withdrawal for drinking purpose only. Therefore, total groundwater withdrawal for industrial use may be considered as nil.

D_{inB} = Nil

3.5.7 Total Draft of Buffer Zone

D_{tB} = D_{iB} + D_{dB} + D_{lB} + D_{inB}

= 4.92 + 2.555 + 0.13 + Nil

= 7.605mcm/annum

Total recharge of the buffer zone is 21.518mcm/annum while total groundwater draft is 7.605mcm/annum. The groundwater development in the area is about 30% of total groundwater recharge. Therefore, buffer zone is coming under Safe category as per

groundwater development status, indicating that the basin possesses surplus groundwater storage available for long-term development and planning. As per groundwater resources assessment carried out by Central Ground Water Board, stage of groundwater development in Singrauli district is coming under Safe category.

3.5.8 Allocation of Ground Water for Domestic use for Future Development

Domestic use of population within 10 km radius of project site has been projected for year 2038. Considering population growth percentage @34.65% per decade, population in year 2038 is estimated to be 100000 persons. Dependency of population is mainly on the groundwater in this area. Considering 100 litres (0.1 m3) as domestic consumption in rural and semi urban area, the total water withdrawal for domestic use will be:

D_{dB} = 100000 x 0.1 x 365 days

= 3.65 mcm/annum

Present draft due to domestic use is 2.555 mcm/annum; hence additional water allocated for future domestic use works out to be 3.65-2.555 = 1.095 mcm/annum.

3.5.9 Summary of Buffer Zone Water Balance

Description of items	In MCM/Year
Groundwater Recharge in 10 km radius area	
Recharge due to Rainfall	17.04
Recharge from other sources:	
Return Flow from Applied Irrigation	3.71
Recharge due to Surface Water Bodies	0.768
Recharge due to Canal Seepage	-
GROSS RECHARGE	21.518
Groundwater Draft	
Draft due to Applied irrigation	4.92
Draft due to Domestic use	2.555
Draft due to Livestock	0.13
Draft due to Industries	-
Total Draft	7.605
Net Groundwater Available (B-D)	4.04
Percentage of Groundwater Development	30%
Category of the area for Groundwater Development	SAFE
Allocation for Future Domestic Purpose (in addition to present consumption)	1.095

3.6 Soil Environment

The Singrauli District is generally covered with Alluvial soil, red Sandy soil and yellow

loamy Sandy soil, laterite soil and red loam soil. The district comprises sedimentary, crystalline and metamorphic rocks, weather into red soil. Similarly, the red colour of the laterite soil is more due to diffusion of Iron compounds rather than due to high proportion of Iron oxides.

3.6.1 Selection of Sampling Location

The soil samples were collected from 10 locations around the 10 km radius of cluster site. The samples were analyzed and the results were obtained. The samples were collected during winter season from the selected locations **(Figure 3.18).** The results of all the specified parameters at each location are given in **Table 3.14**. Lab Reports are enclosed as Aneexure-6. Locations were selected on the basis of soil characteristic such as, Agricultural land, Residential land, Forest land etc.

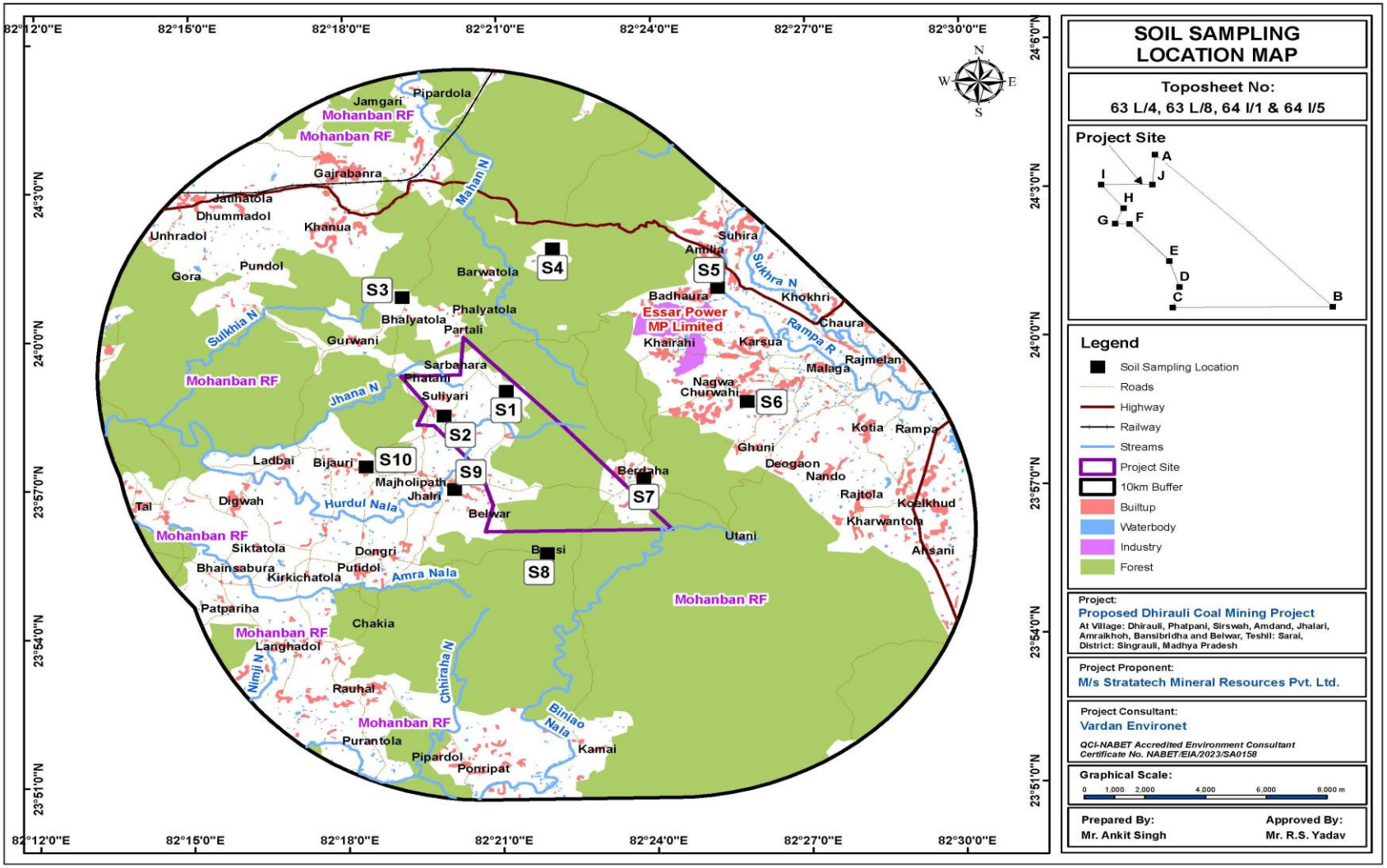


Figure 3.18: Soil Quality Sampling Locations Map (March to May 2021)

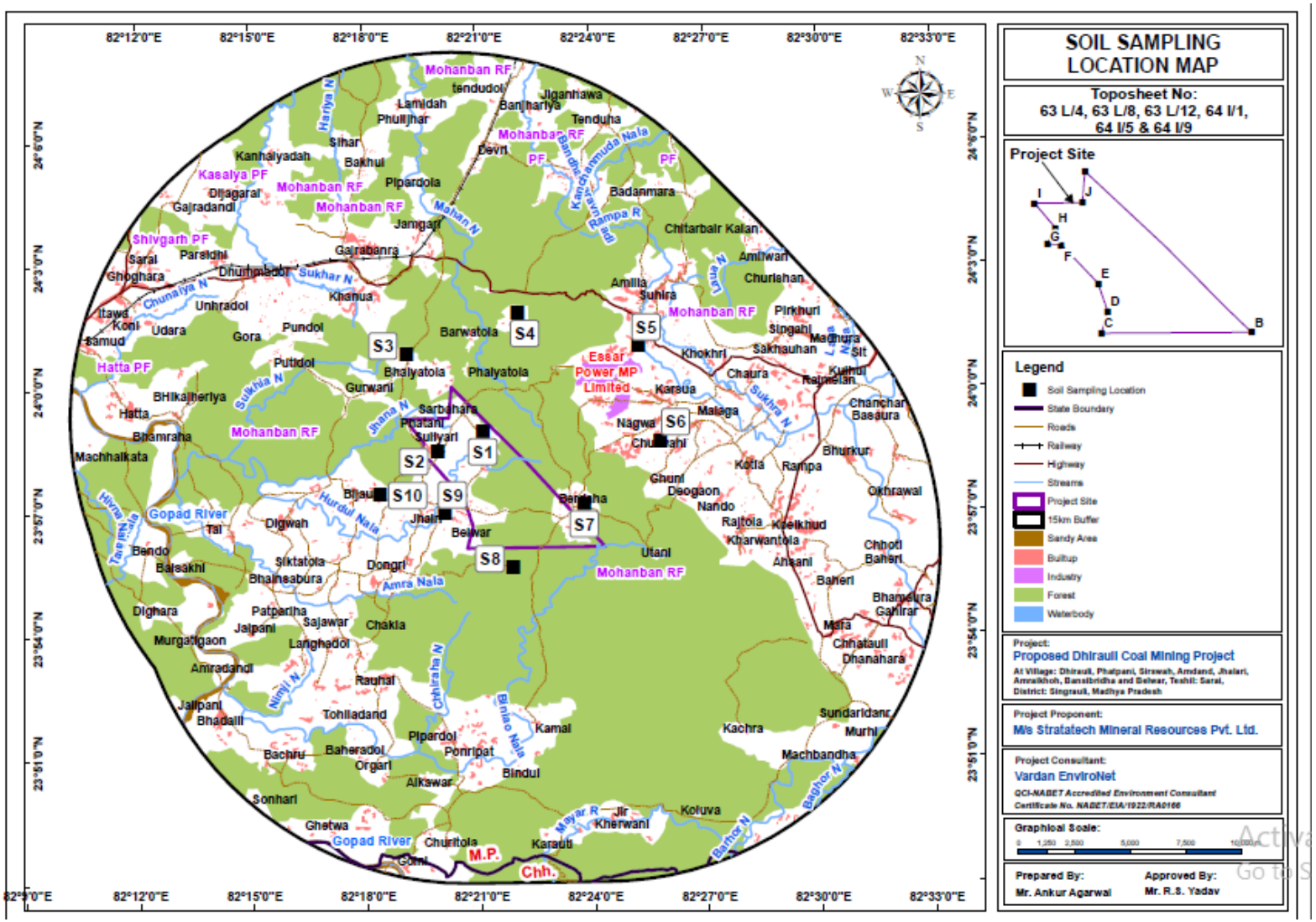


Figure 3.19: Soil Quality Sampling Locations Map (October to December2021)

Table 3.17: Soil Quality Sampling Locations (March to may 2021 & October to December 2021)

Location	Name	Latitude	Longitude	Distance (km)/ Direction	Criteria
S1	Mine Area (Dhirauli)	23°58'57.86"N	82°21'05.18"E	ML Area	Mine area (Agricultur)
S2	Mine Area (Suliyari)	23°58'28.90"N	82°19'52.98"E	ML Area	Buildup area
S3	Bhaiyatola	24°00'53.12"N	82°19'06.52"E	2.0/NNW	Waste land
S4	Budheri	24°01'49.37"N	82°22'03.91"E	3.9/N	Forest area
S5	Badhaura	24°01'02.21"N	82°25'15.19"E	4.7/NE	Near Industry
S6	Churwani	23°58'41.54"N	82°25'47.35"E	4.6/E	Waste land
S7	Berdaha	23°57'11.13"N	82°23'45.80"E	0.5/ESE	Agriculture
S8	Bansi	23°55'40.62"N	82°21'53.28"E	0.8/S	Forest area
S9	Majholipath	23°56'58.64"N	82°20'05.53"E	0.8/SW	Buildup area
S10	Bijauri	23°57'28.00"N	82°18'22.55"E	2.6/W	Agriculture

Source: Primary On-site Data Collected by Vimta (March to may) and Vardan Envirolab (Oct-Dec)

Table 3.18: Soil Analysis Results (March to May 2021)

Sr. No.	Parameters	Unit	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
1	Texture	----	sandy	sandy	Clay	Clay	Clay	sandy		sandy	sandy	sandy
a	Sand	%	49	51	23	21	22	48	24	53	49	46
b	Silt	%	15	10	25	15	20	13	14	11	12	16
c	Clay	%	36	39	52	64	58	39	62	36	39	38
2	Textural Class		sandy	sandy	Clay	Clay	Clay	sandy	Caly	sandy	sandy	sandy
3	Bulk Density	g/cc	1.3	1.2	1.2	1.1	1.2	1.3	1.2	1.2	1.3	1.2
4	pH (1:5 Aq. Extraction)	----	4.89	5.98	5.67	5.56	5.94	7.06	5.44	5.35	6.40	5.49
5	Conductivity (1:5 Aq. Extraction)	µS/cm	63	74.5	66.9	51	161	106.9	103.6	83.10	98.30	130.90
6	Exchangeable Calcium as	mg/kg	1918.9	1476.3	1096.3	1138.3	2871.1	2440.6	1559.8	1033.8	2028.6	1869.1
7	Exchangeable Magnesium as Mg	mg/kg	449.3	424.2	508.6	303.3	721.7	735.3	595.3	748.8	604.1	531.5
8	Exchangeable Sodium as	mg/kg	17.0	12.7	14.7	13.3	31.1	13.9	16.5	18.9	11.7	12.4
9	Sodium Absorption Ratio	----	0.02	0.01	0.02	0.02	0.03	0.01	0.03	0.04	0.01	0.02
10	Available Nitrogen as N	Kg/hac	53.9	84.2	136.0	112.6	155.3	104.9	140.8	103.7	90.1	97.2

11	**Available Phosphorous as**	Kg/hac	79.7	63.7	103.8	85.1	109.1	68.2	107.2	71.5	68.9	75.0
12	**Available Potassium as K**	Kg/hac	120.3	248.9	143.1	240.1	378.1	360.0	296.9	364.2	355.8	265.9
13	**Organic Carbon**	%	0.25	0.42	0.68	0.61	0.77	0.48	0.70	0.52	0.42	0.49
14	**Organic Matter**	%	0.43	0.72	1.17	1.06	1.34	0.83	1.21	0.89	0.72	0.84
15	**Water Soluble Chlorides as Cl**	mg/kg	134.5	99.2	120.4	113.0	85.0	148.9	127.5	92.1	170.0	148.8
16	**Water Soluble Sulphates**	mg/kg	36.2	32.2	43.6	50.9	37.0	29.1	38.8	35.6	27.2	31.8
17	**Aluminum**	%	0.98	1.11	1.93	1.01	1.38	0.47	0.72	1.16	0.51	0.65
18	**Total Iron**	%	0.54	0.49	0.66	0.55	1.82	0.60	1.04	0.68	1.09	0.71
19	**Manganese**	mg/kg	216.3	487.2	214.2	183.2	444.3	250.6	385.8	159.3	356.5	196.4
20	**Boron**	mg/kg	96.5	100.2	93.0	88.3	76.4	55.8	49.3	60.7	52.7	49.2
21	**Zinc**	mg/kg	14.0	35.1	33.8	31.2	38.1	19.8	16.1	20.2	27.1	12.0
22	**Total Chromium as Cr**	mg/kg	46.5	19.0	16.2	25.4	74.5	30.2	43.9	10.6	35.6	45.5
23	**Lead as Pb**	mg/kg	13.1	6.6	18.3	9.4	10.3	3.1	11.6	15.7	6.7	12.0
24	**Nickel as Ni**	mg/kg	8.8	20.7	24.7	16.4	29.2	11.2	10.3	14.5	8.2	6.6
25	**Arsenic as As**	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

26	**Mercury as Hg**	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
27	**Cadmium as Cd**	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.36	<0.1	<0.1
28	**Exchangeable Calcium**	mg/l	9.59	7.38	5.48	5.69	14.36	12.20	7.80	5.17	10.14	9.35
29	**Exchangeable**	mg/l	3.74	3.53	4.24	2.53	6.01	6.13	4.96	6.24	5.03	4.43
30	**Exchangeable Sodium**	mg/l	0.07	0.06	0.06	0.06	0.14	0.06	0.07	0.08	0.05	0.05
31	**Exchangeable Potassium**	mg/l	0.03	0.07	0.04	0.07	0.11	0.09	0.08	0.10	0.09	0.07
32	**Cation Exchange**	mg/l	13.44	11.04	9.82	8.35	20.61	18.48	12.91	11.59	15.32	13.90

Source: Primary On-site Data Collected by Vimta

Table 3.19: Soil Analysis Results (October to December 2021)

Sr. No.	Parameters		Unit	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
1.	pH (at 25 0C)		---	7.43	7.60	7.57	7.49	7.55	7.60	7.63	7.67	7.61	7.76
2.	Conductivity		mS/cm	0.269	0.248	0.335	0.316	0.324	0.340	0.275	0.225	0.342	0.326
3.	Soil Texture	Sand	---	55	50	52	48	45	53	46	46	54	48
		Silt		25	35	32	34	37	35	37	37	34	34
		Clay		20	15	16	18	18	12	17	18	12	18
4.	Color		--	Yellowish Brown	Yellowish Brown	Yellowish Brown	Yellowish Brown	Yellowish Brown	Yellowish Brown	Yellowish Brown	Yellowish Brown	Yellowish Brown	Yellowish Brown
5.	Water holding capacity		%	30.56	31.52	34.29	33.59	34.78	32.16	35.62	36.11	37.14	33.17
6.	Bulk density		gm/cc	1.40	1.42	1.36	1.43	1.47	1.39	1.41	1.33	1.51	1.47
7.	Chloride as Cl		mg/100g	33.58	29.66	35.69	37.49	38.59	39.46	41.25	34.68	40.69	34.65
8.	Calcium as Ca		mg/100g	29.14	31.68	31.85	34.15	34.25	35.15	38.24	38.61	36.48	30.49
9.	Sodium as Na		mg/kg	41.24	37.61	47.63	46.31	50.58	48.56	50.49	48.24	49.83	46.74
10.	Potassium as K		kg/hec.	88.57	74.14	115.45	116.24	126.78	133.58	126.11	118.11	135.57	109.28
11.	Organic Matter		%	0.26	0.31	0.39	0.42	0.44	0.38	0.42	0.38	0.51	0.43
12.	Magnesium as Mg		mg/100g	12.54	16.23	12.86	14.62	14.14	13.68	14.68	15.22	16.12	12.89
13.	Available Nitrogen as N		kg./hec.	105.00	102.35	134.58	138.11	152.85	146.74	132.10	129.48	147.15	124.61
14.	Available Phosphorus		kg./hec.	9.96	10.26	11.68	14.92	14.62	12.68	12.46	11.69	13.62	10.98
15.	Zinc (as Zn)		mg/kg	1.26	1.10	4.45	4.41	4.32	4.87	4.28	3.62	4.88	1.37
16.	Manganese (as Mn)		mg/kg	0.87	1.58	1.56	1.59	1.54	1.52	1.55	1.28	1.53	0.96
17.	Lead (as Pb)		mg/kg	0.54	0.53	0.52	0.51	0.50	0.48	0.52	0.54	0.49	0.46
18.	Cadmium (as Cd)		mg/kg	0.36	0.41	0.63	0.37	0.33	0.29	0.31	0.28	0.36	0.27
19.	Chromium (as Cr)		mg/kg	0.25	0.23	0.21	0.22	0.25	0.16	0.27	0.21	0.27	0.16
20.	Copper (as Cu)		mg/kg	0.69	0.81	0.96	1.62	1.41	1.38	1.47	1.33	1.40	1.02

Source: Primary On-site Data Collected by Vardan

3.7 Noise Environment

Noise is generated by all opencast mining operations from different fixed, mobile and impulsive sources, thus becoming an integral part of the mining environment. It is defined as sound without agreeable musical quality or as unwanted sound. In opencast mines, noise is a common environmental factor as generated by the heavy earthmoving machineries. Noise pollution poses a major health risk to the mine workers. When noise in the form of waves impinges the eardrum, it begins to vibrate, stimulating other delicate tissues and organs in the ear. If the magnitude of noise exceeds the tolerance limits, it is manifested in the form of discomfort leading to annoyance and in extreme cases to loss of hearing. Detrimental effects of noise pollution are not only related to sound pressure level and frequency, but also on the total duration of exposure and the age of the person. The noise occurring during extraction works (i.e. drilling-blasting, excavation, loading and transporting) that take place in both open and underground pits is important when considering labor health and job performance as the highest disease and illness rates in mining continue to be mine worker's permanent or temporary hearing loss. The following report provides the cumulative noise propagation levels in Dhirauli mines or operational phases.

3.7.1 Selection of Sampling Location and Study Area

The noise recording stations were located within 10 km radius of the prposed site. A total of 8 locations were fixed for the recording of noise levels around the mine sites **(Figure 3.20)**. The locations were selected based on the upwind, downwind, sensitive locations and residential area factors. The baseline noise levels so obtained will be used in predicting the incremental noise levels due to operation of projects in cluster form.

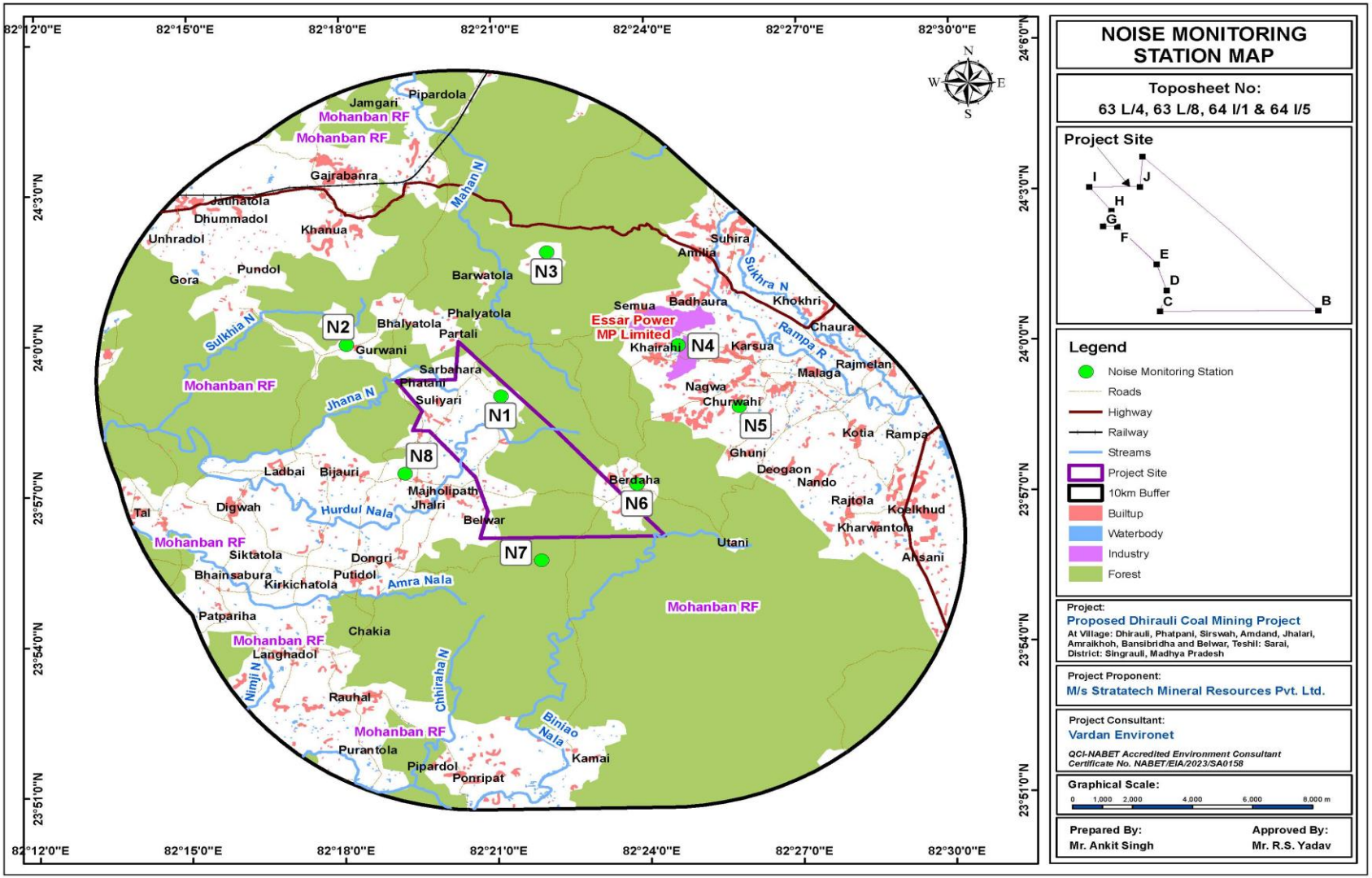


Figure 3.20: Noise Quality Monitoring Location Map (March to May 2021)

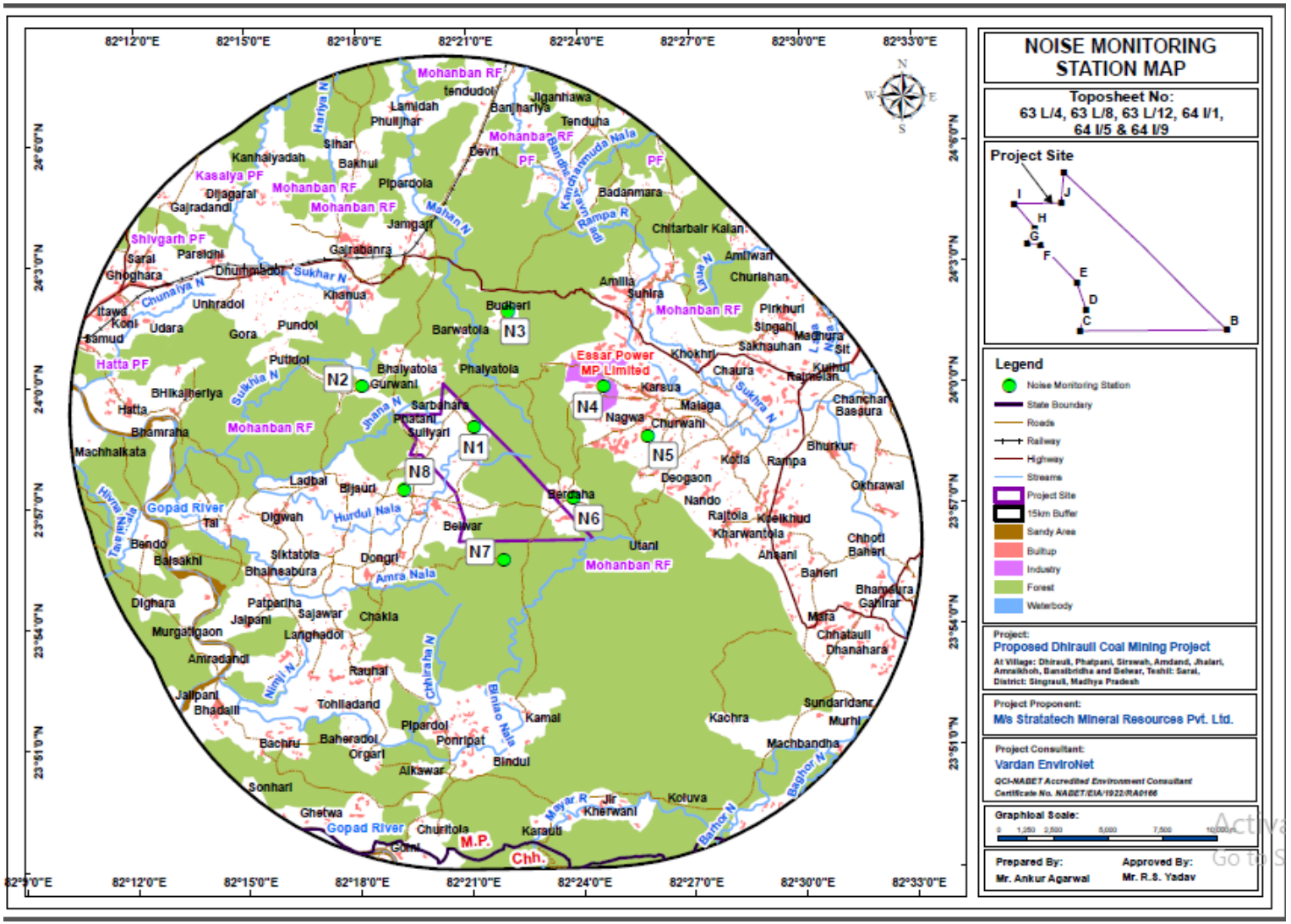


Figure 3.21: Noise Quality Monitoring Location Map (October to December 2021)

Table 3.20: Noise Quality Monitoring Station (March to May 2021 & October to December 2021)

Stations	Name	Latitude	Longitude	Distance (km) Direction	Criteria
N1	Mine Site (Dhirauli)	23°58'55.55"N	82°21'6.85"E	--	Mine site
N2	Bhaiyatola	23°59'59.97"N	82°18'5.31"E	2.0/NNW	Cross wind direction of first predominant
N3	Budheri	24°01'49.38"N	82°22'2.41"E	3.9/N	Cross wind direction of first predominant
N4	Khairahi	23°59'55.82"N	82°24'36.26"E	4.5/NE	Up wind direction of second predominant and located near to industrial area
N5	Churwani	23°58'42.89"N	82°25'49.61"E	4.6/E	Downwind direction of first predominant
N6	Berdaha	23°57'10.44"N	82°23'46.54"E	0.5/ESE	Cross wind direction of first predominant
N7	Bansi	23°55'41.32"N	82°21'52.54"E	0.8/S	Downwind direction of second predominant and forest area
N8	Jhalri	23°57'24.56"N	82°19'12.64"E	1.5/W	Up wind direction of first predominant

Source: Primary On-site Data Collected by Vimta (March to may) and Vardan Envirolab (Oct-Dec)

3.7.2 Noise measurement Survey

The physical description of sound concerns its loudness as a function of frequency. Noise in general is sound, which is composed of many frequency components of various types of loudness distributed over the audible frequency range. Various noise scales have been introduced to describe, in a single number, the response of an average human being to a complex sound made up of various frequencies at different loudness levels. The most common and highly favored of these scales is the 'A' weighted decibel dB(A). The scale has been designed to weigh various components of noise according to the response of a human ear.

The impact of noise sources on surrounding community depends on:

- Characteristics of noise sources (instantaneous, intermittent or continuous in nature). It is well known that a steady noise is not as annoying as one that is continuously varying in loudness;
- The time of day at which noise occurs, for example, loud noise levels at night in residential areas are not acceptable because of sleep disturbance; and
- The location of the noise source, with respect to noise sensitive land use, which determines the loudness and period of noise exposure.

The environmental impact of noise can have several effects varying from Noise Induced Hearing Loss (NIHL) to annoyance depending on loudness of noise levels. The environmental impact assessment of noise from the proposed activity can be carried out by taking into consideration various factors potential damage to hearing, potential physiological responses, annoyance and general community responses.

The assessment of noise pollution on neighborhood environment due to the proposed expansion mine operations was carried out keeping in view all the considerations mentioned above. The existing status of noise levels within the study zone, a primary requirement of impact assessment studies, has been undertaken through reconnaissance, identification of the existing noise sources, land use pattern and monitoring of baseline noise levels.

Sound Pressure Level (SPL) measurements were measured at all locations. The readings were taken for every hour for 24 hours. The day noise levels have been monitored during 6 am to 10 pm and night levels during 10 pm to 6 am at all the locations covered in 10 km radius of the study area.

Noise levels were measured using integrated sound level meter manufactured by Quest Technologies, USA (Model No.2900). The integrating sound level meter is an integrating/ logging type with Octave filter attachment (model OB-100) with frequency range of 31.5 to 16000 Hz. This instrument is capable of measuring the Sound Pressure

Level (SPL), Leq and octave band frequency analysis.

The noise levels were monitored on working days only and Saturdays, Sundays and public holidays were not monitored. During each hour Leq was directly computed by the instrument based on the sound pressure levels. Lday (Ld), Lnight (Ln) and Ldn values were computed using corresponding hourly Leq of day and night respectively. Monitoring was carried out at 'A' response and fast mode.

3.7.3 Equivalent Sound Pressure Level (L_{eq}) of Day and Night

The L_{eq} is the equivalent continuous sound level, which is equivalent to the same sound energy as the actual fluctuating sound measured in the same period. This is necessary because sound from noise source often fluctuates widely during a given period of time.

This is calculated from the following equation

$$L_{eq}=L_{50}+ (L_{10}-L_{90})^2/60$$

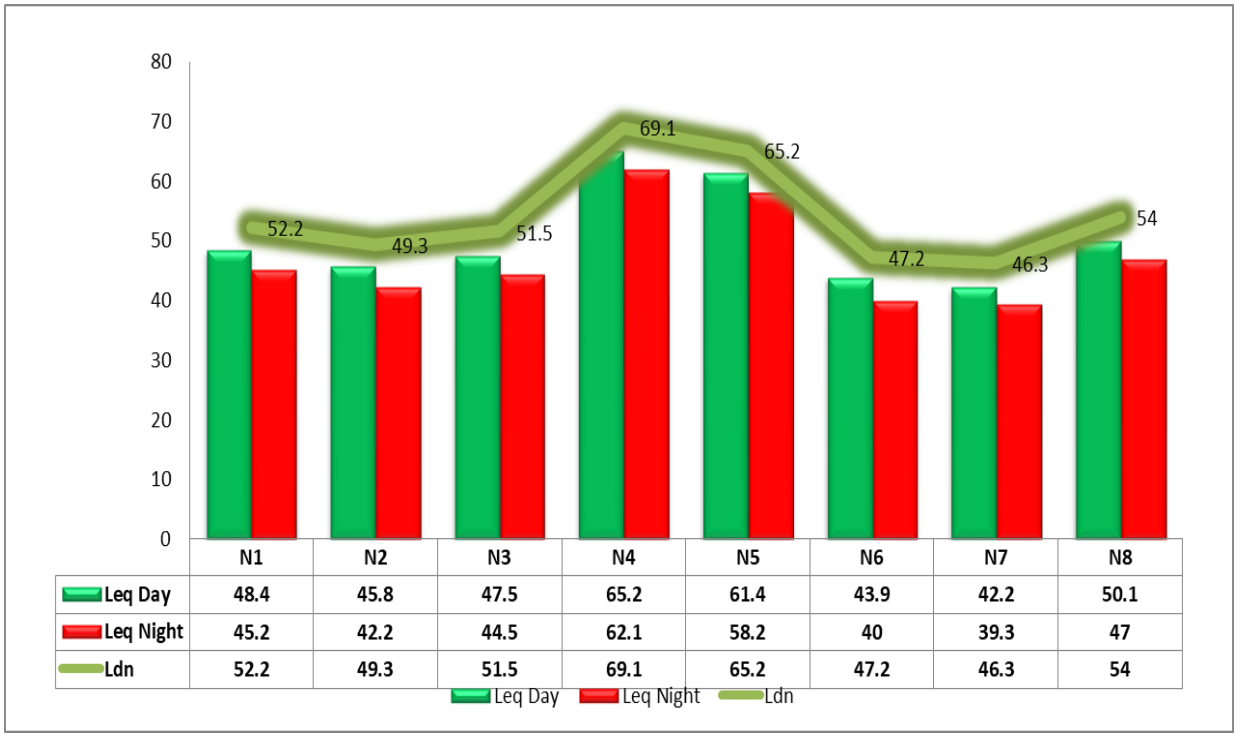
Lday is defined as the equivalent noise level measured over a period of time during day (6 am to 10 pm). Lnight is defined as the equivalent noise level measured over a period of time during night (10 pm to 6 am).

Hourly noise recorded data and Lday values (16 hours) Lnight (8 hours) and Ldn (24 hours) are computed **(Figure 3.22 and 3.23)** and tabulated. Lab Reports are enclosed as Aneexure-4.

Table 3.21: Noise Level Data (All Data is expressed in dB(A)

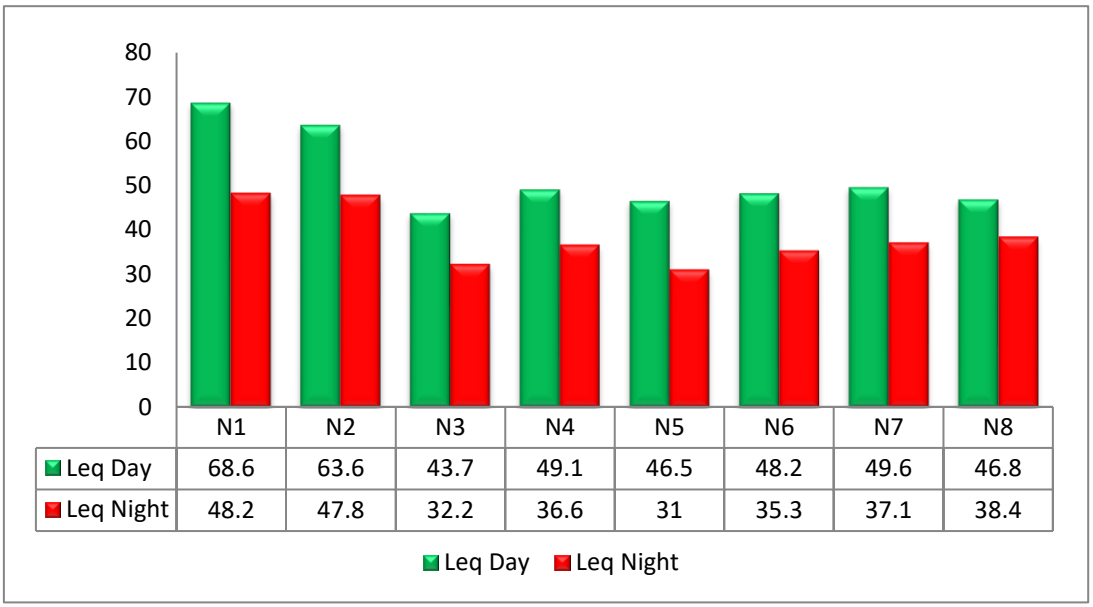
S.No.	Locations	March to May 2021				October to December 2021	
		Average Noise Levels in dB(A)				Average Noise Levels in dB(A)	
		Leq	Lday	Lnight	Ldn	Lday	Lnight
1	Mine Site (Dhirauli)	47.8	48.4	45.2	**52.2**	54.30	44.35
2	Bhaiyatola	44.9	45.8	42.2	**49.3**	52.20	43.25
3	Budheri	46.9	47.5	44.5	**51.5**	50.00	42.85
4	Khairahi	64.6	65.2	62.1	**69.1**	65.12	57.41
5	Churwani	60.9	61.4	58.2	**65.2**	51.95	43.15
6	Berdaha	42.8	43.9	40.0	**47.2**	52.45	42.48
7	Bansi	41.7	42.2	39.3	**46.3**	49.05	41.62
8	Jhalri	49.6	50.1	47.0	**54.0**	52.55	43.06

Source: Primary On-site Data Collected by Vimta (March to may) and Vardan Envirolab (Oct-Dec)



	N1	N2	N3	N4	N5	N6	N7	N8
Leq Day	48.4	45.8	47.5	65.2	61.4	43.9	42.2	50.1
Leq Night	45.2	42.2	44.5	62.1	58.2	40	39.3	47
Ldn	52.2	49.3	51.5	69.1	65.2	47.2	46.3	54

Figure 3.22: Equivalent Noise Levels at all locations (March to May 2021)



	N1	N2	N3	N4	N5	N6	N7	N8
Leq Day	68.6	63.6	43.7	49.1	46.5	48.2	49.6	46.8
Leq Night	48.2	47.8	32.2	36.6	31	35.3	37.1	38.4

Figure 3.23: Equivalent Noise Levels at all locations (Oct to Dec 2021)

Table 3.22: Noise Standards as per Noise Regulation (Pollution & Control) Rules, 2000

Category of Zones	Categorization of locations	L_{eq} in dB(A)	
		Day	Night
Industrial	N1, N4,	75	70
Commercial	-	65	55
Residential	N2, N3, N5, N6, N7, N8	55	45
Silence Zone	-	50	40

Source: Noise Regulation (Pollution & Control) Rules, 2000

3.8 Land Use Environment

Land use/cover change detection is very essential for better understanding of landscape dynamic during a known period of time having sustainable management. Land use and land cover change has been recognized as an important driver of environmental change on all spatial and temporal scales; Changes may involve the nature or intensity of change but may also include spatial and time aspects. Land use/ Land cover changes also involve the modification, either direct or indirect, of natural habitats and their impact on the ecology of the area. Land use mapping has always been a time consuming and expensive process. Space technology in recent years has emerged as a powerful tool for land use /land cover studies, particularly change detection. Contrary to the traditional methods of field survey in which it took several years for the preparation and initial mapping of land use/ land cover of an area, remote sensing technology, due to synoptic view, map like format and repetitive coverage, is a viable source of gathering quality land cover information at local, regional and global scales. Land use is a matter of continuous growth and change in pattern.

As an information system GIS provides for the organization, storage, analysis, modeling, mapping, and display of physical and biological data, as well as the distribution of cultural or socio-economic data. The Land use Land cover study has been carried out using Digital Image Processing and Digital Image Interpretation techniques. The Image Processing and Geographical Information Systems software have been used for the Spatial Analysis.

3.8.1 Land use / Land cover Classification

Digital image processing was carried out to delineate various land use / land cover categories in the lease area viz. built up area, crop area, forests, scrub land, and water bodies etc. by assigning necessary training sets, which were identified based on tone, texture, size, shape pattern and location information **(Figure 3.16, 3.18 & 3.19)**. Necessary care was taken to identify proper land use class, where there is conflict between the signatures of various classes. The interpreted map was verified on ground

at limited points and final land use / land cover map was prepared.

3.8.2 Various Land Use Classes Considered

The buffer zone can be broadly classified in to forest areas, built-up areas, agriculture areas and other land with or without scrubs.

3.8.2.1 Industry

Industrial area means an area of land transferred to or placed at disposal of the Corporation by the state Government or the land purchased, acquired or otherwise held by the Corporation or reserved or set apart or here after reserved or set apart under any law for setting up an industry or industries including essential welfare and supporting services

3.8.2.2 Forest

All the areas declared as reserve forest / protected forest areas are shown in this class.

3.8.2.3 Agriculture

The areas where farmers practice cultivation in one season/ two seasons in a year.

3.8.2.4 scrubs

Generally waste lands-non agriculture and non-forest areas covered with or without scrubs.

3.8.2.5 Waste lands

Land without any usage and without scrubs and sometimes they are rock exposed areas.

3.8.2.6 Water Bodies

The oceans, rivers, streams, lakes, tanks, reservoirs, canals, are etc. will be identified in this class.

3.8.2.7 Built-up

The villages/ colonies/ towns area are shown in this class.

3.8.3 Land Use / Land Cover

The land use/land cover pattern of the area have been framed from the Satellite Imagery and Topo-sheet and authenticated by field visit. The land use/land cover pattern has been divided into 8 classes as follows: ((I) Water body, (ii) Sandy Area, (iii) Industrial, (Iv), Forest, (V) Builtup (Vi), Agriculture land, (Vii) Open Scrub, (Viii) Waste land. The given categories of land use and land cover pattern covers an area of about 59626 Ha. Various classes and their respective areas with percentage of coverage are given in **Figure 3.26**& **Table 3.29.**

Table 3.23: Land use of the study area

Landuse Classification	Area in Hectare	Area in %
Water body	209	0.19
Sandy Area	465	0.42
Industry	340	0.30
Forest	56335	50.55
Builtup	2929	2.63
Agriculture land	24216	21.73
Open Scrub	20939	18.79
Waste land	6006	5.39
Total	**111439**	**100.00**

Source: IRS P-6 Satellite Imagery, Google Imagery and On-site Data Collected

3.8.3.1 Forest Area

Forest covers major portion of the project area. The forest land consists mostly of Protected Forest or Reserved Forest as well as revenue forest land as per legal land status. Some open mixed jungles are also situated in the study area. The study area is covered by mohanban RF. The total forest area cover is about 56335 Ha which is 50.55% of the total study area.

3.8.3.2 Idustry

Few part of the study area is coverd with the industry. The total indstry area covers about 340 Ha which is 0.30% of the total study area.

3.8.3.3 Scrub Land

The soil of this type of land is with very little vegetation and is unsuitable for agricultural purposes and is classified in the wasteland category. Only small thorny bushes are sustained in the soil. Generally this type of land cover may be observed to be spread within the agricultural land areas. Land area with the scrubs covers 20939 Ha of land area which is about 18.79% of total land area.

3.8.3.4 Agriculture Land

The Agricultural land covers the third major land area of the project which is about 24216 Ha, 21.73% of the total land area. Major part of the agriculture land is double cropped agriculture land.

3.8.3.5 Waste Land

Wastelands are lands which are unproductive, rocky, unfit for cultivation and other economic uses due to rough terrain and eroded soils. The soil of this type of land area with very little vegetation is unsuitable for agricultural purposes. This type of land-use and land cover pattern covers about 6006 Ha of land which is 5.39% of the total area.

3.8.3.6 Built-up

Built-up in the project area refers to the village settlements with all infrastructural facilities like school, market, play ground and various other facilities. In the study area the settlements are mostly rural settlements scattered all over in patches but mainly in the northern direction of the coal blocks. Total area comes under built-up is 2929 Ha, which is 2.63% of the total.

3.8.3.7 Waterbody

Water bodies refer to the small collection of water in any natural or manmade storage like ponds, lakes, tanks, reservoirs etc. In the study area these water bodies are present in very small patches near village settlements. Such types of water bodies are very few covering only 209 Ha of land area which is 0.19% of total study area.

3.8.3.8 Sandy area

An area covered with sand is called sandy area. This is commonly found in the area covered with riverbed and also occur on the river flood plains. The area usually consists of silts, sands, and gravels deposited during riverflow.

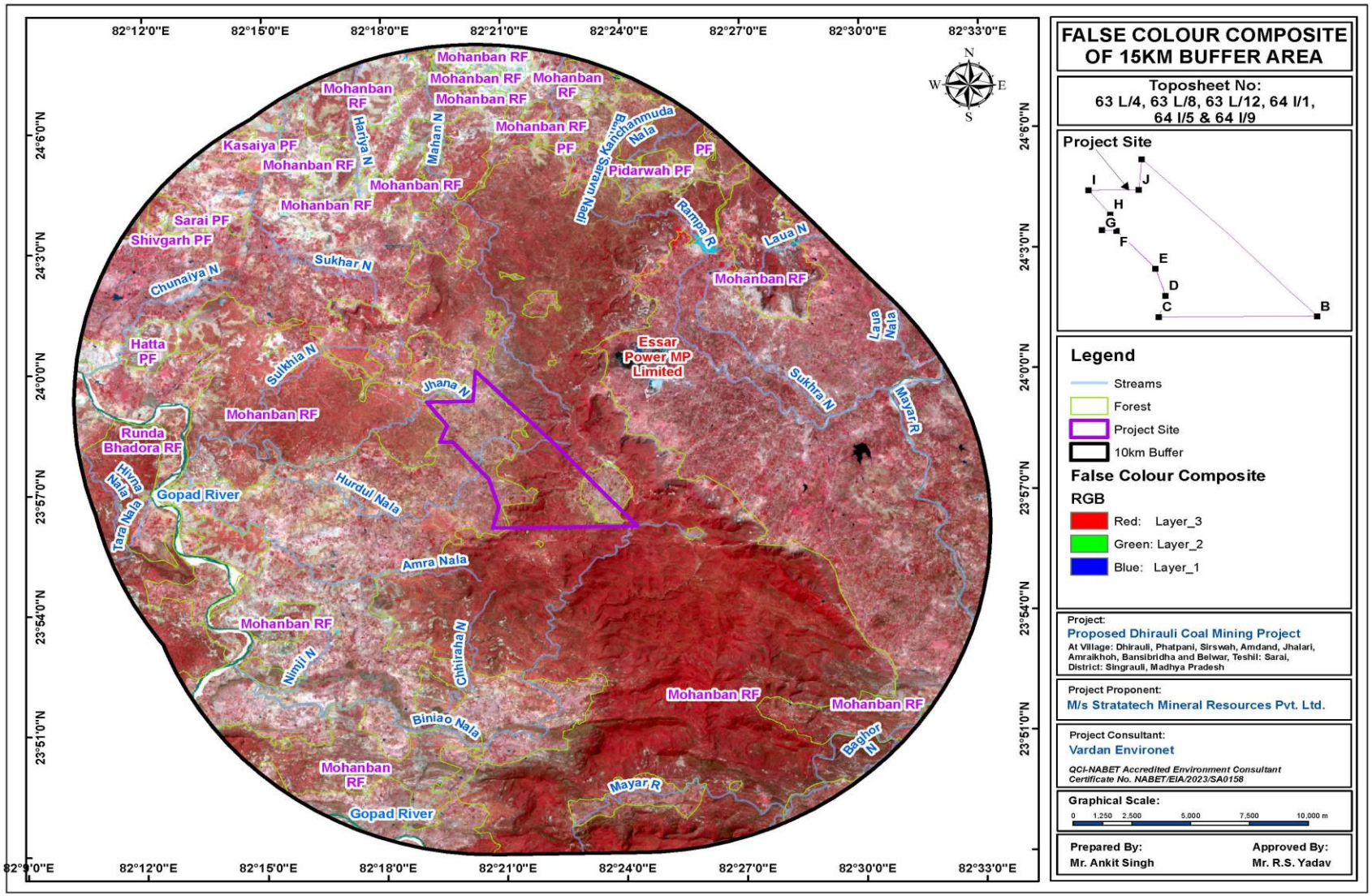


Figure 3.24: Satellite Imagery of 15 Km Study Area

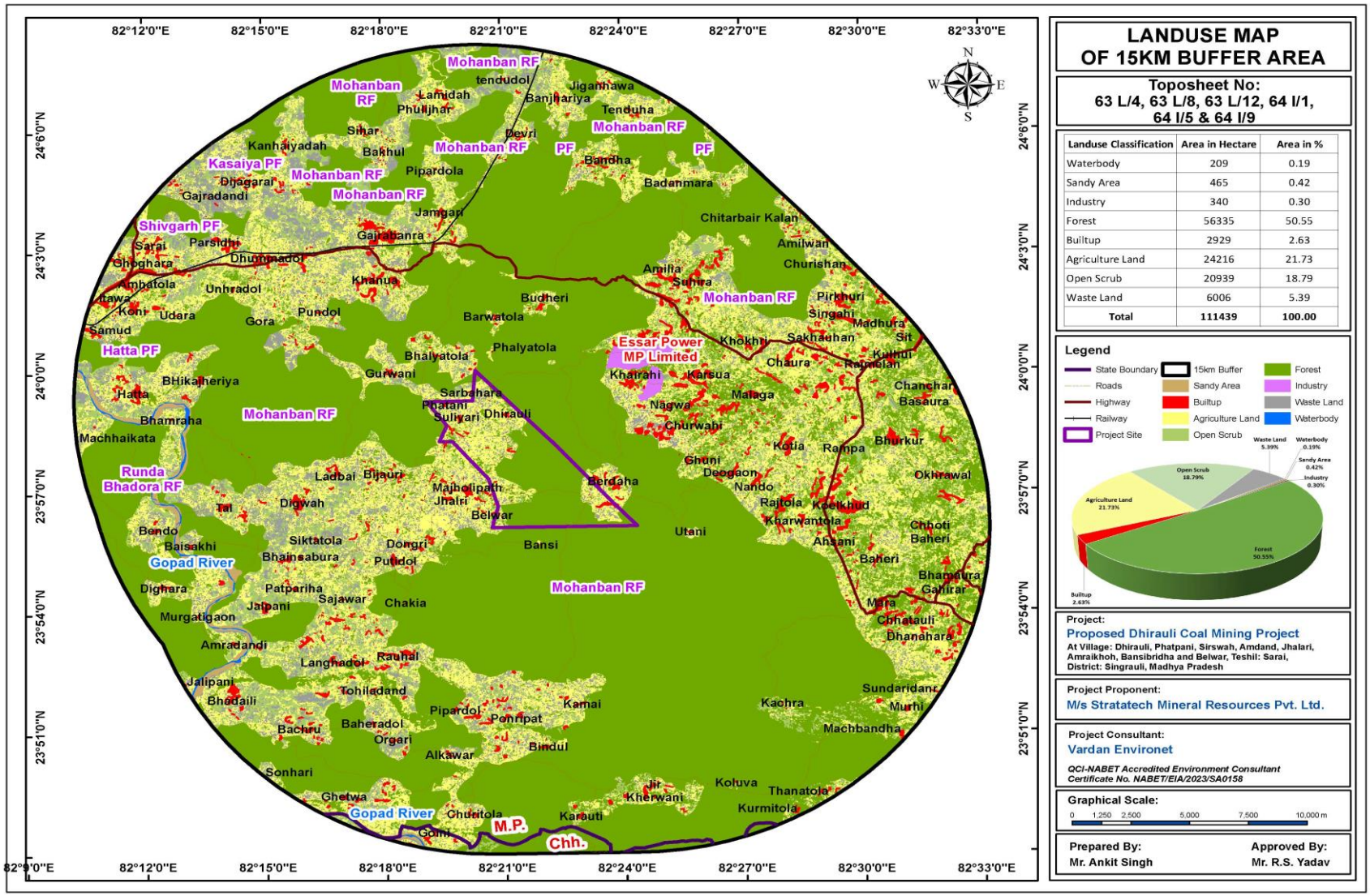


Figure 3.25: LULC map of 15 km Study Area

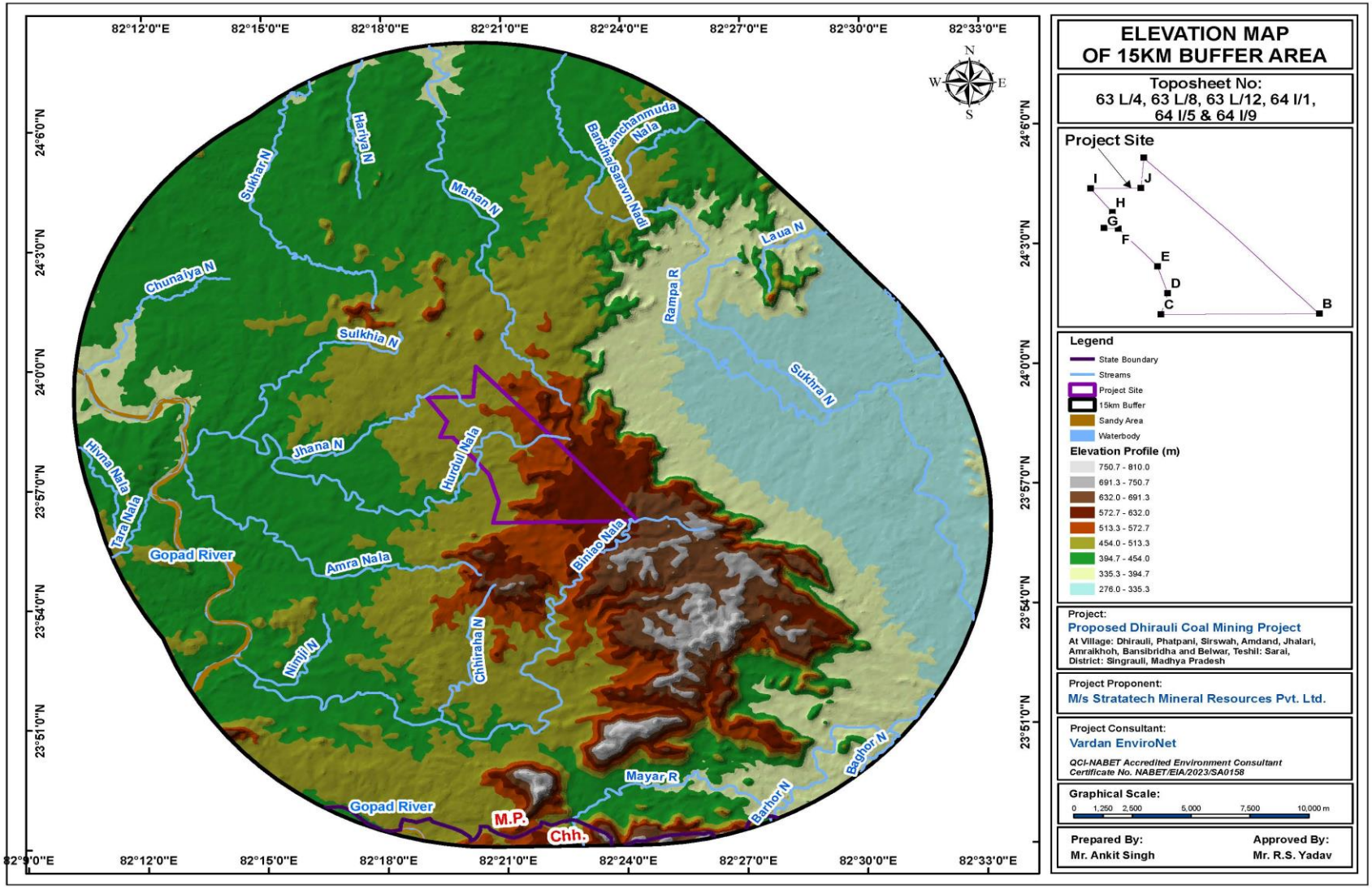


Figure 3.26: Elevation Map of 15 Km Study area

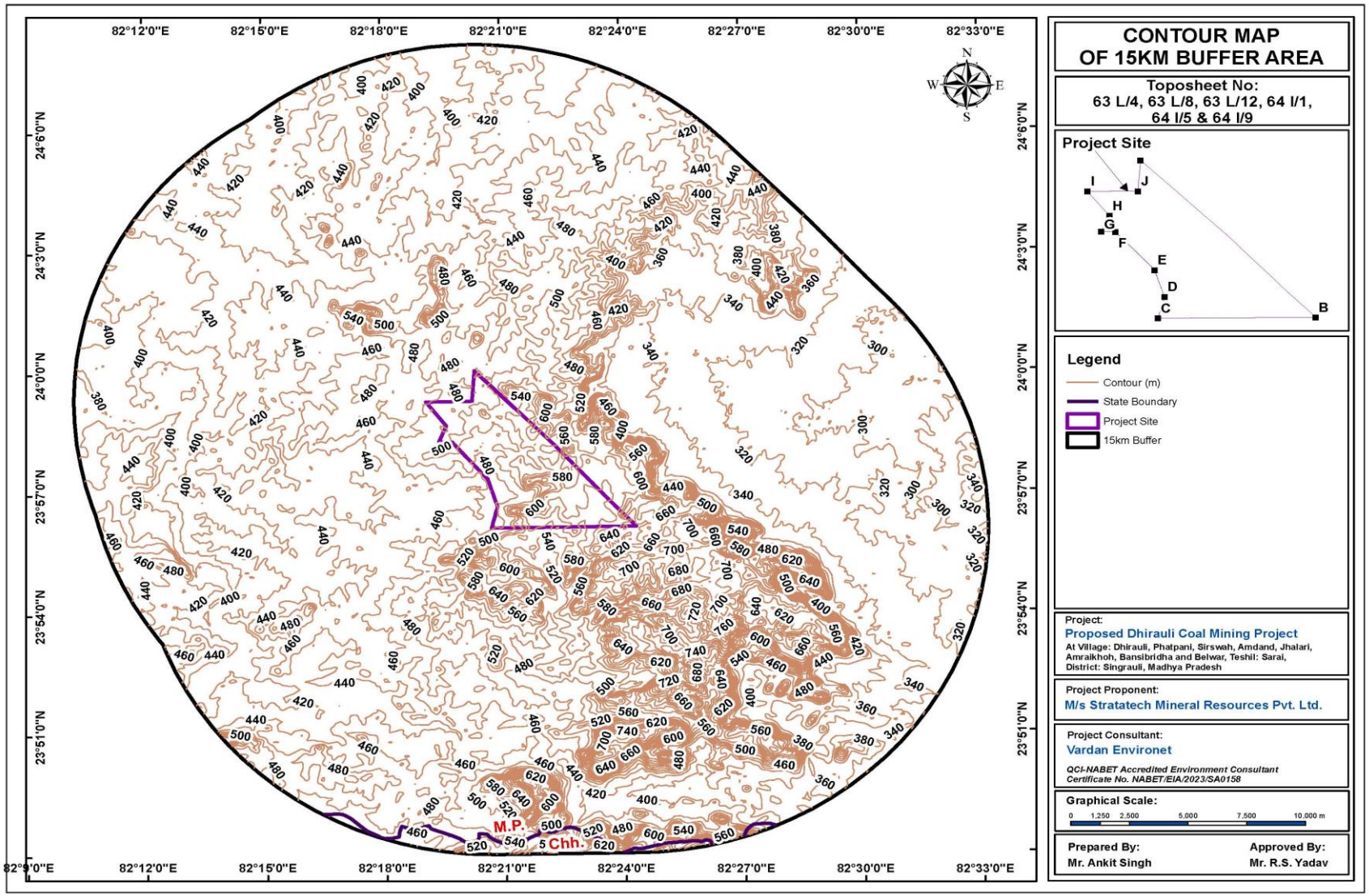


Figure 3.27: Contour Map of Study Area

3.9 Socio Economic Environment

The latest available data has been complied to generate the existing socio-economic scenario of the study area. Information on socio-economic profile was collected from the Primary Census Abstract, 2011 including the population details of the region.

The Socio-Economic Status of the study areas is mentioned below and the villages surveyed are enlisted in Table below:

Table 3.24: Summarized Demographic Structure of the Study Area

Sl. No.	Parameter	Study Area (Rural)
1.	No. of Villages	38
2.	Household	10724
3.	Household Ratio	4.6
4.	Total Population	49383
5.	Male Population %	25143(50.91%)
6.	Female Population %	24240(49.08%)
7.	Population (0-6 Years) %	9688(19.61%)
8.	Sex Ratio	964
9.	Child Sex Ratio	906
10.	Scheduled Caste %	6954(14.08%)
11.	Scheduled Tribes %	24401(49.41%)
12.	Literates %	21449(43.43%)
13.	Main Workers %	14424(29.20%)
14.	Marginal Workers %	8455(17.12%)
15.	Non-Workers %	26504(53.67%)

Source: PCA, 2011, MP State

3.9.1 Village

The basic unit for rural areas is the revenue village which has definite surveyed boundaries. The revenue village may comprise of one or more hamlet but the entire village is treated as one unit for presentation of data.

3.9.2 Administrative set up of the Study Region

The 11 Mining Blocks in the region are coming from Singrauli and Deosar Tehsil of Singrauli District. So, to represent the population facts of the area the District and Blockwise details have been presented in the following Tables.

The study area was defined as an area within 10 km radius around the proposed mining project site of covers 38 villages of Singrauli tehsil of Singrauli District of Madhya

Pradesh State. The summarized demographic structure of the study area with rural and urban area is presented in **Table 3.21.**

Singrauli District Singrauli is the 50th district in the state of Madhya Pradesh, which was formed on 24th May 2008 by division of Sidhi district, which covers a region comprising of the eastern part of the Sidhi district in Madhya Pradesh and the adjoining region in Sonebhadra district in Uttar Pradesh. Historically Singrauli belonged to the princely state of Rewa, a part of the Baghelkhand region. It is rich in natural and mineral resources, covered with dense forests and inhospitable terrain in ancient times. Due to abundance of mineral resources and Power Plants this region is also called Urjanchal.

In 2011, Singrauli had population of 1,178,273 of which male and female were 613,637 and 564,636 respectively. In 2001 census, Singrauli had a population of 920,169 of which males were 478,633 and remaining 441,536 were females. There was change of 28.05 percent in the population compared to population as per 2001. In the previous census of India 2001, Singrauli District recorded increase of 38.60 percent to its population compared to 1991.

Table 3.25: Population in Singrauli District

Description	2011	2001
Population	11.78 Lakhs	9.20 Lakhs
Actual Population	1,178,273	920,169
Male	613,637	478,633
Female	564,636	441,536
Population Growth	28.05%	38.60%
Area Sq. Km	5,675	5,675
Density/km2	208	162
Sex Ratio (Per 1000)	920	922
Child Sex Ratio (0-6 Age)	923	955
Average Literacy	60.41	49.25
Male Literacy	71.34	65.45
Female Literacy	48.53	31.52
Total Child Population (0-6 Age)	209,792	196,253

Description	2011	2001
Literates	585,054	356,524
Male Literates	359,923	247,559
Female Literates	225,131	108,965
Child Proportion (0-6 Age)	17.81%	21.33%

Table 3.26: Summarized Demographic Structure of the Tehisl coming under the study area

Name	No_HH	TOT_P	TOT_M	TOT_F	P_06	P_SC	P_ST	P_LIT	M_LIT	F_LIT
Singrauli Tehsil	62420	296940	152382	144558	55177	44254	77932	136697	86353	50344
	4.757129	948.6554	51.31744	48.68256	18.58187	14.90335	26.24503	46.03523	63.1711	36.8289
Deosar Tehsil	69398	324363	170347	154016	59706	42937	134333	152406	95590	56816
	4.673953	904.131	52.5174	47.4826	18.40715	13.23733	41.4144	46.98625	62.72063	37.27937

3.9.2.1 Singruli District

3.9.2.1.1 Singrauli Tehsil

- Total number of households are about 62420
- Total population of villages under the study area is 296940 out of which males are 152382 (51.31) and females are 144558 (48.68%)
- The average family size is about 4.7 persons per family
- Sex ratio (No. of females per 1000 males) is 948 which indicates that females are less in number than their male counterpart in the study area.
- Out of the total population, the population of children within the age of 0-6 age-group is about 55177 (18.58%)
- Scheduled caste population is 44254 (14.90%) and Scheduled tribe population are maximum in the tehsil i.e about 77932(26.24%) in the region
- Out of the total population in the study area is 136697 i.e 46.03% are literates with 63.17% male literates and 37.27% are female literates

3.9.2.2 Deosar Tehisl

- Total number of households in Tehsil are about 69398
- Total population of villages under the study area is 324363 out of which males are 170347(52.51%) and females are 154016 (47.48%)
- The average family size is about 4.6 persons per family
- Sex ratio (No. of females per 1000 males) is 904 which indicates that females are less in number than their male counterpart in the study area.
- Out of the total population, the population of children within the age of 0-6 age-group is about 59706 (18.40%)
- Scheduled caste population is 42937 (13.23%) and Scheduled tribe population are maximum in the tehsil i.e about 134333(41.41%) in the region
- Out of the total population in the study area is 152406 i.e 46.98% are literates with 62.72% male literates and 37.27% are female literates

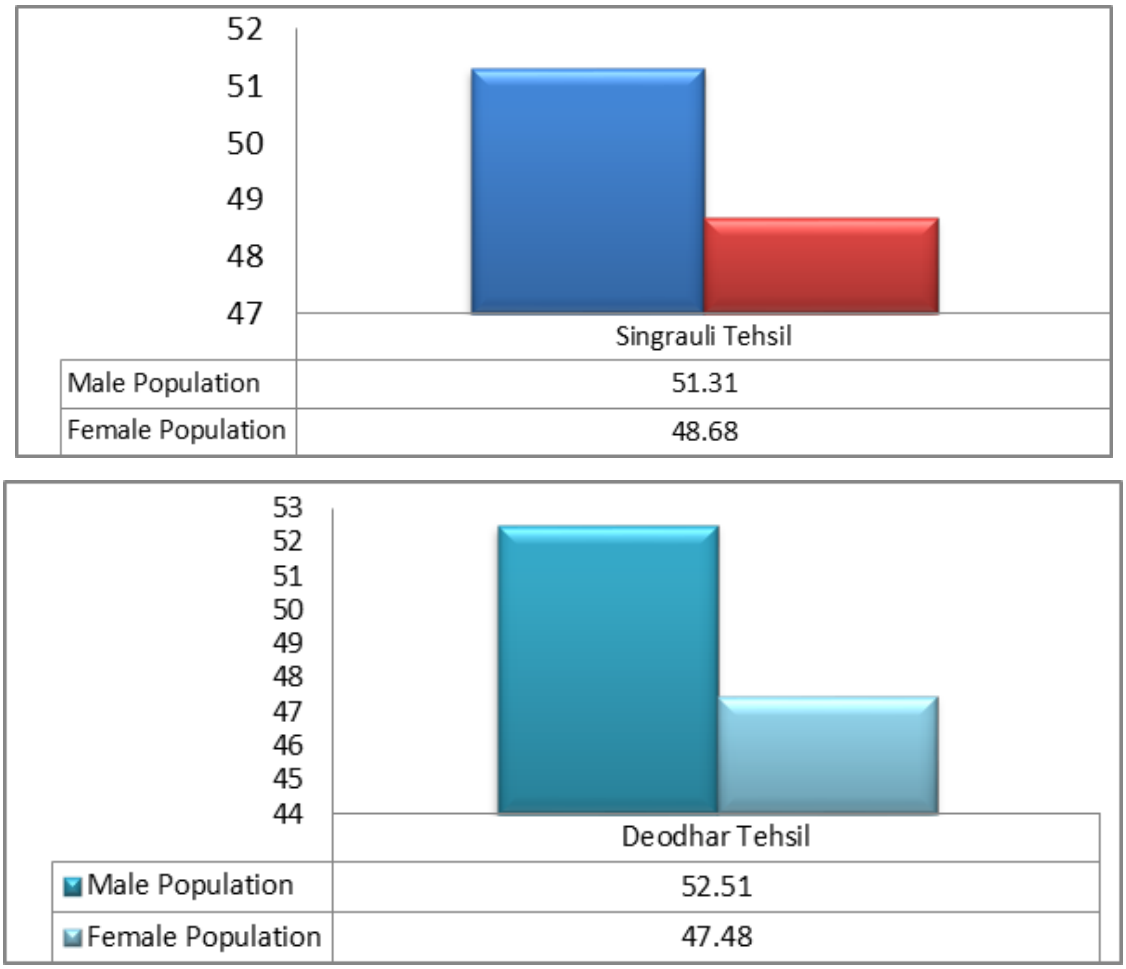
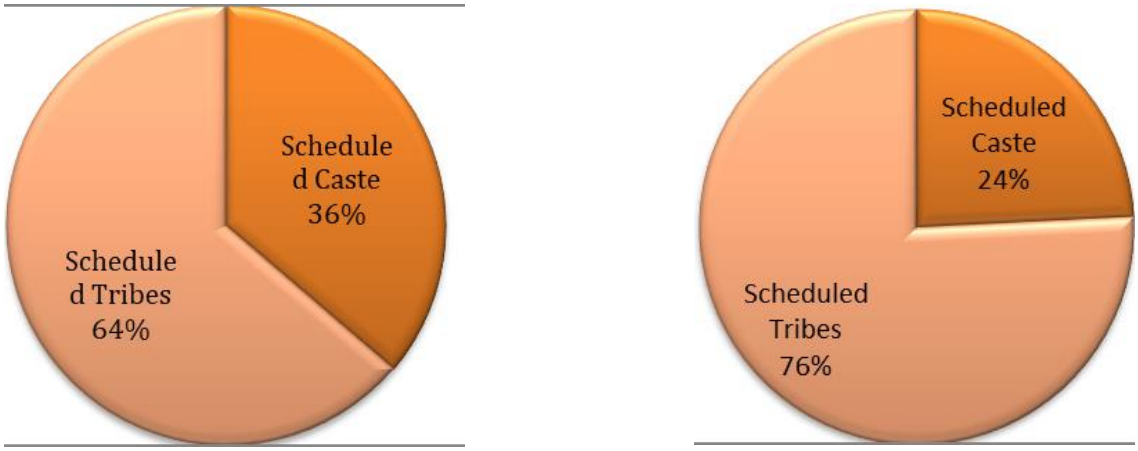


Figure 3.28: Bar Diagram Representing Male and Female Population in the Tehsil

Coming in the Study Area



Singrauli Tehsil **Deosar Tehsil**

Figure 3.29: Distribution of Scheduled Caste and Scheduled Tribes Population in the Tehsil in the Study Area

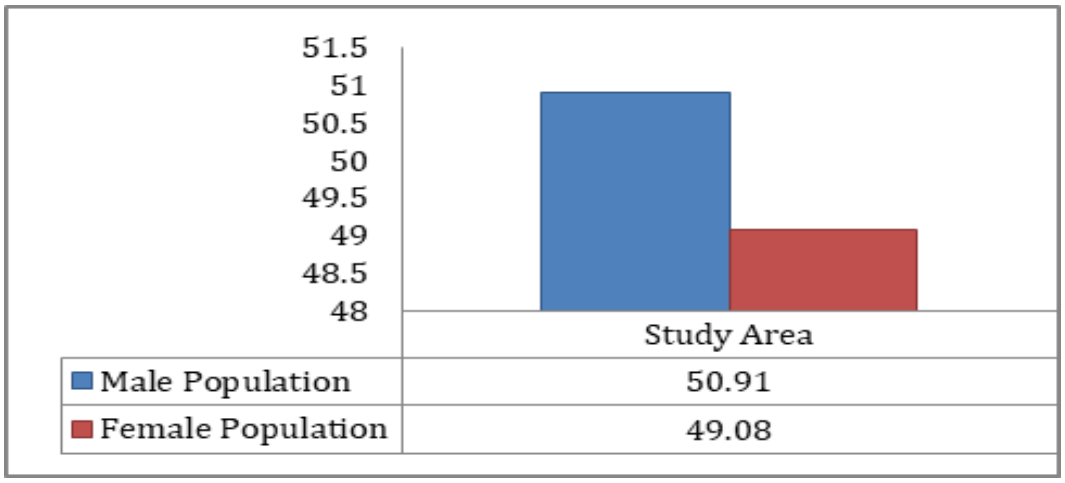


Figure 3.30: Bar Diagram Representing the Population Data of the Region Household Ratio and Population Density

3.9.3 Demographic Profile of the Study Area

3.9.3.1 Household and Population

Total number of households in the study area of rural region is about 10724 with total population in rural area is about 49383 with male population is 25143(50.91%) and female population is 24240(49.08%)

The average family size i.e person per family in Rural and urban area is 4.6. It can be concluded from the data obtained that the rural area is average populated.

Population 0-6 Age-Group

Out of the total population, the population of children within the age of 0-6 age-group

in rural area is 9688(19.61%)

Sex Ratio & Child Sex Ratio

Sex ratio (No. of females per 1000 males) is 964 in rural area which indicates that females are less in number than their male counterpart in rural area and also the Child Sex ratio is 906 in rural area i.e no.of female child per 1000 male child. It can be concluded from the data that female child is lower than the adult female population. The graphical presentation of the distribution of population is given in fig below

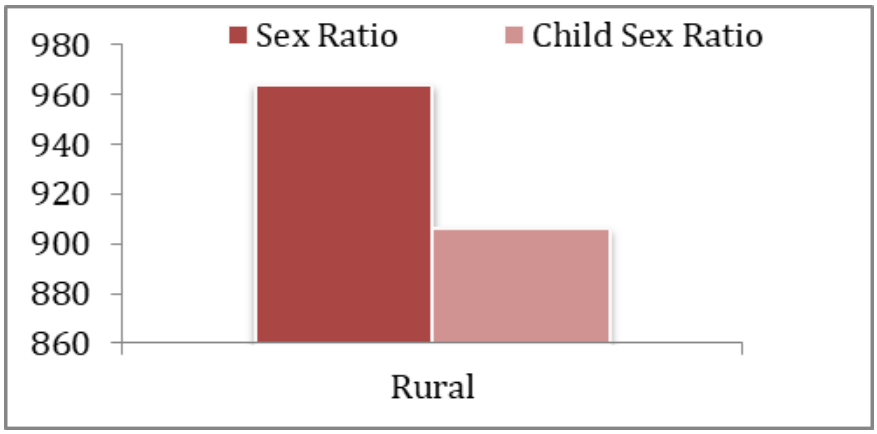


Figure 3.31: Sex Ratio within the Study Area

3.9.3.2 Scheduled Caste and Scheduled Tribes Population in the Study Area

Scheduled caste population in rural area is about 6954 (14.08%) while scheduled tribe population are higher of about 24401(49.41%) in the study area.

3.9.3.3 Literacy Rate in the Study Area

Out of the total population 21449 i.e 43.43% literates are from rural area with male literates 13420(62.56%) and female literates 8029 (37.43%) in the study area. The literacy level of the region is also good while male populations are more literates as compared to the female population.

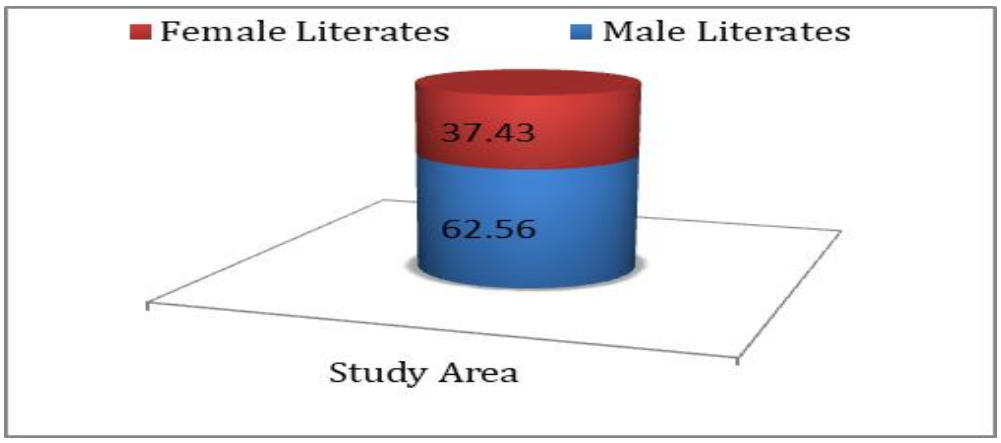


Figure 3.32: Litracy rate of the Study Area

3.9.3.4 Occupational Pattern/ Economic Resource Base

'Work' has been defined as participation in any economically productive activity. Such participation may be physical or mental. Persons on leave and under training are also treated as workers. However, rent receivers and pensioners are not treated as workers.

3.9.3.4.1 Total Workers

The working populations involved in different economically productive activities. The total workers further categorized as main worker, marginal and the non-working population.

Main Workers

Main workers are those who have worked for a major part of the year (i.e. at least six months or 183 days). Main activity of a person who was engaged in more than one activity was reckoned in terMiddle school of time disposition. 14424 (29.20%) in study area from the total population comes under the main workers category from the villages coming in the project site.Main workers are further classified into 4 categories viz., cultivators, agricultural laborers and household workers and other main workers.

Cultivators

Maximum population in the study area is engaged as Cultivators'i.e depended on agriculture. The cultivator population within the rural area is 7209(49.97%). It can be concluded from the data the populations in the villages are mainly engaged in agriculture activity.

Agricultural Laborers

Persons working on land owned by others for wages or share in the yield have been treated as agricultural laborers. Out of the total main worker category in the study area, agricultural laborers population in rural area is about 6001(41.60%).

Laborers in Household Industry

The laborers engaged in household activity are quite low in all the study area. Among the total main worker very few populations are engaged in household activity are only 53 persons in the study area.

Other Workers

All main workers i.e. those who have been engaged in some economic activity during the last one year and who are neither cultivators nor agricultural laborers or household industry workers are classified as other main workers. The type of workers that come under this category includes factory workers, plantation workers, those in trade, commerce, business, transport, construction, political or social works, all government servants, municipal employees, teachers, priests, entertainers, artists etc. Among the total population of the study area only 8.04% are engaged in other activity.

It can be concluded that maximum population from the villages are engaged in other activities which means either in service, labourer or business activity. Different types of workers in total worker population may be classified and described below while presented in **Fig 3.24.**

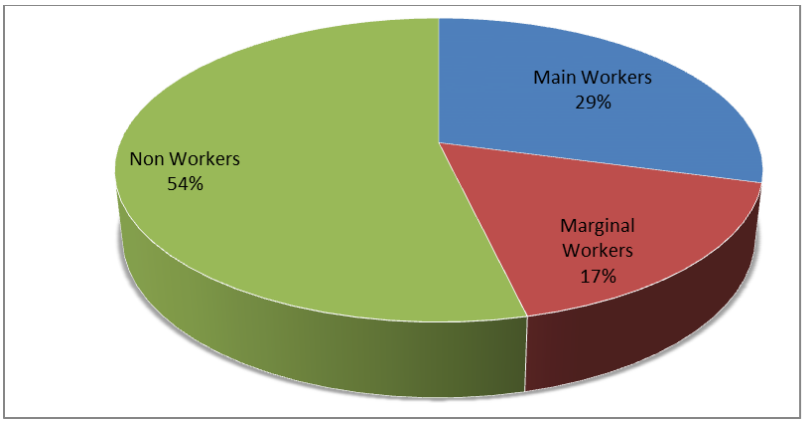


Figure 3.33: Occupational structure in the Study Area

Marginal Workers

Marginal workers are those who have worked any time in the year for less than six months or 183 days but have not worked for a major part of the year. The population of marginal workers within the rural area comprises of about 17.12% of the total population.

Non-Workers

Non-Workers are those who have not worked any time at all in the year. Non-workers constitute householders, students, dependents, retired persons etc.

The economy of the study area is primarily based on agriculture. The agriculture sector has thus absorbed a major portion of the working force. It is being observed that the

53.67% population are unemployed in villages.

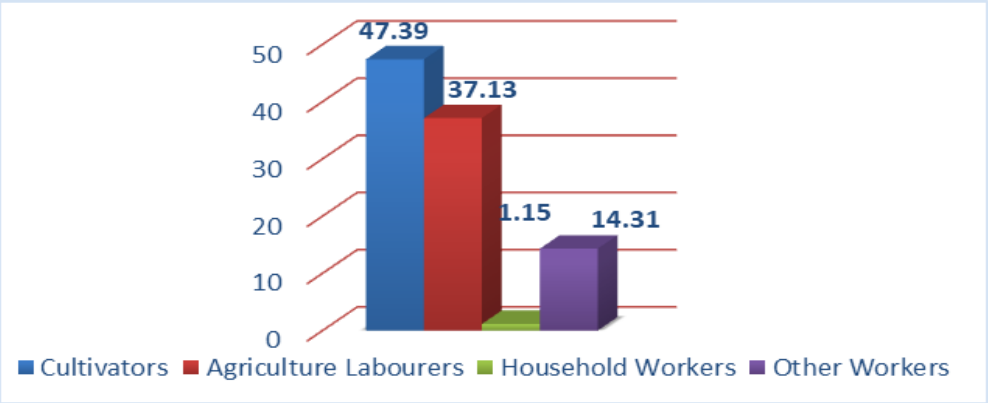
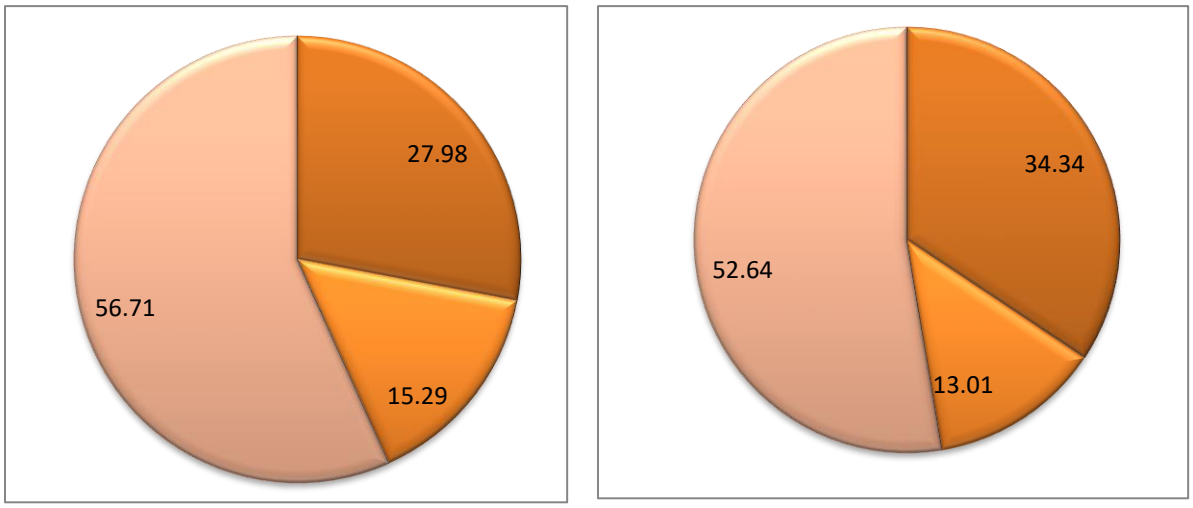


Figure 3.34: Category of main workers in rural area of the study area

3.9.3.5 Occupational pattern/ economic resource base (Tehsil Basis)

3.9.3.5.1 Singrauli Tehsil

- Main Workers in the rural area are about 83102 i.e 27.98% of the total population.
- The population of marginal workers in the rural area is about 45420 i.e 15.29% out of the total population.
- The economy of the study area is primarily based on agriculture and major portion of the working force are observed to be engaged in agriculture activity as Cultivators and Agriculture Labourers (81.55%). Only 15.29% are engaged in other activity which is mostly temporary. It is observed that 56.71% population are unemployed in villages



Singrauli **Deosar Tehsil**

Figure 3.35: Employment Pattern of Main, Marginal and Non-Workers in the Tehsil Coming in the Study Area

Table 3.27: Demographic Structure of the Study Area

Sr.No.	Villages	Households	Total Population	Male Population	Female Population	Population (0-6 Years)	Scheduled Caste	Scheduled Tribes	Literates
Madhya Pradesh State									
Singrauli District									
1.	Gorwani	148	623	336	287	155	23	540	212
2.	Dhirauli	236	1186	609	577	250	24	801	333
3.	Amrai Khoh	25	111	63	48	23	0	30	48
4.	Amdand	35	163	91	72	28	0	0	76
5.	Majhauli Path	128	673	349	324	108	21	214	321
6.	Basi Berdaha	218	1049	518	531	233	0	936	333
7.	Belwar	86	385	192	193	74	1	60	180
8.	Dogari	541	2752	1389	1363	583	334	1436	1171
9.	Siraswah	15	82	41	41	13	6	39	50
10.	Chalari	422	1852	940	912	369	244	751	877
11.	Phatpani	141	741	358	383	171	300	208	306
12.	Bajaudi	322	1645	856	789	339	173	636	834
13.	Ladbai	72	419	207	212	75	4	387	169
14.	Tal	323	1607	810	797	339	108	1182	632
15.	Digwah	217	1051	544	507	181	122	918	471
16.	Bhaisa Buda	298	1452	710	742	296	231	908	532
17.	Khanua Nawa	629	2687	1340	1347	502	117	2028	1135
18.	Khanua Khas	173	849	433	416	166	129	465	353
19.	Jamgadi	343	1607	816	791	319	93	1001	716
20.	Bhalyatola	214	1098	583	515	210	0	382	553
21.	Budher(Bugher)	40	165	82	83	32	0	93	71

22.	Langhadol	417	1922	952	970	429	314	1436	667
23.	Sajawar	196	896	445	451	199	80	598	286
24.	Rauhal	266	1363	674	689	297	25	460	573
25.	Kamai	147	653	309	344	136	0	493	200
26.	Jeer	344	1548	761	787	298	200	809	633
27.	Pondi Path	338	1688	860	828	381	127	1363	635
28.	Padari Khairwari Tola	87	376	186	190	43	35	274	199
29.	Nadau	247	1155	602	553	227	179	430	496
30.	Amiliya	657	3171	1592	1579	605	431	821	1397
31.	Semua	110	463	231	232	97	14	147	191
32.	Bandhaura	347	1642	833	809	342	737	369	775
33.	Khairahi	402	1840	948	892	403	350	1148	770
34.	Nagwa	1126	4501	2370	2131	783	1227	1869	2164
35.	Dhuni	198	950	500	450	172	313	224	422
36.	Karsua Raja	715	2886	1525	1361	472	849	426	1506
37.	Churwahi	124	602	293	309	98	77	82	312
38.	Malga	377	1530	795	735	240	66	437	850
Total		**10724**	**49383**	**25143**	**24240**	**9688**	**6954**	**24401**	**21449**

Source: PCA Census 2011, Singrauli District, Madhya Pradesh State

Table 3.28: Occupational Structure of the Study Area (RURAL)

Sr.No.	Villages	Total Main Workers	Main Workers				Marginal Workers	Non-Workers
			Cultivators	Agricultural Laborers	Household Laborers	Other Workers		
Madhya Pradesh State								
Singrauli District								
1.	Gorwani	210	11	196	0	3	21	392
2.	Dhirauli	437	146	254	2	35	164	585
3.	Amrai Khoh	45	40	4	0	1	0	66
4.	Amdand	78	64	12	0	2	1	84
5.	Majhauli Path	291	284	3	0	4	28	354
6.	Basi Berdaha	28	19	0	4	5	525	496
7.	Belwar	164	115	33	3	13	1	220
8.	Dogari	1290	220	1038	1	31	82	1380
9.	Siraswah	34	31	3	0	0	0	48
10.	Chalari	565	389	130	0	46	227	1060
11.	Phatpani	255	125	129	0	1	106	380
12.	Bajaudi	565	423	124	0	18	284	796
13.	Ladbai	105	98	3	0	4	106	208
14.	Tal	747	154	574	1	18	6	854
15.	Digwah	245	235	0	0	10	279	527
16.	Bhaisa Buda	728	522	203	0	3	15	709
17.	Khanua Nawa	1268	427	801	2	38	105	1314
18.	Khanua Khas	452	238	201	0	13	1	396
19.	Jamgadi	796	230	527	0	39	6	805
20.	Bhalyatola	166	153	8	1	4	407	525

21.	Budher(Bugher)	72	64	7	0	1	0	93
22.	Langhadol	671	501	157	0	13	330	921
23.	Sajawar	362	104	253	0	5	18	516
24.	Rauhal	409	12	384	6	7	333	621
25.	Kamai	211	183	20	0	8	121	321
26.	Jeer	393	252	111	0	30	332	823
27.	Pondi Path	499	442	32	5	20	515	674
28.	Padari Khairwari Tola	158	129	25	0	4	67	151
29.	Nadau	341	262	10	0	69	172	642
30.	Amiliya	715	356	236	0	123	784	1672
31.	Semua	14	3	0	0	11	49	400
32.	Bandhaura	337	105	45	7	180	236	1069
33.	Khairahi	31	1	2	0	28	767	1042
34.	Nagwa	234	60	40	2	132	1544	2723
35.	Dhuni	233	117	107	2	7	49	668
36.	Karsua Raja	759	341	226	13	179	405	1722
37.	Churwahi	19	3	3	0	13	310	273
38.	Malga	497	350	100	4	43	59	974
Total		**14424**	**7209**	**6001**	**53**	**1161**	**8455**	**26504**

Source: Source: PCA Census 2011, Singrauli District, Madhya Pradesh State

3.9.4 Infrastructure Resource Base in the Study Area

The details of infrastructure resources base of the study area with reference to education, medical facility, water supply, post and telegraph, transportation, communication facility, power supply, existence of nearest town etc. are presented in **Table 3.24 to 3.39.** The significant features of these important parameters for each study area are discussed as below:

3.9.4.1 Educational Facility

The numbers of educational institution in the study area are only 3 primary schools, 4 middle schools, no Secondary and senior secondary schools in the study area. Villagers avail the higher education facility in Raj Milan, Bindul, Khanua Nawa, Chalari and Baidhan villages. Villages of the study area avail and College from the nearest town that is Baidhan, Siddhi and Rewa town.

Table 3.29: Details of education status available in singrauli district

PARTICULARS	PRIMARY	UPPER PRIMARY
Gross Enrolment Ratio (%)	119.60	96.10
Net Enrolment Ratio (%)	95.10	76.10
Drop Out Rate (%)	7.90	4.51
Pupil-Teacher Ratio (%)	55.00	78.00
Student-Classroom Ratio (%)	29.00	45.00
Girl's Enrolment (%)	49.20	54.30
Female Teachers (%)	25.20	19.50
New Government Schools since 2003 (%)	20.00	46.90
Schools with girls toilet (%)	95.00	89.50
Schools with boys toilet (%)	96.40	92.50
Schools with drinking water facility (%)	93.50	91.70
Schools with electricity (%)	5.80	12.20

Source: District Census Handbook, Annual Survey 2013-14

3.9.4.2 Drinking Water Facility

The numbers of major sources of drinking water in the study area is through Hand Pump facility in 35 villages, covered well is available in 38 villages, Uncovered Wells in 27 villages. Most of the villages do not have treated tap water facility and the quality of water is very poor in the study area.

3.9.4.3 Medical Facility

Medical institutions in rural parts of the region are inadequate, as per the data recorded in the village amenities CD 2011 there are Community Health Centre and Primary

health centre is in Khanua Nawa village, Primary health sub-centre (PHS) in 4 villages (Langhadol,Pondi Path, Amiliya and Bandhaura) and Dispensary is in Khanua Nawa village in the study area.

3.9.4.4 Sanitation & Drainage Facility

It is observed that there are open nallas in most of the villages of the study area. Toilet facility is available in very few houses in the villages. Most of the villages have public toilets build by the government.

3.9.4.5 Communication Facility

Communication facility is available in the form of Post and Telegraph office is available in 17 villages and telephone connections are available in mostly all the villages.

3.9.4.5.1 Details of the Educational Institution in Dharauli Cluster, Chitarangi Block

High School Dharauli is a school cluster in Chitarangi block of Singrauli district in Madhya Pradesh Which is having about 1 Schools in it. This cluster includes all private and govt. schools of this area.

PVT DVS PUBLIC SCHOOL DHARAULI was established in 2015 and it is managed by the Pvt. Unaided. The school consists of Grades from 1 to 5. The school is Co-educational, and it have an attached pre-primary section. Hindi is the medium of instructions in this school. This school is approachable by all weather roads.

The school has rented building. It has got 7 classrooMiddle schools for instructional purposes. All the ClassrooMiddle School are in good condition. It has 2 other rooMiddle schools for non-teaching activities. The school has Pucca boundary wall. The school has electric connection. The source of Drinking Water in the school is Hand PumPrimary School and it is functional. The school has 5 boys' toilet and it is functional. and 5 girls' toilet and it is functional. The school has a playground. The school has a library and has 500 books in its library. The school has 6 computers for teaching and learning purposes and all are functional. The school is having a computer aided learning lab. The school is Provided and Prepared in School Premises providing mid-day meal:

3.9.4.5.2 Details of the Educational Institution Khanua Cluster, Waidhan Block

Hrs Khanua is a school cluster in Waidhan block of Singrauli district in Madhya Pradesh Which is having about 48 Schools in it. This cluster includes all private and govt. schools of this area.

Table 3.30: List of the Schools in Hrs Khanua Cluster, Waidhan Block

Sr. No.	List of the Schools in Hrs Khanua Cluster, Waidhan Block
1	Middle School Khanua
2	UEGS Gora Purv Tola
3	Primary School Khanua Khas
4	Primary School Gora
5	UEGS Chaupal Jhariya (Tenduha)
6	UEGS Baheradol (Khanua)
7	UEGS Jalfadol
8	UEGS Pipardol Jamgadi
9	Private. Primary School Maa Saraswati Shishu Mandir Khanua Nawa
10	UEGS Chatak Tola Bandha
11	Primary school Gorwani
12	UEGS Budher
13	UEGS Badanmada
14	Primary school Gora
15	Primary school Tenduha
16	UEGS Karahi Khadi (Dhumma Dol)
17	Primary school Pidarwah
18	Middle school Tenduha
19	Govt. High School Bandha
20	Primary school Khanua Nawa
21	Private Middle School Indira Gandhi Primary School, Bandha
22	UEGS Mahuagodam Tola (Jamgadi)
23	Middle School Lamidah
25	Primary school Jathha Tola
26	Govt. High school, Khanua Nawa
27	Middle school Gora
28	Uegs Majhi Tola (Dewari)
29	Primary school Lamidah
30	Primary school Pondi Dol

31	Uegs Barwa Tola Jamgadi
32	Primary school Jamgadi
33	Uegs Paschim Tola (Bandha)
34	Uegs Chhatainidand (Bandha)
35	Middle school Jamgadi
36	Middle school Jathha Tola
37	Middle school Pondi Dol
38	Middle school Bandha
39	Uegs Purv Tola Jamgadi
40	Primary school Badijhiriya
41	Middle school Bhalya Tola
42	Primary school Uttar Tola Jattha Tola Gora
43	Uegs Jiganhwa Tola (Tenduha)
44	Primary school Dewari
45	Uegs Pahadi Tola (Khanua)
46	Uegs Agariyan Tola Dewari
47	Primary school Dhummadop
48	Primary school Bandha

3.9.4.6 Medical Facility

Medical facility is available in the form of medical colleges, Community health centres, Primary health Centres, mobile health centres and Dispensaries in the state. In Singrauli district there is 1 District Hospital, 7 Community Health Centres, 15 Primary Health Centres. It is found that there are 227 primary health sub-centres in the District. Mobile health Unit is only 1.

Table 3.31: Medical Facilities

S. No.	Health Instituitions	Approved
1	District Hospital	1
2	Community Health Center	7
3	Primary Health Center	15
4	Sub Health Center	227
5	Mobile Medical Unit	1

3.9.5 Economic Resource Base in the Study Area

3.9.5.1 Agriculture Scenario in the Region

Singrauli located in the north eastern corner of the state of Madhya Pradesh is one of the most important economic zones of the state. The region which initially started off as an agricultural economy is now known as South Asia's largest industrial base. The discovery of coal in the region has fueled the economy with many state owned as well as private owned Thermal power stations situated here. Owning to the enormous energy potential of Singrauli, it is also known as the Energy Capital of India.

Economic History of Singrauli

Singrauli lies in the forest belt of Central India, which remained mainly agricultural and pastoral community for much of its known history. The discovery of coal in the region by English Captain Rabthan led to the setting up of the first open cast mine at Kotav in 1857. Later Coal India Ltd set up the first modern operations in the region laying the road for full-fledged mining activity here.

Agricultural of Singrauli

Singrauli was essentially an agricultural community with the local population dependent mainly on farming and forest produce. The forests are home to the local tribes who earn their living from the trees like Saguan, Mahua, Chironji, Tendu etc. This region lies in the warm tropical monsoonal climate zone with an annual rainfall of 1014mm and hence ideal for growing crops like Rice, Maize, wheat, Pigeon Pea, Chickpea, Barley etc. Apart from this, there is also thriving livestock, poultry and fisheries industry.

Economic Dependency of Tribals in the Region

Major population of the district comprises of tribal population. Tribal communities such as Baigas Gonds, Agarias, Panikas, Khairawars in Singrauli region have always being heavily dependent on forest for their food, fuel and livelihood needs.

The main tribes are Baiga, Kanwar, Panika, and Dand Korwa dependent on agriculture. On the hilly areas' grains like maize, barley, kodo, mahua, kutki, bajra, and gondali are grown. Bagai grass in this region is used for making cots. Many tribals used to sell the grass to people outside for ₹30 kilo or ₹3000 a quintal now the grass has stopped in the region because of the Industries working in the region.

Mining Activity in Singrauli District

Northern Coalfields Limited was separated from Central Coalfields Limited (both subsidiaries of state-owned Coal India) in 1985, solely for the purpose of taking over operations on the Singrauli coalfield. The current surface coal mines are on the Moher sub-basin of the Singrauli coalfield, which is only 312 sq km in size. The main Singrauli

basin, which is 1,890 sq km in size and is located further to the west, is largely unexplored.

Numerous existing and proposed coal power plants are sited in the two districts in which this coalfield is found: Bina Thermal Power Project, Chitrangi Power Project, Gorgi power station, Jaypee Nigrie Super Thermal Power Project, Mahan Super Thermal Power Project, Sasan Ultra Mega Power Project, and Vindhyachal power station in Singrauli district of Madhya Pradesh, and Anpara thermal power station, Anpara-C power station, Anpara-D power station, Churk captive power station, Obra Thermal Power Station, Renusagar power station, Rihand power station, and Singrauli Super Thermal Power Station in Sonbhadra district of Uttar Pradesh. If all these projects are completed as planned, the two districts will have 30 GW of coal-fired generating capacity in total.

3.9.6 PUBLIC CONSULTATION

- Most of the respondents are aware about the project but they are not aware when the project will commission.
- Many respondents were positive about the proposed project and were willing to give there land if proper and adequate compensation is given to them while few respondents were not positive towards the land acquisition as according to them there will be loss of there cultivable land and also the cultural and emotional attachment towards their anscestral land.
- Most of the respondents expect Employment opportunities may be increase due to project works
- Compensation for the loss of land should be given on market rate.
- Villagers opined that the project proponent should work for improving the health facility in the village and also develop the water facility.

School Building In Surveyed Villages

Primary Health Sub-Centre In Khanua Khas

Gram Panchyat Building In Raila Village

Discussion with the villagers in the study area

Figure 3.36: Socieo Economic Survey Photographes

3.9.7 Rehabilitation and Resettlement

R&R Plan for the project affected people is prepared and will be done as per the provisions and recommendations mentioned in RTFCTLARRA, 2013.

3.9.8 District Mineral Foundation (DMF) Schemes

In order to ensure the parcipation of the Mine Holders for the interests and welfare of the area and individuals affected by mining operations, the Government of India created provisions under Section 9B of the 'Mine and Minerals Development and Regulation (Amendment) Act, (MMDRA) 2015'5 for the establishment of District Mineral Foundation (DMF). DMF is a non-profit statutory 'Trust' for each and every district affected by mining-related operations.

The main objective of DMF is to protect the interest of communities and benefit the people in those areas. It is evident that for years, mining has benefitted mining companies, individual miners and governments, not the communities living there.

Because of mining, people are displaced from their land and suffer other negative consequences like loss of livelihood, health risks due to extreme pollution of

environment and lack of provision of basic facilities.The mining Institute Trust will use grant amount received to the given overall requirements in the area affected by mining operations such as Health, Education, environment and Sanitation etc. and the local community will develop an attachment towards mining.

Year	2015-16	2016-17	2017-18	2018-19
Coal	4.9	698.8	348.1	296.5
Non -Coal	NIL	NIL	NIL	2.1
Total	4.9	698.8	348.1	298.6

Source: Government of Madhya Pradesh, Depatrment of Mineral Resources

3.9.9 Activities Taken Under Environmental Protection and Pollution Control Measures from DMF

Drinking Water Facility

- Rs.12.27 crores spent on 1468 Handpumps
- Rs. 9.75 Crores sanctioned for 8 Pipeline Water Supply Schemes benefitting 1.25 lakh persons

Environment:

- Rs. 15.20 crores for plantation of 7.65 lakhs trees over 530 Hectares.

Health Care

- Rs 21.41 crores for extension and strengthening of health infrastructure as per IPHS (Indian Public Health Standard) norms
- Rs. 19.55 crores allocated for procurement of equipments resulting increase in improvement in health outcomes

Education

- Rs. 78.26 crores spent on development of school infrastructure- Repair and construction of school buildings, boundary walls for schools.
- Dual Desks for students in 100% Middle Schools, High Schools.
- Building as Learning Aid works as per parameters of Niti Ayog.
- "Shiksha Sarathi" project initiated for providing eligible teachers in zero teachers schools. Increase in enrolment, attendance and learning outcomes.

Welfare of Aged and Disabled People

- Rs. 5.50 crores worth distribution of artificial equipments to 6431
- Disabled and 4400 old age beneficiaries.
- Rs. 2.90 crores spent on construction of 851 ramps. Ministry of Social Justice and Empowerment, GoI recognised the efforts by delivering National Award, 2018 for the "Outstanding Work in Creation of Barrier–Free Environment For Persons With Disabilities" to the district.
- Skill Development: - Rs. 1.15 crores were spent on skill development

- training along with employment assistance.

Physical Infrastructure

- Rs. 233.15 crores allocated for physical infrastructure in District Singrauli.
- 6 major projects of road construction of about 51.64 Kms are going to complete soon with expenditure amount Rs. 57.80 crores
- 91 projects of bridge construction with expenditure amount Rs.
- 18.21 crores facilitating millions in district to reach Health Institutes, Schools Colleges and Aanganbadi Centers
- Roads leading to Increase in Antenatal Check-ups of pregnant women, Institutional Deliveries, Immunization, aid in extension of Supplementary Nutrition program under ICDS and lower IMR, MMR along with decrease in number of mall-nourished, underweight and stunted children.

Infrastructure Development

Education Facality

Skill Development

Figure 3.37: Photographs of activities undertaken under the district mineral funds in singrauli region

3.9.9.1 Environment Preservation and Pollution Control

- Effluent treatment plants, Prevention of pollution on nearby water bodies and other water sources in the region
- Measures for control of air pollution caused by mining operations and from dumps
- Prevention of pollution from Surface run-off from mines, waste dumps etc.
- Prevention of pollution from Mine drainage
- Rehabilatation of abandoned mines.

- Other air, water & surface land pollution control mechanisms required for environment-friendly and sustainable mine development.

3.9.9.2 Health Care

- Focus is on creation of primary / secondary health care facilities in the affected areas.
- Emphasis on the creation of the health care infrastructure.
- Provision of necessary staffing,
- Equipment and supplies required for making such facilities effective.

3.9.9.3 Education

- Construction of educational institutes
- Vocational training centres,
- Additional class rooms, laboratories, libraries, Art and crafts room,
- Toilet blocks,
- Drinking water provisions
- Residential Hostels for students/teachers in remote areas
- Sports infrastructure
- Engagement of teachers/other supporting staff, e-learning setup
- Arrangement of transport facilities for students (bus/van/cycles/rickshaws etc.) and nutrition related programs.

3.9.9.4 Agriculture and Allied Activities

- Development of activities related to agriculture & allied activities and agro forestry.
- Assistance to farmers through provision of seed mini kits,
- Financial assistance for agricultural implements and micro irrigation facilities including drip irrigation
- Financial assistance for bore wells and pumps energisation.
- Assistance to farmers for allied activities of agriculture such as dairy, poultry, fisheries agro forestry etc.

3.10 Ecology and Biodiversity

3.10.1 Status of Terrestrial Ecology in the Study Area

3.10.1.1 Ecology of the Area

The area of Singrauli coal fields is about 2202 sq. km. This coal field can be divided into two basins, viz. Moher Sub-basin (312 Sq. km), and Singrauli Main basin (1890 sq. km). Major part of the Moher Sub-basin lies in the Singrauli district of Madhya Pradesh and a small part lies in the Sonbhadra district of Uttar Pradesh. Singrauli main basin lies in the western part of the coalfield and largely unexplored.

There are twenty six coal blocks identified by Ministry of Coal, Government of India, New Delhi. They are Amelia (North), Amelia, Chatarsal, Mahan, Mara Mahan, Suliyari, Patpahari, Dhirauli, Bandha, Bandha North, Gondbahera Ujheni, Gondbahera Ujheni East, Pachaur, Makri Barka East, Makri Barka, Makri Barka West Phase-I, Gurbara South, Gurbara Central, Gurbara North, Purail, Saratola, Borka, Bari Mahuli, Hattadudhmania, Sarai East, Sarai West, Dongri Tal-I and Dongri Tal-II.

Dhirauli Coal Block is located in Singrauli Coalfield (Main Basin), Village Dhirauli, Phatpani, Sirswah, Amdand, Jhalari, Amraikhoh, Bansibridha, and Belwar, Tehsil: Sarai, Singrauli district of Madhya Pradesh.

The Biodiversity conservation and habitat fragmentation are terms that are often used together because of the burgeoning human population and rapidly declining biodiversity all over the world. A logical consequence of an increasing human population and subsequent use of land for development projects is less space for flora and fauna and greater pressure on remaining habitat fragments.

Cropping Pattern Adopted by Villagers:

Two seasonal crops mainly Kharif (summer crop) and Rabi (winter crop) are well developed in this region. The crops grown are Paddy, Jawar, Maize and Kodo. Besides pulses like Arhar, Mung, Mustard and Til are also grown. The main Rabi crop is also paddy which is cultivated with a short rotation and this type of crop is grown only where irrigation facilities are available during winter. In addition Alsi, Mustard, etc. are also grown during Rabi. A very significant matter is use of fertilizers and pesticides in this region are very much limited as most of the agricultural practitioners are traditional and support use of green manure..

Extent of Biotic Pressure of the villagers on the study area

At present agriculture is not imposing any biotic pressure on the natural ecosystem particularly of this region. The population growth is a common phenomenon all over which is not restricted to only the study area. The population growth has its impact on the natural ecosystem, common to everywhere. The energy consumption by the

villagers for cooking food items entirely depends on adjoining forest areas i.e. collection of fuel wood.

Number of Families depending upon the NTFP Collection:

A majority of families in the impact area belong to SC and ST, who are involved in collection of NTFP. The main NTFP (non-timber forest produce) product is *mouha* (*Madhuca indica*) flower. *A*apart from mouha they also collect Amla (*Emblica officinalis*), Baheda (*Terminalia bellirica*), Harra (*Terminalia chebula*) and Aam (*Mangifera indica*) fruits. Honey and *Jhuna (raal)* (resin from Sal tree) collection is infrequent in the study area. Tendu leaf collection is also practised here. However, during our survey we did not found any family entirely dependent on NTFP collection. The left over family members of the main work force (old age people, women and children) are mostly engaged in NTFP collection. All family members' joins for collection of NTFP during the lean period when no other engagement for earning their lively hood is available. Apart from NTFP, fire wood (locally called *Jhati)* collection from forest is a traditional and common practice in the study area. Villagers cut the tree for small timber and firewood for their own consumption. They collect their fencing materials and materials required for agricultural tools from the surrounding forests. On an average per standard family (Father+ mother+ one child) consumes 10 kg of firewood per day.

Method of NTFP Collection:

Handpicking from the ground is the main system of collection of mohua. For collecting from the ground villagers clean the forest floor by igniting fire, which destroy the ground vegetation, as well as restrict the regeneration of tree species. Repeated use of this method adversely impact herbivore population. Due to the impact of this cleaning process of underground forest growth, the ground becomes completely barren at places to check the rainwater flow, resulting in to soil erosion.

3.10.1.2 Forest type in study area

The forest cover of the State is 76,013 km2, which is 24.66% of the geographic area. Very dense forest is 4,239 km2, moderately dense forest, 36,843 km2, and open forest, 34,931 km2, whereas, the scrub is 2,172 km2. The recorded forest area of Madhya Pradesh is 94,689 km2, which is 30.72% of its geographical area. According to revised

Forest Types (Champion & Seth, 1968) the forest type of the lease area confirms to following forest types:-

Dry Peninsular Sal Forest (5B/C1c)

Northern Dry Mixed Deciduous Forest (5B/C2)

Dry Deciduous Scrub (5/DS1)

Dry Bamboo Brakes (5/E9)

Dry Peninsular Sal Forest (5B/C1c):

Sal occurs either pure or in mixture with *Terminalia tomentosa, Terminalia bellerica, Pterocarpus marsupium, Anogeissus latifolia, Lagerstroemia parviflora, Madhuca latifolia, Diospyros melanoxylon, Buchanania lanzan, Ougeinia dalbergiodes* etc. Under storey consists of *Combretum decandrum, Flacourtia cataphracta, Randia dumetorum, Zizyphus mauritiana, Gardenia gummifera, Holarrhena* Spp., *Lantana Camara, Eupatorium odoratum* etc.

Northern Dry Mixed Deciduous Forest (5B/C2): The upper canopy in this forest type is usually light, open and irregular, the trees having relatively short bole and poor form and a height rarely over 10 m. The canopy is formed entirely of deciduous trees. The main species found are *Cassia fistula, Diospyros tomentosa, Acacia catechu, Anogeissus latifolia, Bombax ceiba, Albizzia lebbeck, Albizzia procera, Melia azadirachta, Acacia nilotica, Acacia modesta, Bauhinia variegate, Bauhinia purpurea, Bauhinia racemosa, Cassaria eliptica, Syzygium cumini, Mangifera indica, Ehrilia laevis, Phoenix sylvestris, Morus alba, Morus Australia, Terminalia tomentosa, Boswellia serrata, Aegle marmelos, Erythrina suberosa, Ficus glomerata, Grewia elastica, Mallotus philippensis* and *Shorea robusta* (Rarely).

The under growth is mainly *Zizyphus mauritiana, Carissa apaca, Holarrhena antidysenterica, Diospyros cordifolia, Capparis deciduas, Adhatoda vasica, Murraya koenigii, Agave Americana, Capparis sepiaria, Cordia dichotoma, Cassia tora, Zizyphus nummularia, Zizyphus oenopolia, Woodfordia fruticosa, Vitex negundo, Dodonea viscosa*.

Climbers found are *Bauhinia vahlii, Militia extensa, Mucuna* Spp., *Tinospora cordifolia, Pueraria tuberose, Vallaris solanacea*. Grasses are *Panicum antidotate, Aristida depressa,*

Bothrichloa intermedia, Cynodon dactylon, Bothrichloa pertusa, Cymbopogon marini, Dendrophtoe falcate and Eriophorim comosum.

Dry Deciduous Scrub (5/DS1): This forest type represents a degradation stage of the Dry Deciduous Forest and has been brought into existence by adverse biotic factors like excessive grazing, lopping, felling and fires. In spite of sufficient rains, moisture retention is poor and the type has now become a stable edaphic climax. The crop is open with less tree cover. The main tree species found are *Diospyros tomentosa, Acacia leucopholea, Butea monosperma, Premna barbata, Cassia fistula, Anogeissus latifolia and Lannea grandis*. The undergrowth is mainly *Carissa apaca, Woodfordia fruticosa, Nyctanthes arbor-tristis and Flacourtia indica*.

Dry Bamboo Breaks (5/E9): In this forest type, only one species *Dendrocalamus strictus* ocuurs and forms low but often dense bamboo breaks. This forest type occurs mainly on dry hillsides of the study area.

Figure 3.38: Bamboosetum in Buffer Zone

3.10.2 Core Zone Flora

The core zone i.e. Dhirauli Coal Block, in Singrauli Coalfield, in the State of Madhya Pradesh has been allocated to M/s Stratatech Mineral Resource Private Limited (SMRPL) vide Letter No. NA-104/7/2020-NA dated 03.03.2021 by MoC, GoI.

The lease is located in Singrauli Coalfields (Main Basin), Village: Dhirauli, Phatpani, Sirswah, Amdand, Jhalari, Amraikhoh, Bansibridha, and Belwar, Tehsil: Sarai, Singrauli district of Madhya Pradesh. The details of floral diversity of Dhirauli coal block (core zone).

Table 3.32: Floral Diversity within Core of Proposed Coal Mine

Scientific Name	Local Name	Family	Habit
TREES			
Acacia catechu	Khair	Fabaceae	Tree
Acacia leucophloea	Reunjha	Fabaceae	Tree
Acacia nilotica	Babul	Fabaceae	Tree
Aegle marmelos	Bel	Rutaceae	Tree
Ailanthus excels	Maharukh	Simaroubaceae	Tree
Alangium salvifolium	Ankol	Cornaceae	Tree
Albizia lebbeck	Kala Siris	Fabaceae	Tree
Artocarpus heterophyllus	Kathal	Moraceae	Tree
Azadirachta indica	Neem	Rutaceae	Tree
Bauhinia malabarica	Aasta	Caesalpiniaceae	Tree
Bauhinia purpurea	Kachnar	Caesalpiniaceae	Tree
Bauhinia racemosa	Kathmahula	Caesalpiniaceae	Tree
Bombax ceiba	Semal	Malvaceae	Tree
Boswellia serrata	Salai	Burseraceae	Tree
Buchanania lanzan	Chironji	Anacardiaceae	Tree
Butea monosperma	Palash	Fabaceae	Tree
Careya arborea	kumbhi	Lecythidaceae	Tree
Cassia fistula	Amaltas	Caesalpiniaceae	Tree
Cassine glauca	Jamrashi	Celastraceae	Tree
Catunaregam nilotica	Kharhar	Rubiaceae	Tree
Cordia dichotoma	Lasora	Boraginaceae	Tree
Corymbia citriodora	Safeda	Myrtaceae	Tree
Dalbergia latifolia	Shisham	Fabaceae	Tree
Dillenia indica	Bhavya	Dilleniaceae	Tree
Diospyros melanoxylon	Tendu	Ebenaceae	Tree
Diospyros montana	Patvan	Ebenaceae	Tree
Dodonaea angustifolia	Khareta	Sapindaceae	Tree
Erythrina suberosa	Haduwa	Fabaceae	Tree
Ficus benghalensis	Bargad	Moraceae	Tree
Ficus hispida	Kathmur	Maoraceae	Tree
Ficus racemosa	Gular	Moraceae	Tree
Ficus religiosa	Papal	Moraceae	Tree
Ficus virens	Pakar	Moraceae	Tree
Flacourtia indica	Kaakai	Salicaceae	Tree
Gardenia gummifera	Kaapar	Rubiaceae	Tree
Gardenia latifolia	Papra	Rubiaceae	Tree
Garuga pinnata	Kharpat	Burseraceae	Tree
Gmelina arborea	Khamer	Verbenaceae	Tree
Grewia tiliifolia	Dhankat	Tiliaceae	Tree
Haldina cordifolia	Haldu	Rubiaceae	Tree
Holarrhena pubescens	Kutki	Apocynaceae	Tree
Holoptelea integrifolia	Chilbil	Ulmaceae	Tree
Kydia calycina	Barunga	Malvaceae	Tree

Scientific Name	Local Name	Family	Habit
Lagerstroemia parviflora	Sendha	Lythraceae	Tree
Lannea coromandelica	Gunja	Anacardiaceae	Tree
Madhuca longifolia	Mahua	Sapotaceae	Tree
Mallotus philippensis	Sindoor	Euphorbiaceae	Tree
Mangifera indica	Aam	Anacardiaceae	Tree
Manilkara hexandra	Khirni	Sapotaceae	Tree
Melia azedarach	Bakain	Meliaceae	Tree
Mitragyna parvifolia	Kaima	Rubiaceae	Tree
Moringa oleifera	Sainjna	Moringaceae	Tree
Morus alba	Sehtut	Moraceae	Tree
Phoenix sylvestris	Khajur	Arecaceae	Tree
Phyllanthus emblica	Aaonla	Euphorbiaceae	Tree
Polyalthia longifolia	Ashok	Annonaceae	Small Tree
Pongamia pinnata	Karanj	Fabaceae	Tree
Pterocarpus marsupium	Bijasal	Fabaceae	Tree
Salix tetrasperma	Bansa	Salicaceae	Tree
Schleichera oleosa	Kusum	Sapindaceae	Tree
Semecarpus anacardium	Bhilma	Anacardiaceae	Tree
Shorea robusta	Sal	Dipterocarpaceae	Tree
Sterculia urens	Kullu	Sterculiaceae	Tree
Sterculia villosa	Udaal	Sterculiaceae	Tree
Strychnos nux-vomica	Kochila	Loganiaceae	Tree
Syzygium cumini	Jamun	Myrtaceae	Tree
Tamarindus indica	Imli	Caesalpiniaceae	Tree
Tectona grandis	Sagaun	Verbenaceae	Tree
Terminalia alata	Sanja	Combretaceae	Tree
Terminalia arjuna	Arjun	Combretaceae	Tree
Terminalia bellirica	Bahera	Combretaceae	Tree
Terminalia catappa	Badam	Combretaceae	
Terminalia chebula	Harra	Combretaceae	Tree
Wrightia tinctoria	Dudhi	Apocynaceae	Tree
SHRUBS			
Abelmoschus manihot	Jangali Bhindi	Malvaceae	Shrub
Abutilon indicum	Kanghi	Malvaceae	Shrub
Adhatoda zeylanica	Adusa	Acanthaceae	Shrub
Alangium salvifolium	Ankola	Cornaceae	Shrub
Annona squamosa	Sitaphal	Annonaceae	Shrub
Calotropis gigantea	Safed Aak	Asclepiadaceae	Shrub
Calotropis procera	Gulabi Aak	Asclepiadaceae	Shrub
Carica papaya	Papita	Caricaceae	Shrub
Carissa opaca	Karaunda	Apocynaceae	Shrub
Carissa spinarum	Jangali Karaunda	Apocynaceae	Shrub
Cassia occidentalis	Kasaundhi	Caesalpiniaceae	Shrub
Catunaregam nilotica	Kharhar	Rubiaceae	Shrub
Citrus limon	Neebu	Rutaceae	Shrub

Scientific Name	Local Name	Family	Habit
Clerodendrum multiflorum	Bharangi	Verbenaceae	Shrub
Combretum nanum	Bilaura, Medila	Combretaceae	Shrub
Euphorbia nivulia	Sehund	Euphorbiaceae	Shrub
Flemingia chappar	Galphula	Fabaceae	Shrub
Flemingia nana	Gursankari	Tiliaceae	Shrub
Flemingia paniculata	Ramdant	Fabaceae	Shrub
Helicteres isora	Marodfali	Sterculiaceae	Shrub
Hibiscus rosa-sinensis	Gudhal	Malvaceae	Shrub
Holarrhena pubescens	Kurriya	Apocynaceae	Shrub
Indigofera tinctoria	Neel	Fabaceae	Shrub
Ixora pavetta	Khujja	Rubiaceae	Shrub
Jatropha curcas	Ratanjyot	Euphorbiaceae	Shrub
Lawsonia inermis	Mehndi	Lythraceae	Shrub
Murraya paniculata	Aathil	Rutaceae	Shrub
Nyctanthes arbor-tristis	Harsingar	Oleaceae	Shrub
Phoenix acaulis	Bhui Khajur	Arecaceae	Shrub
Phyllanthus reticulatus	Panjoli	Euphorbiaceae	Shrub
Ricinus communis	Rendi	Euphorbiaceae	Shrub
Thespesia lampas	Chaumukhia,	Malvaceae	Shrub
Vitex negundo	Nirgundi	Verbenaceae	Shrub
Woodfordia fruticosa	Dhavai	Lythraceae	Shrub
Ziziphus mauritiana	Ber	Rhamnaceae	Shrub
Ziziphus oenoplia	Barari	Rhamnaceae	Shrub
HERBS			
Achyranthes aspera	Apamarg	Amaranthaceae	Herb
Acorus calamus	Buch	Araceae	Herb
Aerva lanata	Gorakhganja	Amaranthaceae	Herb
Ageratum conyzoides.	Agreatum	Asteraceae	Herb
Allium leptophyllum	Van Lehsun	Liliaceae	Herb
Alternanthera sessilis	Gudari sag	Amaranthaceae	Herb
Alysicarpus monilifer	Alisicarpus	Fabaceae	Herb
Andrographis paniculata	Kalmegh	Acanthaceae	Herb
Anisomeles indica	Jangali Tulsi	Lamiaceae	Herb
Argemone Mexicana	Swarnchhiri (Peeli)	Papaveraceae	Herb
Bacopa monnieri	Brahmi	Scrophulariaceae	Herb
Bacopa procumbens	Jal-Neem	Scrophulariaceae	Herb
Boerhavia diffusa.	Raktpunarwa	Nyctaginaceae	Herb
Bulbostylis barbata		Cyperaceae	Sedges
Cassia tora	Chakramard	Caesalpiniaceae	Herb
Catharanthus roseus	Sadabahar	Apocynaceae	Herb
Centella asiatica	Mandukparni	Apiaceae	Herb
Chlorophytum tuberosum	Safed Musli	Liliaceae	Herb
Cleome gynandra	Hurhur	Capparaceae	Herb
Commelina benghalensis	Kanchara	Commelinaceae	Herb

Scientific Name	Local Name	Family	Habit
Commelina diffusa Burm	Kanshura	Commelinaceae	Herb
Convolvulus prostratus	Shankhpushpi	Convolvulaceae	Herb
Crotalaria prostrate	Kartik Jhumka	Fabaceae	Herb
Curcuma angustifolia	Tikhur	Zingiberaceae	Herb
Curculigo orchioides	Kali Musli	Hypoxidaceae	Herb
Curcuma aromatica	Van Haldi	Zingiberaceae	Herb
Cyperus rotundus	Motha	Cyperaceae	Sedges
Dentella repens	Parpat	Rubiaceae	herb
Desmodium triflorum	Desmodium	Fabaceae	Herb
Eclipta prostrata	Bhringraj	Asteraceae	Herb
Elytraria acaulis	Sahasramuniya	Acanthaceae	herb
Euphorbia hirta	Doodhi	Euphorbiaceae	Herb
Evolvulus alsinoides	Sakhpushpi	Convolvulaceae	Herb
Fimbristylis dipsacea	NA	Cyperaceae	Sedges
Fimbristylis falcata	Hathi Paw	Cyperaceae	Sedges
Fumaria indica	Pitpapra	Papaveraceae	Herb
Heliotropium indicum	Hastimundi	Boraginaceae	Herb
Ipomoea eriocarpa	Besharam	Convonvulaceae	Herb
Justicia quinqueangularis	Justicia	Acanthaceae	Herb
Leucas aspera	Bhondaki	Lamiaceae	Herb
Melilotus indica	Van Maithi	Fabaceae	herb
Ocimum basilicum	Ban Tulsi	Lamiaceae	Herb
Oxalis corniculata	Teenpati	Oxalidaceae	Herb
Oxalis corniculata	Teen Patti	Oxalidaceae	Herb
Oxalis richardiana	Teenpatti	Oxalidaceae	Herb
Phyllanthus amarus	Bhuin Anwla	Euphorbiaceae	Herb
Physalis minima	Chirponta	Solanaceae	Herb
Polygonum barbatum	Polygonum	Polygonaceae	Herb
Polygonum glabrum	Polygonum		Herb
Rauvolfia serpentina	Sarpandha	Apocynaceae	Herb
Rungia pectinata	Rungia	Acanthaceae	Herb
Sida acuta Burm.	Mahabala	Malvaceae	Herb
Sida cordifolia	Kharenti	Malvaceae	Herb
Sida rhombifolia	Atibala	Malvaceae	Herb
Solanum nigrum	makoya	Solanaceae	Herb
Solanum virginianum	Katai	Solanaceae	Herb
Tridax procumbens	Khal Muriya	Asteraceae	Herb
Triumfetta pentandra	Chipki	Tiliaceae	Herb
Triumfetta rhomboidea	Chipki	Tiliaceae	Herb
Xanthium strumarium	Gokharu	Asteraceae	Herb
GRASSES			
Aristida adscensionis.	Aristida	Poaceae	Grasses
Bambusa bambos	Bamboo	Poaceae	Grasses
Bothriochloa pertusa	Bothricloa	Poaceae	Grasses
Cenchrus ciliaris	Cenchurus	Poaceae	Grasses

Scientific Name	Local Name	Family	Habit
Chrysopogon serrulatus	Chrysopogan	Poaceae	Grasses
Cynodon dactylon	Doob	Poaceae	Grasses
Dichanthium annulatum	Dichanthium	Poaceae	Grasses
Digitaria stricta	Digitaria	Poaceae	Grasses
Eragrostis amabilis	Erogrostis	Poaceae	Grasses
Heteropogon contortus	hetropogan	Poaceae	Grasses
Imperata cylindrica	Imperata	Poaceae	Grasses
Oryza minuta J.Presl	Jangali Dhan	Poaceae	Grasses
Saccharum spontaneum	Kans	Poaceae	Grasses
Dendrocalamus strictus	Bans	Poaceae	Grasses
CLIMBERS			
Abrus precatorius	Kali Ghughchi	Fabaceae	Climber
Asparagus racemosus	Shatawar	Liliaceae	Climber
Butea superba	Palas Bel	Fabaceae	Climber
Cissus quadrangularis	Hadjood	Vitaceae	Climber
Coccinia grandis	Kunduru	Cucurbitaceae	Climber
Combretum roxburghii	Bilora, Medila	Combretaceae	Climber
Cryptolepis buchanani	Nagbel	Asclepiadaceae	Climber
Gymnema sylvestre	Gudmar	Asclepiadaceae	Climber
Tinospora cordifolia	Giloya	Menispermaceae	Climber
EPIPHYTES			
Cuscuta reflexa.	Amarbel	Convolvulaceae	Epiphyte
Vanda tessellata	Vanda	Orchidaceae	Epiphyte

Source: Primary On-site Data and Working Plan

3.10.3 Faunal Diversity within Core Zone

The Fauna of a particular region indicates environmental conditions and the well being of the population residing in the region. Faunal studies help to understand the well being of the natural systems and indicate functioning of ecosystem. It helps to monitor pollution levels, biological richness or heritage quality, habitat change quantifying threatened species. The faunal components such as Arthropods, Molluscs, Pisces, Birds and Mammals are very sensitive to any change in the ecosystem, therefore are very good indicators of the health of an ecosystem. The details of faunal diversity of Dhirauli coal block (Core Zone)

Table 3.33: Faunal Diversity within Core Zone

Sl. No.	Common Name	Scientific Name	Schedule as per WPA, 1972	Conservation Status as per IUCN
Mammals				
1	Spotted Deer	*Axis axis*	III	LC #
2	Bandicoot Rat	*Bandicota bengalensis*	V	LC #
3	Jackal	*Canis aureus*	II	LC #
4	Indian Wolf	*Canis lupus callipes*	I	LC #
5	Short Nosed Fruit Bat	*Cynopterus sphinx*	V	LC #
6	Wild Cat	*Felis chaus*	II	LC #
7	Five striped Palm squirrel	*Funambulus pennanti*	IV	LC #
8	Mongoose	*Herpestres edwardsii*	IV	LC #
9	Striped Hyena	*Hyaena hyaena*	III	NT #
10	Indian Porcupine	*Hystrix indica*	IV	LC #
11	Hare	*Lepas nigricollis*	IV	LC #
12	Rhesus Macaque	*Macaca mulatta*	II	LC #
13	Indian Pangolin	*Manis crassicaudata*	I	EN #
14	Honey Badger	*Mellivora capensis*	I	LC #
15	Sloth Bear	*Melursus ursinus*	I	Vu #
16	Barking Deer	*Muntiacus muntjak*	III	LC #
17	Indian Field Mouse	*Mus booduga*	V	LC #
18	Hedgehog	*Paraechinus micropus*	IV	LC #
19	Indian Pipistrelle	*Pipistrellus mimus*	IV	LC #
20	Barking Deer	*Muntiacus muntjak*	III	LC #
21	Flying Fox	*Pteropus giganteus*	V	LC #
22	Common house Rat	*Rattus rattus*	V	LC #
23	Hanuman Langur	*Semnopithecus entellus*	II	LC #
24	Musk Shrew	*Suncus murinus*	-	LC #
25	Wild Pig	*Sus scrofa*	III	LC #
26	Common Fox	*Vulpes bengalensis*	II	LC #
27	Indian Civet	*Viverricula indica*	II	LC#
	Birds			
1	Shikra	*Accipter badius*	IV	LC #
2	Jungle Mynah	*Acridotheres fuscus*	IV	LC #
3	Common Mynah	*Acridotheres tristis*	IV	LC #
4	Common Iora	*Aegithina tiphia*	IV	LC #
5	Common Kingfisher	*Alcedo atthis*	IV	LC #
6	Quaker Babbler	*Alcippe poioicephala*	IV	LC #
7	Rufous-tailed Finch-lark	*Ammomanes phoenicurus*	IV	LC #
8	Open Billed Stork	*Anastomus oscitans*	IV	LC #
9	House swift	*Apus affinis*	IV	LC #

Sl. No.	Common Name	Scientific Name	Schedule as per WPA, 1972	Conservation Status as per IUCN
10	Tawny Eagle	*Aquila rapax*	I	VU #
11	Pond Heron	*Ardeola grayii*	IV	LC #
12	Ashy Swallow Shrike	*Artamus fuscus*	-	LC #
13	Eagle Owl	*Bubo bubo*	IV	LC #
14	Cattle Egret	*Bubulcus ibis*	IV	LC #
15	Common Indian Nightjar	*Caprimulgus asiaticus*	IV	LC #
16	Crow Pheasant	*Centropus sinensis*	IV	LC #
17	Crow Pheasant	*Centropus sinensis*	IV	LC #
18	Golden-fronted Leaf-bird	*Chloropsis aurifrons*	IV	LC #
19	Gold-mantled Leafbird	*Chloropsis chochinchinensis*	IV	LC #
20	Pied Crested Cuckoo	*Clamator jacobiuns*	IV	LC #
21	Blue Rock Pegion	*Columba livia*	IV	LC #
22	White Rumped Shama	*Copsychus malabaricus*	IV	LC #
23	Magpie Robin	*Copsychus saularis*	IV	LC #
24	Indian Roller	*Coracias benghalensis*	IV	LC #
25	Large Cuckoo-shrike	*Coracina novaehollandiae*	-	LC #
26	Jungle Crow	*Corvus marorhynchos*	IV	LC #
27	Common Crow	*Corvus splendens*	V	LC #
28	Common Quail	*Coturnix coturnix*	IV	LC #
29	Brain-fever bird	*Cuculus varius*	IV	LC #
30	Indian Tree Pie	*Dendrocitta vagabunda*	IV	LC #
31	Tickell's Flower Pecker	*Dicaeum erythrarthynchos*	IV	LC #
32	Fire-breasted Flower Pecker	*Dicaeum ignipectus*	IV	LC #
33	Drongo	*Dicrurus adsimilis*	IV	LC #
34	White-bellied Drongo	*Dicrurus caerulescens*	IV	LC #
35	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	IV	LC #
36	Lesser Golden Backed Woodpecker	*Dinopium benghalense*	IV	LC #
37	Black Winged Kite	*Elanus caeruleus*	IV	LC #
38	Ashy-crowned Finch-lark	*Eremopterix grisea*	IV	LC #
39	Red Munia	*Estrilda amandava*	IV	LC #
40	Koel	*Eudynamis scolopacea*	IV	LC #
41	Lesser Kestrel	*Falco naumanni*	IV	LC #
42	Common Kestrel	*Falco tinnunculus*	IV	LC #
43	Black Partridge	*Francolinus francolinus*	IV	LC #

Sl. No.	Common Name	Scientific Name	Schedule as per WPA, 1972	Conservation Status as per IUCN
44	Painted Partridge	*Francolinus pictus*	IV	LC #
45	Grey Partridge	*Francolinus pondicerianus*	IV	LC #
46	Red Spurfowl	*Galloperdix spadicea*	IV	LC #
47	Red Jungle Fowl	*Gallus gallus*	IV	LC #
48	Jungle Owlet	*Glaucidium radiatum*	IV	LC #
49	White Rumped Vulture	*Gyps bengalensis*	I	CR #
50	White Breasted Kingfisher	*Halcyon smyrnensis*	IV	LC #
51	Heartspotted Woodpecker	*Hemicircus canente*	IV	LC #
52	Indian Cliff Swallow	*Hirundo fluvicola*	-	LC #
53	Wire-tailed Swallow	*Hirundo smithii*	-	LC #
54	Rufous Backed Shrike	*Lanius schach*	-	LC #
55	Black-headed Munia	*Lonchura malacca*	IV	LC #
56	Coppersmith Barbet	*Megalaima haemacephala*	IV	LC #
57	Crested Bunting	*Melophus lathami*	IV	LC #
58	Small Green Bee-eater	*Merops orientalis*	IV	LC #
59	Blue tailed Bee-eater	*Merops philippinus*	IV	LC #
60	Blue cheeked Bee-eater	*Merops superciliosus*	IV	LC #
61	Pariah Kite	*Milvus migrans*	IV	LC #
62	Blacknaped Flycatcher	*Monarcha azurea*	IV	LC #
63	Blue headed Rock Thrush	*Monticola cinclorhynchus*	IV	LC #
64	Pied Wagtail	*Motacilla alba*	-	LC #
65	Grey Wagtail	*Motacilla cinerea*	-	LC #
66	Yellow Wagtail	*Motacilla flava*	-	LC #
67	Large Pied Wagtail	*Motacilla maderaspatensis*	-	LC #
68	Tickell's Blue Flycatcher	*Muscicapa tickelliae*	IV	LC #
69	Purple Sunbird	*Nectarinia asiatica*	IV	LC #
70	Crested Hawk Eagle	*Nisaetus cirrhatus*	I	LC #
71	Golden Oriole	*Oriolus oriolus*	IV	LC #
72	Black Headed Oriole	*Oriolus xanthornus*	IV	LC #
73	Tailor Bird	*Orthotomus sutorius*	IV	LC #
74	Grey Tit	*Parus major*	IV	LC #
75	Yellow-cheeked Tit	*Parus xanthogenys*	IV	LC #
76	House Sparrow	*Passer domesticus*	IV	LC #
77	Pea-fowl	*Pavo cristatus*	I	LC #
78	Jungle Bush Quail	*Perdicula asiatica*	IV	LC #

Sl. No.	Common Name	Scientific Name	Schedule as per WPA, 1972	Conservation Status as per IUCN
79	Small Minivet	*Pericrocotus cinnamomeus*	IV	LC #
80	Scarlet Minivet	*Pericrocotus flammmeus*	IV	LC #
81	Black Redstart	*Phoenicurus ochruros*	IV	LC #
82	Yellow-fronted Pied Woodpecker	*Picoides mahrattensis*	IV	LC #
83	Indian Pitta	*Pitta brachyura*	IV	LC #
84	Weaver Bird	*Ploceus philippinus*	IV	LC #
85	Slaty-headed Scimitar Babbler	*Pomatorhinus horsfieldi schisticeps*	IV	LC #
86	Ashy Wren-warbler	*Prinia socialis*	IV	LC #
87	Blossom headed Parakeet	*Psittacula cyanocephala*	IV	LC #
88	Large Indian Parakeet	*Psittacula eupatria*	IV	NT #
89	Rose Ringed Parakeet	*Psittacula krameri*	IV	LC #
90	Red Vent Bulbul	*Pycnonotus cafer*	IV	LC #
91	Red Whiskered Bulbul	*Pycnonotus jocosus*	IV	LC #
92	White-throated Fantail Flycatcher	*Rhipidura albicolis*	IV	LC #
93	White-browed Fantail Flycatcher	*Rhipidura aureola*	IV	LC #
94	Pied Bush-chat	*Saxicola caprata*	IV	LC #
95	Collared Bush-chat	*Saxicola torquata*	IV	LC #
96	Indian Robin	*Saxicoloides fulicata*	IV	LC #
97	Chestnut-bellied Nuthatch	*Sitta castanea*	-	LC #
98	Velvet-fronted Nuthatch	*Sitta frontalis*	-	LC #
99	Crested Serpent Eagle	*Spilornis cheela*	-	LC #
100	Spotted Dove	*Streptopelia chinensis*	IV	LC #
101	Indian Ring Dove	*Streptopelia decaocto*	IV	LC #
102	Red Turtle Dove	*Streptopelia tranquebarica*	IV	LC #
103	Pied Mynah	*Sturnus contra*	IV	LC #
104	Grey-Headed Mynah	*Sturnus malabaricus*	IV	LC #
105	Black-headed Mynah	*Sturnus pagodarum*	IV	LC #
106	Rosy Pastor	*Sturnus roseus*	IV	LC #
107	Paradise Flycatcher	*Terpsiphone paradisi*	IV	LC #
108	Black Headed Ibis	Threskiornis *melanocephalus*	IV	NT#
109	Indian Grey Hornbill	*Tokus birostris*	-	LC #
110	Yellow-footed Green Pigeon	*Treron phoenicoptera*	IV	LC #
111	Jungle Babbler	*Turdoides striatus*	IV	LC #

Sl. No.	Common Name	Scientific Name	Schedule as per WPA, 1972	Conservation Status as per IUCN
112	Hoopoe	*Upupa epops*	IV	LC #
113	Red Wattled Lapwing	*Vannelus indicus*	IV	LC #
114	Red Wattled Lapwing	*Vannelus indicus*	IV	LC #
	Reptiles			
1	Green Vine Snake	*Ahaetulla nasuta*	IV	LC #
2	Garden Lizard	*Calotes versicolor*	-	-
3	Russel's Viper	*Daboia russelii*	IV	LC #
4	Geckos	*Hemidactylus sps.*	IV	-
5	Common Skink	*Mabuya carinata*	-	LC #
6	Indian Cobra	*Naja naja*	IV	LC #
7	Yellow Rat Snake	*Ptyas mucosa*	II	-
8	Indian Python	*Python morulus*	I	Vu #
9	Bengal Monitor Lizard	*Varanus bengalensis*	I	LC #
	Fishes			
1	Chela	*Chela sp.*	NA	NA
2	Magur	*Clarias batrachus*	NA	NA
3	Punti	*Barbus sp.*	NA	NA
4	Snakehead	*Ophiocephalus punctatus*	NA	NA
	Butterflies			
1.	Common Emigrant	*Catopsilia pomona*	NA	NA
2.	Stripped Tiger	*Danaus genutia*	NA	NA
3.	Common crow	*Euploea core*	NA	NA
4.	Common Grass Yellow	*Eurema hecabe*	NA	NA
5.	White orange tip	*Ixias marianne*	NA	NA
# LC – Least Concern; NT – Near Threatened; Vu – Vulnerable; EN – Endangered; CR – Critically Endangered				

Source: Primary On-site Data

3.10.4 Buffer Zone Flora

The northern and southern parts of the mine are occupied by hillocks. The study area best represents as moist region. The vegetation is fairly dense and occurs on crystalline rocks and yellow loam soils. Soil and topography vary together. It can be helpful to differentiate three subtypes of topography; hilltops and plateaus, lower hill slopes and valley bottom. There is light shrub and weed growth under the forest canopy. The vegetation mainly consists of tall tress of *Shorea robusta, Tectona grandis, Terminalia tomentosa, Madhuca indica*. The vegetation can be described as moist peninsular Sal forest.

The total species of plants are indicating the floristic richness of the area. However, these species are not uniform in their distribution. The most dominant genera were

Shorea, Tectona, Bahuinia, Cassia, Ficus, Euphorbia followed by *Acacia, Anogessus, Lagerstromia, Bamboo, Jatropha* and *Madhuca.*

There is predominance of herbs and trees followed by shrubs, climbers, epiphytes, grasses and sedges. The common climbers are *Butea superba, Combretum decandrum,* and *Bauhinia vahli.* Only two Gymnosperms were noticed which are cultivated in gardens. The Pteridophytes represented reasonably good number along with Bryophytes. They are very much sensitive to humidity and moisture. List of plant species as reported according to the Working Plans of **Dhirauli Forest Division** has been studied out of which the main associates of Sal as observed in the field are furnished below

Table 3.34: Floral Diversity within buffer zone of Proposed coal mine

Scientific Name	Local Name	Family	Habit
TREES			
Acacia catechu	Khair	Fabaceae	Tree
Acacia leucophloea	Reunjha	Fabaceae	Tree
Acacia nilotica	Babul	Fabaceae	Tree
Aegle marmelos	Bel	Rutaceae	Tree
Ailanthus excelsa	Maharukh	Simaroubaceae	Tree
Alangium salvifolium	Ankol	Cornaceae	Tree
Albizia lebbeck	Kala Siris	Fabaceae	Tree
Albizia odoratissima	Chichwa	Fabaceae	Tree
Albizia procera	Safed Siris	Fabaceae	Tree
Anogeissus latifolia	Dhawda	Combretaceae	Tree
Artocarpus heterophyllus	Kathal	Moraceae	Tree
Azadirachta indica	Neem	Rutaceae	Tree
Bauhinia malabarica	Aasta	Caesalpiniaceae	Tree
Bauhinia purpurea	Kachnar	Caesalpiniaceae	Tree
Bauhinia racemosa	Kathmahula	Caesalpiniaceae	Tree
Bombax ceiba	Semal	Malvaceae	Tree
Boswellia serrata	Salai	Burseraceae	Tree
Bridelia retusa	Kasai	Euphorbiaceae	Tree
Buchanania lanzan	Chironji	Anacardiaceae	Tree
Butea monosperma	Palash	Fabaceae	Tree
Careya arborea	kumbhi	Lecythidaceae	Tree
Cassia fistula	Amaltas	Caesalpiniaceae	Tree
Cassine glauca	Jamrashi	Celastraceae	Tree
Catunaregam nilotica	Kharhar	Rubiaceae	Tree
Chloroxylon swietenia	Bhirra	Rutaceae	Tree
Cordia dichotoma	Lasora	Boraginaceae	Tree
Cordia obliqua	Lasora	Boraginaceae	Tree
Corymbia citriodora	Safeda	Myrtaceae	Tree
Dalbergia latifolia	Shisham	Fabaceae	Tree
Dillenia indica	Bhavya	Dilleniaceae	Tree
Dillenia pentagyna	Karkat	Dilleniaceae	Tree

Scientific Name	Local Name	Family	Habit
Diospyros melanoxylon	Tendu	Ebenaceae	Tree
Diospyros montana	Patvan	Ebenaceae	Tree
Dodonaea angustifolia	Khareta	Sapindaceae	Tree
Ehretia laevis	Charmor	Boraginaceae	Tree
Erythrina suberosa	Haduwa	Fabaceae	Tree
Ficus benghalensis	Bargad	Moraceae	Tree
Ficus hispida	Kathmur	Maoraceae	Tree
Ficus mollis	Baril	Moraceae	Tree
Ficus racemosa	Gular	Moraceae	Tree
Ficus religiosa	Papal	Moraceae	Tree
Ficus tinctoria	Paakar	Moraceae	Tree
Ficus virens	Pakar	Moraceae	Tree
Flacourtia indica	Kaakai	Salicaceae	Tree
Gardenia gummifera	Kaapar	Rubiaceae	Tree
Gardenia latifolia	Papra	Rubiaceae	Tree
Garuga pinnata	Kharpat	Burseraceae	Tree
Gmelina arborea	Khamer	Verbenaceae	Tree
Grewia tiliifolia	Dhankat	Tiliaceae	Tree
Haldina cordifolia	Haldu	Rubiaceae	Tree
Holarrhena pubescens	Kutki	Apocynaceae	Tree
Holoptelea integrifolia	Chilbil	Ulmaceae	Tree
Kydia calycina	Barunga	Malvaceae	Tree
Lagerstroemia parviflora	Sendha	Lythraceae	Tree
Lannea coromandelica	Gunja	Anacardiaceae	Tree
Litsea glutinosa	Maida	Lauraceae	Tree
Madhuca longifolia	Mahua	Sapotaceae	Tree
Mallotus philippensis	Sindoor	Euphorbiaceae	Tree
Mangifera indica	Aam	Anacardiaceae	Tree
Manilkara hexandra	Khirni	Sapotaceae	Tree
Melia azedarach	Bakain	Meliaceae	Tree
Miliusa tomentosa	Kaari	Annonaceae	Tree
Mitragyna parvifolia	Kaima	Rubiaceae	Tree
Moringa oleifera	Sainjna	Moringaceae	Tree
Morus alba	Sehtut	Moraceae	Tree
Oroxylum indicum	Sonpatha	Bignoniaceae	Tree
Ougeinia oojeinensis.	Tinsa	Fabaceae	Tree
Phoenix sylvestris	Khajur	Arecaceae	Tree
Phyllanthus emblica	Aaonla	Euphorbiaceae	Tree
Polyalthia longifolia	Ashok	Annonaceae	Tree
Pongamia pinnata	Karanj	Fabaceae	Tree
Pterocarpus marsupium	Bijasal	Fabaceae	Tree
Salix tetrasperma	Bansa	Salicaceae	Tree
Schleichera oleosa	Kusum	Sapindaceae	Tree
Schrebera swietenioides	Ghainta	Oleaceae	Tree
Semecarpus anacardium	Bhilma	Anacardiaceae	Tree

Scientific Name	Local Name	Family	Habit
Shorea robusta	Sal	Dipterocarpaceae	Tree
Sterculia urens	Kullu	Sterculiaceae	Tree
Sterculia villosa	Udaal	Sterculiaceae	Tree
Stereospermum colais	Chota Padar	Binoniaceae	Tree
Strychnos nux-vomica	Kochila	Loganiaceae	Tree
Symplocos racemosa	Lodra	Symplocaceae	Tree
Syzygium cumini	Jamun	Myrtaceae	Tree
Tamarindus indica	Imli	Caesalpiniaceae	Tree
Tectona grandis	Sagaun	Verbenaceae	Tree
Terminalia alata	Sanja	Combretaceae	Tree
Terminalia arjuna	Arjun	Combretaceae	Tree
Terminalia bellirica	Bahera	Combretaceae	Tree
Terminalia catappa	Badam	Combretaceae	
Terminalia chebula	Harra	Combretaceae	Tree
Trema orientalis	Jibhi	Ulmaceae	Tree
Trema politoria	Trema	Ulmaceae	Tree
Trewia polycarpa	Surahi	Euphorbiaceae	Tree
Wrightia tinctoria	Dudhi	Apocynaceae	Tree
Ziziphus mauritiana	Ber	Rhamnaceae	Small Tree
SHRUBS			
Abelmoschus manihot	Jangali Bhindi	Malvaceae	Shrub
Abutilon indicum	Kanghi	Malvaceae	Shrub
Adhatoda zeylanica	Adusa	Acanthaceae	Shrub
Alangium salvifolium	Ankola	Cornaceae	Shrub
Annona squamosa	Sitaphal	Annonaceae	Shrub
Barleria prionitis	Katsaraiya	Acanthaceae	Shrub
Boehmeria macrophylla	Sohkhara	Urticaceae	Shrub
Calotropis gigantea	Safed Aak	Asclepiadaceae	Shrub
Calotropis procera	Gulabi Aak	Asclepiadaceae	Shrub
Carica papaya	Papita	Caricaceae	Shrub
Carissa opaca	Karaunda	Apocynaceae	Shrub
Carissa spinarum	Jangali Karaunda	Apocynaceae	Shrub
Cassia occidentalis	Kasaundhi	Caesalpiniaceae	Shrub
Catunaregam nilotica	Kharhar	Rubiaceae	Shrub
Citrus limon	Neebu	Rutaceae	Shrub
Clerodendrum multiflorum	Bharangi	Verbenaceae	Shrub
Colebrookea oppositifolia	Ameda	Lamiaceae	Shrub
Combretum nanum	Bilaura, Medila	Combretaceae	Shrub
Euphorbia neriifolia	Sehud	Euphorbiaceae	Shrub
Euphorbia nivulia	katthuar	Euphorbiaceae	Shrub
Flemingia chappar	Galphula	Fabaceae	Shrub
Flemingia nana	Gursankari	Tiliaceae	Shrub
Flemingia paniculata	Ramdant	Fabaceae	Shrub
Grewia helicterifolia	Vansuli	Tiliaceae	Shrub
Grewia hirsuta	Gursankari	Tiliaceae	Shrub

Scientific Name	Local Name	Family	Habit
Helicteres isora	Marodfali	Sterculiaceae	Shrub
Hibiscus rosa-sinensis	Gudhal	Malvaceae	Shrub
Holarrhena pubescens	Kutki, Kurriya	Apocynaceae	Shrub
Indigofera tinctoria	Neel	Fabaceae	Shrub
Ixora pavetta	Khujja	Rubiaceae	Shrub
Jasminum humile	Pili Chameli	Oleaceae	Shrub
Jatropha curcas	Ratanjyot	Euphorbiaceae	Shrub
Lawsonia inermis	Mehndi	Lythraceae	Shrub
Leea macrophylla	Hatfun	Leeaceae	Shrub
Murraya paniculata	Aathil	Rutaceae	Shrub
Nyctanthes arbor-tristis	Harsingar	Oleaceae	Shrub
Ochna obtusata	Kanak Champa	Ochnaceae	Shrub
Phoenix acaulis	Bhui Khajur	Arecaceae	Shrub
Phyllanthus reticulates	Panjoli	Euphorbiaceae	Shrub
Plumbago zeylanica	Chitrak	Plumbaginaceae	Shrub
Premna barbata	Aradi	Verbenaceae	Shrub
Ricinus communis	Rendi	Euphorbiaceae	Shrub
Tamarix ericoides	Jhau	Tamaricaceae	Shrub
Thespesia lampas	Chaumukhia,	Malvaceae	Shrub
Vitex negundo	Nirgundi	Verbenaceae	Shrub
Woodfordia fruticosa	Dhavai	Lythraceae	Shrub
Ziziphus mauritiana	Ber	Rhamnaceae	Shrub
Ziziphus oenoplia	Barari	Rhamnaceae	Shrub
HERBS			
Acalypha ciliata	Chipki	Asteraceae	Herb
Achyranthes aspera	Apamarg	Amaranthaceae	Herb
Acorus calamus	Buch	Araceae	Herb
Aerva lanata	Gorakhganja	Amaranthaceae	Herb
Aerva sanguinolenta	Gorakh Ganja	Amaranthaceae	Herb
Ageratum conyzoides	Agreatum	Asteraceae	Herb
Allium leptophyllum	Van Lehsun	Liliaceae	Herb
Alternanthera sessilis	Gudari sag	Amaranthaceae	Herb
Alysicarpus monilifer	Alisicarpus	Fabaceae	Herb
Ammannia baccifera	Dadmari	Lythraceae	Herb
Andrographis paniculata	Kalmegh	Acanthaceae	Herb
Anisomeles indica	Jangali Tulsi	Lamiaceae	Herb
Aponogeton crispum	*Aponogeton*	Aponogetonaceae	Herb
Argemone mexicana	Swarnchhiri	Papaveraceae	Herb
Asphodelus tenuifolius	Bokat	Linaceae	Herb
Atylosia scarabaeoides	Lotar	Fabaceae	Herb
Bacopa monnieri	Brahmi	Scrophulariaceae	Herb
Bacopa procumbens.	Jal-Neem	Scrophulariaceae	Herb
Barleria cristata	Katsaraiya	Acanthaceae	Herb
Boerhavia diffusa	Raktpunarwa	Nyctaginaceae	Herb
Bulbostylis barbata		Cyperaceae	Sedges

Scientific Name	Local Name	Family	Habit
Cassia tora	Chakramard	Caesalpiniaceae	Herb
Catharanthus roseus	Sadabahar	Apocynaceae	Herb
Centella asiatica	Mandukparni	Apiaceae	Herb
Chlorophytum tuberosum	Safed Musli	Liliaceae	Herb
Cleome gynandra	Hurhur	Capparaceae	Herb
Cleome viscose	Hurhur	Capparaceae	Herb
Commelina benghalensis	Kanchara	Commelinaceae	Herb
Commelina diffusa	Kanshura	Commelinaceae	Herb
Convolvulus prostratus	Shankhpushpi	Convolvulaceae	Herb
Crotalaria prostrata	Kartik Jhumka	Fabaceae	Herb
Curcuma angustifolia	Tikhur	Zingiberaceae	Herb
Curculigo orchioides	Kali Musli	Hypoxidaceae	Herb
Curcuma aromatica	Van Haldi	Zingiberaceae	Herb
Cyperus rotundus	Motha	Cyperaceae	Sedges
Dentella repens	Parpat	Rubiaceae	herb
Desmodium heterocarpon	Salparni	Fabaceae	Herb
Desmodium triflorum	Desmodium	Fabaceae	Herb
Dipteracanthus suffruticosus	Chowlai	Acanthaceae	Herb
Echinops echinatus	Utkatara	Asteraceae	Herb
Eclipta prostrata	Bhringraj	Asteraceae	Herb
Elytraria acaulis	Sahasramuniya	Acanthaceae	herb
Euphorbia hirta	Doodhi	Euphorbiaceae	Herb
Evolvulus alsinoides	Sakhpushpi	Convolvulaceae	Herb
Fimbristylis dipsacea	NA	Cyperaceae	Sedges
Fimbristylis falcata	Hathi Paw	Cyperaceae	Sedges
Fumaria indica	Pitpapra	Papaveraceae	Herb
Heliotropium indicum	Hastimundi	Boraginaceae	Herb
Hygrophila salicifolia	Talamkhana	Acanthaceae	Herb
Ipomoea eriocarpa	Besharam	Convonvulaceae	Herb
Justicia quinqueangularis	Justicia	Acanthaceae	Herb
Leucas aspera	Bhondaki	Lamiaceae	Herb
Melilotus indica	Van Maithi	Fabaceae	herb
Ocimum basilicum	Ban Tulsi	Lamiaceae	Herb
Oxalis corniculata	Teenpati	Oxalidaceae	Herb
Oxalis corniculata	Teen Patti	Oxalidaceae	Herb
Oxalis richardiana	Teenpatti	Oxalidaceae	Herb
Phyllanthus amarus	Bhuin Anwla	Euphorbiaceae	Herb
Physalis minima	Chirponta	Solanaceae	Herb
Polygonum barbatum	Polygonum	Polygonaceae	Herb
Polygonum glabrum	Polygonum	Polygonaceae	Herb
Rauvolfia serpentina	Sarpandha	Apocynaceae	Herb
Rungia pectinata	Rungia	Acanthaceae	Herb
Scleria levis Retz.	Scleria	Cyperaceae	Sedges
Sesbania bispinosa	Sirmili	Fabaceae	Herb
Sida acuta	Mahabala	Malvaceae	Herb

Scientific Name	Local Name	Family	Habit
Sida cordifolia	Kharenti	Malvaceae	Herb
Sida rhombifolia	Atibala	Malvaceae	Herb
Solanum nigrum	makoya	Solanaceae	Herb
Solanum virginianum	Bhatkataiya	Solanaceae	Herb
Tridax procumbens	Khal Muriya	Asteraceae	Herb
Triumfetta pentandra	Chipki	Tiliaceae	Herb
Triumfetta rhomboidea	Chipki	Tiliaceae	Herb
Xanthium strumarium	Gokharu	Asteraceae	Herb
GRASSES			
Apluda mutica	Apluda	Poaceae	Grasses
Apocopis vaginata	Apocopis	Poaceae	Grasses
Aristida adscensionis	Aristida	Poaceae	Grasses
Bambusa bambos	Bamboo	Poaceae	Grasses
Bothriochloa glabra	Bothriochloa	Poaceae	Grasses
Bothriochloa intermedia	Bothriochloa	Poaceae	Grasses
Bothriochloa pertusa	Bothricloa	Poaceae	Grasses
Brachiaria eruciformis	Brachiaria	Poaceae	Grasses
Brachiaria ramosa	Brachiaria	Poaceae	Grasses
Brachiaria reptans	Brachiaria	Poaceae	Grasses
Cenchrus ciliaris	Cenchurus	Poaceae	Grasses
Chloris dolichostachya	Chloris	Poaceae	Grasses
Chloris virgata	Chloris	Poaceae	Grasses
Chrysopogon fulvus	Chrysopogan	Poaceae	Grasses
Chrysopogon serrulatus	Chrysopogan	Poaceae	Grasses
Cymbopogon martinii	Musail	Poaceae	Grasses
Cynodon dactylon	Doob	Poaceae	Grasses
Dichanthium annulatum	Dichanthium	Poaceae	Grasses
Digitaria stricta	Digitaria	Poaceae	Grasses
Eragrostis amabilis	Erogrostis	Poaceae	Grasses
Eragrostis atrovirens	Erogrostis	Poaceae	Grasses
Eragrostis cilianensis	Erogrostis	Poaceae	Grasses
Eragrostis ciliaris	Erogrostis	Poaceae	Grasses
Heteropogon contortus	hetropogan	Poaceae	Grasses
Imperata cylindrica	Imperata	Poaceae	Grasses
Oplismenus compositus	Oplismenus	Poaceae	Grasses
Oropetium thomaeum	Oplismenus	Poaceae	Grasses
Oryza minuta	Jangali Dhan	Poaceae	Grasses
Panicum psilopodium	Panicum	Poaceae	Grasses
Panicum sumatrense	Panicum	Poaceae	Grasses
Paspalidium flavidum	Paspalum	Poaceae	Grasses
Paspalidium punctatum	Paspalum	Poaceae	Grasses
Pennisetum pedicellatum	Pennisetum	Poaceae	Grasses
Pennisetum polystachyon	Pennisetum	Poaceae	Grasses
Perotis indica	Perotis	Poaceae	Grasses
Saccharum spontaneum	Kans	Poaceae	Grasses

Scientific Name	Local Name	Family	Habit
Dendrocalamus strictus	Bans	Poaceae	Grasses
CLIMBERS			
Abrus precatorius	Kali Ghughchi	Fabaceae	Climber
Asparagus racemosus	Shatawar	Liliaceae	Climber
Butea superba	Palas Bel	Fabaceae	Climber
Cissus quadrangularis	Hadjood	Vitaceae	Climber
Coccinia grandis	Kunduru	Cucurbitaceae	Climber
Combretum roxburghii	Bilora, Medila	Combretaceae	Climber
Cryptolepis buchanani	Nagbel	Asclepiadaceae	Climber
Gymnema sylvestre	Gudmar	Asclepiadaceae	Climber
Tinospora cordifolia	Giloya	Menispermaceae	Climber
EPIPHYTES			
Cuscuta reflexa	Amarbel	Convolvulaceae	Epiphyte
Vanda tessellata	Vanda	Orchidaceae	Epiphyte

Primary On-site Data and Working Plan

Figure 3.39: Qualitative Analisis at Mohanban R.F.

3.10.4.1 Fauna in buffer area

A linear transect of 1.0 km each has been chosen for sampling at each site. Each transect was trekked for 1.5 hr for the sampling of faunal diversity through following methods for different categories. For the sampling of butterflies, the standard 'Pollard Walk' method was employed and all the species recorded.

For bird's sampling, 'Point Sampling' along the fixed transect (Foot trails) was carried out. All the species of birds were observed and identified with the help of field guide book and photographs.

For the sampling of mammals, direct count on open width (20m) transect were used. In addition, information on recent sightings/records of mammals by the villagers/locals

were also be collected. For carnivores, indirect sampling was carried out and the mammals were identified by foot marks, faeces and other marks/sign created by them. In case of reptiles mainly lizards were sampled by direct count on open width transects.

The study of fauna takes substantial amount of time to understand the specific faunal characteristic of area. The assessments of fauna were done by extensive field survey of the area.

Table 3.35: Faunal Diversity from Study Area

Sl. No.	Common Name	Scientific Name	Schedule of WPA, 1972	Conservation Status as per IUCN
Mammals				
1	Spotted Deer	*Axis axis*	III	LC #
2	Bandicoot Rat	*Bandicota bengalensis*	V	LC #
3	Nilgai	*Boselaphus tragocamelus*	III	LC #
4	Jackal	*Canis aureus*	II	LC #
5	Indian Wolf	*Canis lupus callipes*	I	LC #
6	Sambhar	*Cervus unicolor*	III	LC #
7	Dhole	*Cuon alpinus*	II	EN #
8	Short Nosed Fruit Bat	*Cynopterus sphinx*	V	LC #
9	Indian Elephant	*Elephas maximus*	I	EN #
11	Wild Cat	*Felis chaus*	II	LC #
12	Five striped Palm squirrel	*Funambulus pennanti*	IV	LC #
13	Chinkara	*Gazella bennettii*	I	LC #
14	Mongoose	*Herpestres edwardsii*	IV	LC #
15	Striped Hyena	*Hyaena hyaena*	III	NT #
16	Indian Porcupine	*Hystrix indica*	IV	LC #
17	Hare	*Lepas nigricollis*	IV	LC #
18	Otter / Odha	*Luthra luthra*	II	NT#
19	Rhesus Macaque	*Macaca mulatta*	II	LC #
20	Indian Pangolin	*Manis crassicaudata*	I	EN #
21	Honey Badger	*Mellivora capensis*	I	LC #
22	Sloth Bear	*Melursus ursinus*	I	Vu #
23	Barking Deer	*Muntiacus muntjak*	III	LC #
24	Indian Field Mouse	*Mus booduga*	V	LC #
25	Leopard	*Panthera pardus*	I	Vu #
27	Hedgehog	*Paraechinus micropus*	IV	LC #
28	Indian Pipistrelle	*Pipistrellus mimus*	IV	LC #
29	Flying Fox	*Pteropus giganteus*	V	LC #
30	Common house Rat	*Rattus rattus*	V	LC #
31	Hanuman Langur	*Semnopithecus entellus*	II	LC #
32	Musk Shrew	*Suncus murinus*	-	LC #
33	Wild Pig	*Sus scrofa*	III	LC #
34	Four-horned antelope	*Tetracerus quadricornis*	I	Vu #

35	Mouse Deer	*Tragulus meminna*	I	LC #
36	Indian Civet	*Viverricula indica*	II	LC#
37	Indian Fox	*Vulpes bengalensis*	II	LC #
		Birds		
1	Shikra	*Accipter badius*	IV	LC #
2	Jungle Mynah	*Acridotheres fuscus*	IV	LC #
3	Common Mynah	*Acridotheres tristis*	IV	LC #
4	Common Iora	*Aegithina tiphia*	IV	LC #
5	Common Kingfisher	*Alcedo atthis*	IV	LC #
6	Quaker Babbler	*Alcippe poioicephala*	IV	LC #
7	Rufous-tailed Finch-lark	*Ammomanes phoenicurus*	IV	LC #
8	Common Teal	*Anas crecca*	IV	LC #
9	Open Billed Stork	*Anastomus oscitans*	IV	LC #
10	Pied Hornbill	*Anthracoceres coronatus*	I	NT #
11	House swift	*Apus affinis*	IV	LC #
12	Tawny Eagle	*Aquila rapax*	I	VU #
13	Grey Heron	*Ardea cineara*	IV	LC #
14	Pond Heron	*Ardeola grayii*	IV	LC #
15	Ashy Swallow Shrike	*Artamus fuscus*	-	LC #
16	Eagle Owl	*Bubo bubo*	IV	LC #
17	Cattle Egret	*Bubulcus ibis*	IV	LC #
18	Common Indian Nightjar	*Caprimulgus asiaticus*	IV	LC #
19	Crow Pheasant	*Centropus sinensis*	IV	LC #
20	Crow Pheasant	*Centropus sinensis*	IV	LC #
21	Whiskered Tern	*Chlidonias hybrida*	-	LC #
22	Golden-fronted Leaf-bird	*Chloropsis aurifrons*	IV	LC #
23	Gold-mantled Leafbird	*Chloropsis chochinchinensis*	IV	LC #
24	White Necked Stork	*Ciconia episcopus*	IV	VU #
25	White stork	*Ciconia episcopus*	I	LC #
26	Pied Crested Cuckoo	*Clamator jacobiuns*	IV	LC #
27	Blue Rock Pegion	*Columba livia*	IV	LC #
28	White Rumped Shama	*Copsychus malabaricus*	IV	LC #
29	Magpie Robin	*Copsychus saularis*	IV	LC #
30	Magpie Robin	*Copsychus saularis*	IV	LC #
31	Indian Roller	*Coracias benghalensis*	IV	LC #
32	Large Cuckoo-shrike	*Coracina novaehollandiae*	-	LC #
33	Jungle Crow	*Corvus marorhynchos*	IV	LC #
34	Common Crow	*Corvus splendens*	V	LC #
35	Common Quail	*Coturnix coturnix*	IV	LC #
36	Brain-fever bird	*Cuculus varius*	IV	LC #
37	Indian Tree Pie	*Dendrocitta vagabunda*	IV	LC #
38	Lesser Whistling Teal	*Dendrocygna javanica*	IV	LC #
39	Tickell's Flower Pecker	*Dicaeum erythrarthynchos*	IV	LC #

40	Fire-breasted Flower Pecker	*Dicaeum ignipectus*	IV	LC #
41	Drongo	*Dicrurus adsimilis*	IV	LC #
42	White-bellied Drongo	*Dicrurus caerulescens*	IV	LC #
43	Greater Racket-tailed Drongo	*Dicrurus paradiseus*	IV	LC #
44	Lesser Golden Backed Woodpecker	*Dinopium benghalense*	IV	LC #
45	Little Egret	*Egretta garzetta*	IV	LC #
46	Black Winged Kite	*Elanus caeruleus*	IV	LC #
47	Ashy-crowned Finch-lark	*Eremopterix grisea*	IV	LC #
48	Red Munia	*Estrilda amandava*	IV	LC #
49	Koel	*Eudynamis scolopacea*	IV	LC #
50	Lesser Kestrel	*Falco naumanni*	IV	LC #
51	Common Kestrel	*Falco tinnunculus*	IV	LC #
52	Black Partridge	*Francolinus francolinus*	IV	LC #
53	Painted Partridge	*Francolinus pictus*	IV	LC #
54	Grey Partridge	*Francolinus pondicerianus*	IV	LC #
55	Fantail Snipe	*Gallinago gallinago*	IV	LC #
56	Moorhen	*Gallinula chloropus*	IV	LC #
57	Red Spurfowl	*Galloperdix spadicea*	IV	LC #
58	Red Jungle Fowl	*Gallus gallus*	IV	LC #
59	Jungle Owlet	*Glaucidium radiatum*	IV	LC #
60	White Rumped Vulture	*Gyps bengalensis*	I	CR #
61	White Breasted Kingfisher	*Halcyon smyrnensis*	IV	LC #
62	Heartspotted Woodpecker	*Hemicircus canente*	IV	LC #
63	Black-winged Stilt	*Himantopus himantopus*	IV	LC #
64	Indian Cliff Swallow	*Hirundo fluvicola*	-	LC #
65	Wire-tailed Swallow	*Hirundo smithii*	-	LC #
66	Pheasant Tailed Jacana	*Hydrophasianus chirurgus*	IV	LC #
67	Rufous Backed Shrike	*Lanius schach*	-	LC #
68	Black-headed Munia	*Lonchura malacca*	IV	LC #
69	Coppersmith Barbet	*Megalaima haemacephala*	IV	LC #
70	Crested Bunting	*Melophus lathami*	IV	LC #
71	Small Green Bee-eater	*Merops orientalis*	IV	LC #
72	Blue tailed Bee-eater	*Merops philippinus*	IV	LC #
73	Blue cheeked Bee-eater	*Merops superciliosus*	IV	LC #
74	Bronze Winged Jacana	*Metopidius indicus*	IV	LC #
75	Pariah Kite	*Milvus migrans*	IV	LC #
76	Blacknaped Flycatcher	*Monarcha azurea*	IV	LC #
77	Blue headed Rock Thrush	*Monticola cinclorhynchus*	IV	LC #
78	Pied Wagtail	*Motacilla alba*	-	LC #

79	Grey Wagtail	*Motacilla cinerea*	-	LC #
80	Yellow Wagtail	*Motacilla flava*	-	LC #
81	Large Pied Wagtail	*Motacilla maderaspatensis*	-	LC #
82	Tickell's Blue Flycatcher	*Muscicapa tickelliae*	IV	LC #
83	Purple Sunbird	*Nectarinia asiatica*	IV	LC #
84	White Scavenger Vulture	*Neophron percnopterus*	I	EN #
85	Golden Oriole	*Oriolus oriolus*	IV	LC #
86	Black Headed Oriole	*Oriolus xanthornus*	IV	LC #
87	Tailor Bird	*Orthotomus sutorius*	IV	LC #
88	Grey Tit	*Parus major*	IV	LC #
89	Yellow-cheeked Tit	*Parus xanthogenys*	IV	LC #
90	House Sparrow	*Passer domesticus*	IV	LC #
91	Pea-fowl	*Pavo cristatus*	I	LC #
92	Jungle Bush Quail	*Perdicula asiatica*	IV	LC #
93	Small Minivet	*Pericrocotus cinnamomeus*	IV	LC #
94	Scarlet Minivet	*Pericrocotus flammmeus*	IV	LC #
95	Small Indian Cormorant	*Phalacrocorax niger*	IV	LC #
96	Black Redstart	*Phoenicurus ochruros*	IV	LC #
97	Yellow-fronted Pied Woodpecker	*Picoides mahrattensis*	IV	LC #
98	Indian Pitta	*Pitta brachyura*	IV	LC #
99	Weaver Bird	*Ploceus philippinus*	IV	LC #
100	Eastern Golden Plover	*Pluvialia dominica*	IV	LC #
101	Slaty-headed Scimitar Babbler	*Pomatorhinus horsfieldi schisticeps*	IV	LC #
102	Purple Moorhen	*Porphyrio porphyrio*	IV	LC #
103	Ashy Wren-warbler	*Prinia socialis*	IV	LC #
104	Blossom headed Parakeet	*Psittacula cyanocephala*	IV	LC #
105	Large Indian Parakeet	*Psittacula eupatria*	IV	NT #
106	Rose Ringed Parakeet	*Psittacula krameri*	IV	LC #
107	Red Vent Bulbul	*Pycnonotus cafer*	IV	LC #
108	Red Whiskered Bulbul	*Pycnonotus jocosus*	IV	LC #
109	White-throated Fantail Flycatcher	*Rhipidura albicolis*	IV	LC #
110	White-browed Fantail Flycatcher	*Rhipidura aureola*	IV	LC #
111	Painted Snipe	*Rostratula benghalensis*	IV	LC #
112	Pied Bush-chat	*Saxicola caprata*	IV	LC #
113	Collared Bush-chat	*Saxicola torquata*	IV	LC #
114	Indian Robin	*Saxicoloides fulicata*	IV	LC #
115	Chestnut-bellied Nuthatch	*Sitta castanea*	-	LC #
116	Velvet-fronted Nuthatch	*Sitta frontalis*	-	LC #

117	Crested Serpent Eagle	*Spilornis cheela*	-	LC #
118	Crested Hawk Eagle	*Nisaetus cirrhatus*	I	LC #
119	Spotted Dove	*Streptopelia chinensis*	IV	LC #
120	Indian Ring Dove	*Streptopelia decaocto*	IV	LC #
121	Red Turtle Dove	*Streptopelia tranquebarica*	IV	LC #
122	Pied Mynah	*Sturnus contra*	IV	LC #
123	Grey-Headed Mynah	*Sturnus malabaricus*	IV	LC #
124	Black-headed Mynah	*Sturnus pagodarum*	IV	LC #
125	Rosy Pastor	*Sturnus roseus*	IV	LC #
126	Paradise Flycatcher	*Terpsiphone paradisi*	IV	LC #
127	Black Headed Ibis	Threskiornis *melanocephalus*	IV	NT#
128	Indian Grey Hornbill	*Tokus birostris*	-	LC #
129	King Vulture	*Sarcogyps calvus*	I	CR #
130	Yellow-footed Green Pigeon	*Treron phoenicoptera*	IV	LC #
131	Redshank	*Tringa totanus*	IV	LC #
132	Jungle Babbler	*Turdoides striatus*	IV	LC #
133	Hoopoe	*Upupa epops*	IV	LC #
134	Red Wattled Lapwing	*Vannelus indicus*	IV	LC #
135	Red Wattled Lapwing	*Vannelus indicus*	IV	LC #
Reptiles				
1	Garden Lizard	*Calotes versicolor*	-	-
3	Russel's Viper	*Daboia russelii*	IV	LC #
4	Geckos	*Hemidactylus sps.*	IV	-
5	Common Skink	*Mabuya carinata*	-	LC #
6	Indian Cobra	*Naja naja*	IV	LC #
7	Yellow Rat Snake	*Ptyas mucosa*	II	-
8	Indian Python	*Python morulus*	I	Vu #
9	Bengal Monitor Lizard	*Varanus bengalensis*	I	LC #
10	Russel's Viper	*Vipera russelii*	II	NA
11	Checkered Keelback	*Xenochrophis piscator*	IV	-
Fishes				
1.	Chelluah	*Aspidoparia morar*	NA	NA
2.	Barna Baril	*Barilius barna*	NA	NA
3.	Katla	*Catla catla*	NA	NA
4.	Chaguni	*Chagunius chagunio*	NA	NA
5.	Great Snakehead	*Channa maruliuss*	NA	NA
6.	Reba Carp	*Cirrhinus reba*	NA	NA
7.	Singi	*Clarias batrachus*	NA	NA
8.	Common Carp	*Cyprinus carpio*	NA	NA
9.	Calbasu	*Labeo calbasu*	NA	NA
10.	Kali, Boalla	*Labeo dyocheilus*	NA	NA
11.	Rohu	*Labeo rohita*	NA	NA
12.	Cat fish	*Mystus cavasius*	NA	NA
13.	Bronze Feather Back	*Notopterus notopterus*	NA	NA
14.	Swamp Barb	*Puntius chola*	NA	NA
15.	Hilsa	*Tenualosa ilisha*	NA	NA

Butterflies				
1.	Common Emigrant	*Catopsilia pomona*	NA	NA
2.	Common map	*Cyrestis thyodamas*	NA	NA
3.	Stripped Tiger	*Danaus genutia*	NA	NA
4.	Plain Tiger	*Danaus chrysippus*	NA	NA
5.	Stripped Tiger	*Danaus genutia*	NA	NA
6.	Common crow	*Euploea core*	NA	NA
7.	Common Grass Yellow	*Eurema hecabe*	NA	NA
8.	western blue sapphir	*Heliophorus sp.*	NA	NA
9.	Danaid Egg Fly	*Hypolimanas misippus*	NA	NA
10.	White orange tip	*Ixias marianne*	NA	NA
11.	Blue pancy	*Junonia orithya*	NA	NA
12.	Common evening Brown	*Melanitis leda*	NA	NA
13.	Common Bush Brown	*Mycalesis perseus*	NA	NA
14.	Lime butterfly	*Papilio demoleus*	NA	NA
	# LC – Least Concern; NT – Near Threatened; Vu – Vulnerable; EN – Endangered; CR – Critically Endangered			

Source: Primary On-site Data and Working Plan of District

3.10.4.2 Scheduled species from study area

As per list of The Indian Wildlife (Protection) Act, 1972, Fauna coming under the schedule - I is treated as endangered species. The schedule - I fauna as per reconnaissance survey are listed in Table Although these are very common species and found in every locality, even in villages, certain steps should be taken to conserve the critical wild life:

Programs for the conservation of wildlife will be formulated and implemented outside the protected areas by educating the local communities with help of local public agencies, and other stakeholders including the environment division officers of our company, in order to reduce the scope of man-animal conflict.

It will be ensured that human activities on the fringe of the protected areas do not degrade the habitat.

Over all, the status of wildlife in a region is an accurate index of the state of ecological resources, and thus, of the natural resources base of human well-being. This indicates the interdependent nature of ecological entities (the web of life), in which wild life is a vital link and a base of eco-tourism. Thus, the importance of conserving and protecting wildlife will be spread among the local people

Table 3.36: List of Scheduled species from study area

Sr. No.	Scientific name	Common Name	Schedule
Mammals			
1.	*Melursus ursinus*	Sloth bear	Schedule-I
2.	*Elephas maximus indicus*	Elephant	Schedule-I

3.	*Manis crassicaudata*	Pangolin	Schedule-I
4.	*Canis lupus callipes*	Indian Wolf	Schedule-I
5.	*Mellivora capensis*	Honey Badger	Schedule-I
6.	*Panthera pardus*	Leopard	Schedule-I
7.	*Tetracerus quadricornis*	Four-horned antelope	Schedule-I
8.	*Gazella bennettii*	Chinkara	Schedule-I
9.	*Tragulus meminna*	Mouse Deer	Schedule-I
Reptiles			
10.	*Varanus bengalensis*	Bengal Monitor Lizard	Schedule-I
11.	*Python molurus*	Python	Schedule-I
Birds			
12.	*Pavo cristatus*	Indian Peafowl	Schedule-I
13.	*Aquila rapax*	Tawny Eagle	Schedule-I
14.	*Gyps bengalensis*	White Rumped Vulture	Schedule-I
15.	*Nisaetus cirrhatus*	Crested Hawk Eagle	Schedule-I
16.	*Anthracoceres coronatus*	Pied Hornbill	Schedule-I
17.	*Ciconia episcopus*	White stork	Schedule-I
18.	*Neophron percnopterus*	White Scavenger Vulture	Schedule-I
19.	*Sarcogyps calvus*	King Vulture	Schedule-I

Source: Primary On-site Data and Working Plan

3.10.5 Aquatic Diversity

The biological species are the best indicators of environmental quality. This includes different species, such as, phytoplankton, zooplankton, benthos, fishes etc. Studies on biological aspects of certain ecosystems are an important part of any environmental impact assessment in view of the need for conservation of environmental quality and safety of aquatic life.

From the baseline survey on existing aquatic environmental conditions in and around the proposed Project on the Hurdul Nala and Jhana Nala within the mine lease area and Mahan Nala, Chhiraha Nala, Sulkhia Nala, Biniao Nala, Sukhra Nala, Nimji Nala, Hariya Nala Ramnpa & Gopad River and other drainages/ponds the following data's were generated:

- Biological characteristics of river water
- Inventorization of phytoplankton and Zooplankton
- Present status of riverine fish fauna: Identification of fish species
- Migratory pattern, feeding and breeding grounds of the fish fauna
- Assessment of local catches during the field trips to assess the fish fauna

The samples for qualitative and quantitative analysis of planktons were collected from the sub surface layer at knee depth. Water samples were filtered through plankton net

of 20µ mesh size (APHA, 1971). The filtered samples were concentrated by using the centrifuge. By using Lackey's drops method and light microscope (Lackey, 1938), the qualitative analysis was carried out for phytoplankton and zooplankton. The standard flora and other literature were followed for the qualitative evaluation of Plankton.

Table 3.37: Phytoplankton and Zooplanktons Recorded in the Study Area

Sr No.	Phytoplankton Species	Zooplankton Species
1.	Navicula sp. (Diatom)	Daphnia sp.
2.	Cyclotella sp. (Diatom)	Moina sp.
3.	Synedra sp. (Diatom)	Paramecium sp.
4.	Pinnularia sp. (Diatom)	Euglena sp.
5.	Oscillatoria sp.	Ranatra sp.
6.	Nostoc sp.	Larvae of culex sp.
7.	Anabaena sp. (Diatom)	Larvae of Dytiscus sp.
8.	Spirogyra sp.	Cyclops sp.
9.	Pediastrum.sp.	Diaptomus sp.
10.	Microspora sp.	

Source: Primary On-site Data

3.10.5.1 Fish

Fish occurrences were determined by collecting samples using different fishing gears like cast net, scoop net, hand net, hook-line, pot and open local devices methods. Also visual observations in different habitats were made. Fishes were identified up to the species level with the help of keys of Jayaram (1981), Menon (1987) and Talwar and Jhingran (1997). IUCN red data list (2006) was compared to assess threatened, endangered and vulnerable species in the study area.

Fishes are the integral component of stream and rivers which are not only the best sources of food and animal protein for the human population but provides a source of income for the local inhabitants. People capture fishes for their consumption and in some cases to sell in local markets as an alternative means for procurement of foods and other requirement of daily needs

Table 3.38: Common Fish Species Recorded in Buffer Zone

S. No.	Common name	Scientific name
1	Catla	*Catla catla*
2	Rohu	*Labeo rohita*
3	Maral	*Channa punctata*
4	Dokh	*Channa gachua*
5	Mangur	*Clarias batrachus*

6	Dandvan	*Garra mulllya*
7	Malya	*Oreochromis mosambicus*
8	Darai	*Puntius sarana*
9	Khavli	Puntius sophore
10	Dara	*Rasbora daniconius*
11	Chikli	*Indoreonectes evezardi*
12	Chikani	*Lepidocephalichthys thermalis*

Source: Primary On-site Data and Working Plan

3.10.5.2 Aquaticflora diversity

Wetlands are very useful to us. By producing resources, enabling recreational activities and controlling flood and pollution, they contribute to the national and local economies and environmental consequences. Wetlands provide important and incredible services to society, these services can neither be sold nor do they have the market value and tried to give wetlands an economic value.

Table 3.39: Common Fish Species Recorded in Buffer Zone

Family	Botanical Name	Local Name
Salviniaceae	*Azolla pinnata*	Mosquito Fern
Commelinaceae	*Commelina benghalensis*	Kana
Cyperaceae	*Cyperus alternifolius*	Umbrella Sedge
Poaceae	*Echinochloa colona*	Shama
Pontederiaceae	*Eichhornia crassipes*	Jal Kumbhi
Lemnaceae	*Lemna minor*	Duck Weed
Onagraceae	*Ludwigia adscendens*	Water Primrose
Marsileaceae	*Marsilea quadrifolia*	Four Leaf Clover
Oxalidaceae	*Oxalis corniculata*	Amrul
Ranunculaceae	*Ranunculus sceleratus*	Aglaon
Typhaceae	*Typha angustifolia*	Patera

Typhya angustifolia ***Eichhornia crassipes***

3.10.5.3 Movement of Mega Wildlife:

According to the book "Right of Passage", Elephant Corridors of India-2017 the elephant habitats in central India extend over 21,000 sq km in the states of Odisha, Jharkhand, Chhattisgarh and southern West Bengal, at times extending to Madhya Pradesh and Bihar, and hold a population of about 3128 elephants (MoEFCC, 2017). There have been recent reports of elephants straying into Madhya Pradesh's eastern districts of Singrauli and Anuppur from bordering northern Chhattisgarh, causing concern among the locals and forest officials. The deterioration in habitat quality has forced elephants to undertake long-range disoriented movements by using smaller forest patches to move to larger forest areas. This is one of the major causes for the migration of elephants into Chhattisgarh and at times extending to Madhya Pradesh.

Elephant is the flagship species of this area and the only mega herbivore (wildlife) with long ranging movement behaviour, present in the Singrauli Forest Division. Elephants have not been reported from the mining lease area as well as from the impact area. However, there are reports of the movement of elephants, far beyond the lease area in the district of Korba and Sarguja of Chhattisgarh State. Elephants follow streams and move in valleys and unless hard pressed try to avoid hilly terrain to conserve energy. This behaviour exposes them close to human habitation. The movement of elephants also reported in the eastern part of the Renukoot Dam. But the dam is a huge barrier for the elephants to reach anywhere near to the presently Dhirauli coal mine lease area. The movement of elephants in Singrauli Forest Division is shown in Figure:

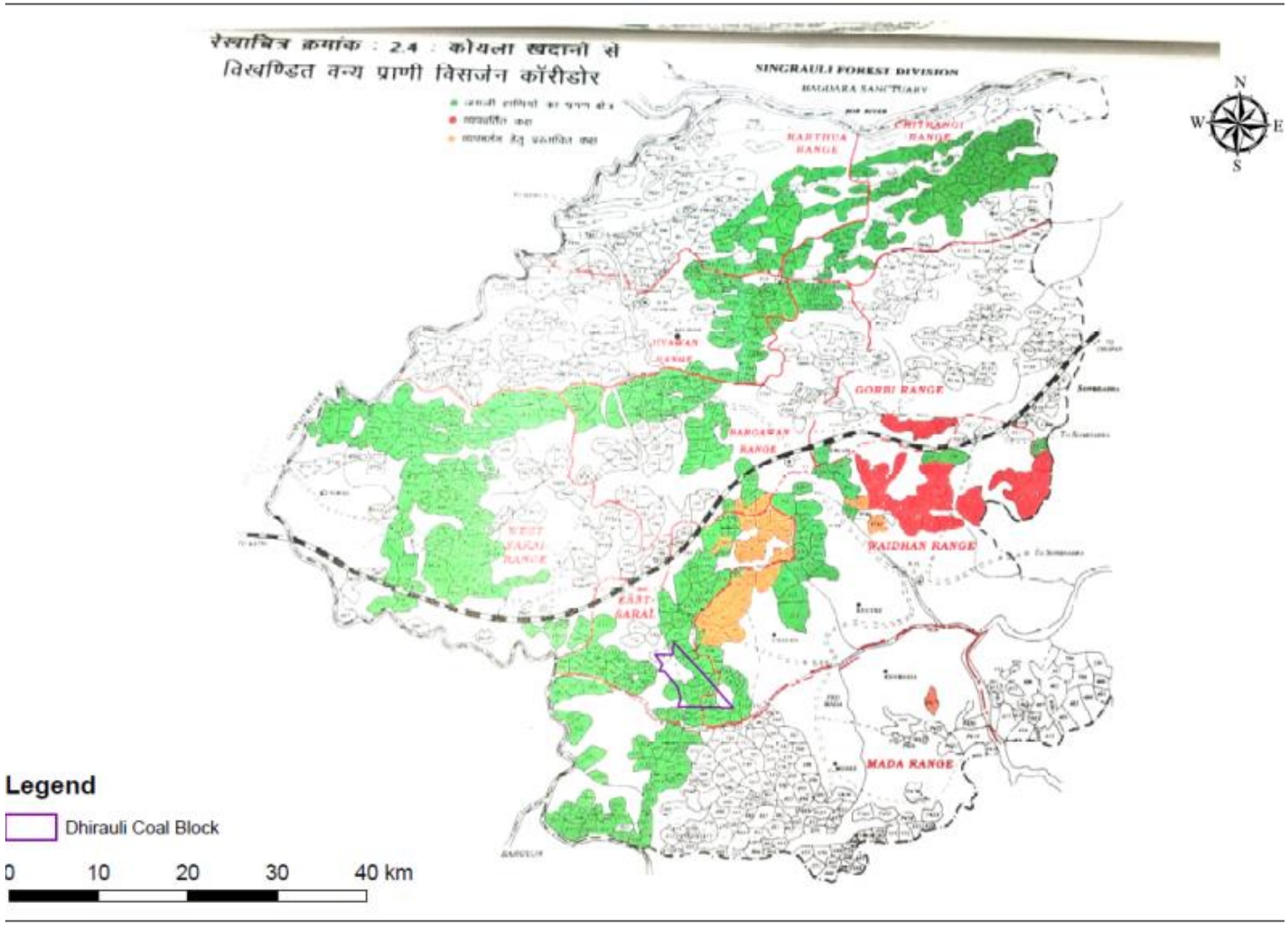


Figure 3.40: Wildlife Movement in Singrauli Coal Block

CHAPTER-4
Cumulative impact potential and Mitigation

4. Cumulative Impact potential & Mitigation

All components of the environment were considered and wherever possible impacts were evaluated in quantitative/qualitative terms. Several scientific methods are available to qualify and predict the impact of project on environmental attributes such as water, air, noise, land ecological socio-economic. Such predictions are superimposed, over baseline environmental status to derive post project scenario of the environmental conditions.

The resultant (post-project) quality of environmental parameters is reviewed with respect to the permissible limits. Based on the impacts thus predicted, preventive and mitigation measures were formulated and incorporated in the environmental management plan to minimize adverse impacts on environmental quality during and after the project execution:

4.1 Identification & Characterization of Impacts

The wastes and pollutants generated due to various activities of the project may cause impacts on different environmental attributes. The major project activities and the anticipated environmental impacts due to the proposed project are discussed below, under the following categories:

- **Impacts during construction**
- **Impacts during operation.**

4.1.1 Impact during Construction

Construction activity includes foundation works, fabrication and erection of Coal Handling Plant in the stuay area. The impact on the environment will be low as all the front for construction shall not be opened at a time. The major activities during construction phase are given below:

4.1.2 IMPACT MATRIX

Environmental impacts could be positive or negative, direct or indirect, local or regional and also reversible or irreversible. The primary function of an environment impact assessment study is to predict and quantify the magnitude of these impacts, evaluate and assess the importance of the identified changes, present information and monitor actual changes. The activities of the proposed project are studied. The impacts of various activities of the proposed project are identified and presented as matrix in Table 4.1. Further the characteristics of these impacts have been evaluated and they are presented as matrix in Table- 4.2 & 4.3.

Table 4.1: Impact Identification Matrix

Aspects Impacted Attributes	Construction phase				Mining, Storage and handling and allied activity (Operation phase)							Post Operation		
	Storage of Raw materials	Ready-mix concrete preparation	Transportation of raw materials	Construction activities	Site Clearance	Operation Open Cast-	Back Filling of Mine	Transportation Mineral	Coal Handling Plant	Generation of waste water	Development Greenbelt	Development of Green belt	(Buffer) Urbanization	Industrialization
Ambient Air	•	•	•	•	•	•	*	•	•	-	*	*	*	*
Water Resource	•	•	-	•	-	•	-	-	-	•	-	*	-	-
Water Quality	•	•	-	•	-	•	-	-	*	-	-	-	-	-
Ambient Noise	-	•	•	•	-	•	•	•	•	-	-	*	-	-
Flora and Fauna	-	-	•	•	•	•	*	-	-	-	*	*	-	-
Soil and Land-use	•	•	•	•	•	•	*	-	*	-	*	*	-	-
Infrastructure	-	-	-	-	•	•	-	-	-	-	-	-	-	-
Traffic	-	-	•	-	-	-	-	*	•	-	-	-	-	•
Health & Safety	•	•	•	•	-	•	-	-	*	-	*	*	-	*
Socio-economic	-	-	-	*	*	*	-	-	-	-	*	*	*	*

*Adverse Impact * Beneficial Impacts.*

Table 4.2: Environmental Impacts during Construction Phase

Activity	Environmental attributes	Cause	Impact characteristics			
			Nature	Duration	Reversibility	Significance, Mitigative measures
Construction of CHP and other infrastructure	Air Pollution (Dust)	Excavation of the area, cutting, CHP, etc.	Direct Negative	Short Term	Reversible	Significant Water sprinkling at specific locations and Personnel Protective Equipment (PPE) shall be used. Greenbelt will be developed for mitigating the air pollution.
	Noise Pollution	Movement of HEMM	Direct Negative	Short Term	Reversible	Significant Acoustic enclosures will be provided in all HEMM and proper maintenance of machineries.
	Land use	Change in land use due to excavation.	Direct Negative	Long Term	Reversible	Significant Reclamation of the area will be done by plantation on the land at the end of mine.
	Water Pollution	Potential for seepage from the waste storage area.	Direct Negative	Short Term	Reversible	Significant Proper care of the storage area shall be taken. Temporary check dam along temporary storage area shall be made, if required.
Site clearing	Air Pollution (Dust)	Conversion of forest land to mining area	Direct Negative	Long Term	Reversible	Significant- There will be afforestation in safety zone, greenbelt along infrastructure as well as gap plantation within Mine lease area.

Activity	Environmental attributes	Cause	Impact characteristics			
			Nature	Duration	Reversibility	Significance, Mitigative measures
	Noise Pollution	Noise generation from earth moving equipment	Direct Negative	Short Term	Reversible	Insignificant. Acoustic enclosures will be provided in all HEMM and proper maintenance of machineries. Personnel Protective Equipment (PPE) shall be used.
	Land use	Change of Land use	Direct Negative	Long Term	Irreversible	Significant After mining the excavated area will be reclaimed and afforested.
	Ecology	Removal of vegetation and loss of flora & fauna	Direct Negative	Long Term	Reversible	Significant After mining the excavated area will be reclaimed and afforested and conservation of flora and fauna will be a part of Biodiversity management plan.
Transportation of scrap/spares/ waste material/ construction material	Air Pollution (Dust & Gases)	Transportation of scrap / waste material by trucks	Direct Negative	Short Term	Reversible	Insignificant Regular emission checks shall be performed. Raw materials will be transported, covered with tarpaulin.
	Noise Pollution	Noise generated from loading / unloading and movement of vehicles	Direct Negative	Short Term	Reversible	Insignificant, Regular vehicle maintenance shall be done. PPE shall be provided.

Activity	Environmental attributes	Cause	Impact characteristics			
			Nature	Duration	Reversibility	Significance, Mitigative measures
Construction activities	Air Pollution (Dust & Gases)	Operation of construction machinery, welding & others	Direct Negative	Short Term	Reversible	Significant. Water sprinkling will be done to suppress the air pollutants PPE shall be provided to workers.
	Noise Pollution	Generation from construction activities	Direct Negative	Short Term	Reversible	Significant. Regular maintenance will be carried out for the machineries used PPE shall be provided to workers
	Land use	Storage of spares/ materials	Direct Negative	Short Term	Reversible	Significant. Storage of materials is temporary and during construction period only
	Ecology	Loss of vegetation	Direct Negative	Short Term	Reversible	Insignificant, No cutting of trees. Green belt development is envisaged.
Disposal of scrap / waste material	Air Pollution (Dust & Gases)	Due to movement of Vehicles and loading / unloading of material	Direct Negative	Short Term	Reversible	Significant. PUC certified vehicles will be utilized and material will be covered by Tarpaulin sheets.
	Noise Pollution	Due to movement of Vehicles and loading / unloading of material	Direct Negative	Short Term	Reversible	Insignificant. Regular vehicle maintenance and pollution check shall be done.

Activity	Environmental attributes	Cause	Impact characteristics			
			Nature	Duration	Reversibility	Significance, Mitigative measures
Development of Road	Air Pollution (Dust & Gases)	Due to development of road Cutting of trees to construct the widening of road	Direct Negative	Short Term	Reversible	Significant- Trees will be planted along the road and water sprinkling will be done during construction phase.
	Noise Pollution	Due to movement of HEMM	Direct Negative	Short Term	Reversible	Insignificant. Regular vehicle maintenance and pollution check shall be done.
	Solid waste	Due to widening road	Direct Negative	Short Term	Reversible	Significant- The solid waste generated from widening of road will be handled as per the waste management rule
	Ecology	Tree cutting and loss of flora fauna	Direct Negative	Long Term	Reversible	Significant Plantation will be done along both sides of road.
	Land Use	Due to widening of road	Direct Negative	Long Term	Irreversible	Significant- construction of road would be designed to minimize the cutting and filling of earth. Land clearing at sit will be kept to the absolute minimum practicable. Construction debris will be managed properly.

Possible cumulative impact approach and appropriate scenarios

	Cumulative impact of a single project on an existing baseline	impact of a single project on an existing baseline	Cumulative impact of multiple projects on a single environmental value	Cumulative impact of multiple/ all projects on multiple environmental
Existing mining region with an established baseline and low risk of cumulative effects	●	●		
Existing mining region with reasonably well understood baseline		●		
Poor baseline, low number of environmental values sensitive to		●	●	●
Poor baseline with multiple environmental values				●
Greenfield mining precinct with known or likely number of new projects over time				●

CHAPTER 5
OUTCOME OF CUMULATIVE IMPACT ASSESSMENT

5. OUTCOME OF CUMULATIVE IMPACT ASSESMENT

The baseline environmental study helps to identify the critical environmental attributes, which are required to be monitored to get the environment pollution load. The study has been carried out to calculate the impact on environment due to the cumulative mine and the outcome of the study has interpreted by comparing the baseline with proposed and existing mine activity to define the sustainability of the project. Outcome of the study mainly considered:

- Baseline condition
- Pollution load or sustainability of project

5.1 Air Environment

5.1.1 Baseline Condition (March to May 2021)

The baseline condition of ambient air quality of the region in general is in conformity with respect to the National Ambient Air Quality Standards of CPCB, with present level of activities. Ambient Air Quality Monitoring reveals that the minimum and maximum concentrations of PM_{10} and $PM_{2.5}$ for all the 10 AAQM stations were found between 26.50 to 61.30 µg/m^3 and 15.80 to 40.20 µg/m^3 respectively.

The maximum value for PM_{10} is observed at Churwani (A6) station, as 61.30 µg/m^3 the reason of maximum result on this location due to the operation of mine near the monitoring station, However the minimum value observed at Bansi (A8) station as 26.50 µg/m^3 during the study period as the monitoring location near to the protected forest and no major activity found near to this monitoring location.

The maximum value for $PM_{2.5}$ was also observed at Churwani (A6) station as 40.2 µg/m^3, this is also due to the operational mining site near to the monitoring location however the minimum value observed at Bansi (A8) station as 15.8 µg/m^3 during the study period as the monitoring location near to the protected forest and no major activity found near to this monitoring location.

SO_2: The maximum value for SO_2 is observed to be 25.1 µg/m^3 at Khairahi (A5) as the monitoring location located near to the thermal power plant, however minimum value observed at Bijauri (A10) station as 12.5 µg/m^3 during the study period.

NOx: The maximum value for NOx is observed at Khairahi (A5) station, as 34.2 µg/m^3 with the minimum value observed at Bijauri (A10) station as 16.4 µg/m^3 during the study period.

CO: The maximum value for CO is observed at Khairahi (A5), as 487 mg/m^3 with the minimum value observed at Bansi (A8) station as 305 mg/m^3 during the study period.

O3: The maximum value for O3 is observed at Khairahi (A5) station, as 9.6 μg/m^3 with the minimum value observed at Bansi (A8) station as 3.7 μg/m^3 during the study period.

5.1.2 Baseline Condition (October to December 2021)

The baseline condition of ambient air quality of the region in general is in conformity with respect to the National Ambient Air Quality Standards of CPCB, with present level of activities. Ambient Air Quality Monitoring reveals that the minimum and maximum concentrations of PM_{10} and $PM_{2.5}$ for all the 10 AAQM stations were found between 30.80 to 63.80 μg/m^3 and 24.60 to 50.40 μg/m^3 respectively.

The maximum value for PM_{10} is observed at Khairahi (A5) station, as 63.80 μg/m^3 the reason of maximum result on this location due to the operation of mine near the monitoring station, However the minimum value observed at Bijauri (A10) station as 30.80 μg/m^3 during the study period as the monitoring location near to the protected forest and no major activity found near to this monitoring location.

The maximum value for $PM_{2.5}$ was also observed at Khairahi (A5) station as 50.40 μg/m^3, this is also due to the operational mining site near to the monitoring location however the minimum value observed at Bijauri (A10) station as 24.60 μg/m^3 during the study period as the monitoring location near to the protected forest and no major activity found near to this monitoring location.

SO_2: The maximum value for SO_2 is observed to be 35.10 μg/m^3 at Churwani (A6) as the monitoring location located near to the thermal power plant, however minimum value observed at Mine Area (Dhirauli North) (A3) station as 17.40 μg/m^3 during the study period.

NOx: The maximum value for NOx is observed at Churwani (A6) station, as 26.30 μg/m^3 with the minimum value observed at Bijauri (A10) station as 12.30 μg/m^3 during the study period.

CO: The maximum value for CO is observed at Khairahi (A5), as 0.59 mg/m^3 with the minimum value observed at Mine Area (Dhirauli North) (A1) station as 0.33 mg/m^3 during the study period.

O3: The maximum value for O3 is observed at Berdaha (A7) station, as 18.80 μg/m3 with the minimum value observed at Tal near Sanjay National park (A11) station as 5.40 μg/m3 during the study period

As per the analytical reports of the project site and the surrounding areas, the ambient air quality is well below the NAAQS limits. From the above interpretation of Air Quality Index for study area responsible parameter for pollution is PM_{10}, $PM_{2.5}$, SO_X, NO_X and CO. The AQI of study area falls under good to satisfactory categorization as per the data obtained during baseline studies. The health impact due to this AQI is very less and it may only cause discomfort to sensitive people.

Table 5.1: AQI Values (Baseline Condition) (March to May 2021 & October to December 2021)

	March to May 2021						October to Dec 2021				
Site	**Conc.**	**Sub-Index**	**Category**	**Color**	**Health Impact**		**Conc.**	**Sub-Index**	**Category**	**Color**	**Health Impact**
Name of the pollutant: PM_{10} (µg/m³)											
A1	49.50	50	Good	Green	Minimal Impact	A1	51.60	52	Satisfactory	Light green	May cause discomfort to sensitive people
A2	52.30	52	Satisfactory	Light green	May cause discomfort to sensitive people	A2	54.30	54	Satisfactory	Light green	May cause discomfort to sensitive people
A3	49.30	49	Good	Green	Minimal Impact	A3	51.30	51	Satisfactory	Light green	May cause discomfort to sensitive people
A4	48.90	49	Good	Green	Minimal Impact	A4	50.30	50	Satisfactory	Light green	May cause discomfort to sensitive people
A5	58.60	59	Satisfactory	Light green	May cause discomfort to sensitive people	A5	63.80	64	Satisfactory	Light green	May cause discomfort to sensitive people
A6	61.30	61	Satisfactory	Light green	May cause discomfort to sensitive people	A6	61.70	62	Satisfactory	Light green	May cause discomfort to sensitive people
A7	51.30	51	Satisfactory	Light green	May cause discomfort to sensitive people	A7	53.40	53	Satisfactory	Light green	May cause discomfort to sensitive people
A8	44.60	45	Good	Green	Minimal Impact	A8	46.80	47	Good	Green	Minimal Impact
A9	51.80	52	Satisfactory	Light green	May cause discomfort to sensitive people	A9	53.80	54	Satisfactory	Light green	May cause discomfort to sensitive people
A10	48.90	49	Good	Green	Minimal Impact	A10	50.90	51	Satisfactory	Light green	May cause discomfort to sensitive people
						A11	52.20	52	Satisfactory	Light green	May cause discomfort to sensitive people
Name of the pollutant: $PM_{2.5}$ (µg/m³)											
A1	29.2	49	Good	Green	Minimal Impact	A1	39.40	66	Satisfactory	Light green	May cause discomfort to sensitive people
A2	30.3	51	Satisfactory	Light green	May cause discomfort to sensitive people	A2	40.20	67	Satisfactory	Light green	May cause discomfort to sensitive people

	March to May 2021						October to Dec 2021				
Site	Conc.	Sub-Index	Category	Color	Health Impact		Conc.	Sub-Index	Category	Color	Health Impact
A3	27.9	47	Good	Green	Minimal Impact	A3	37.90	63	Satisfactory	Light green	May cause discomfort to sensitive people
A4	26.7	45	Good	Green	Minimal Impact	A4	37.10	62	Satisfactory	Light green	May cause discomfort to sensitive people
A5	33.6	56	Satisfactory	Light green	May cause discomfort to sensitive people	A5	50.40	84	Satisfactory	Light green	May cause discomfort to sensitive people
A6	40.2	67	Satisfactory	Light green	May cause discomfort to sensitive people	A6	43.70	73	Satisfactory	Light green	May cause discomfort to sensitive people
A7	39.2	65	Satisfactory	Light green	May cause discomfort to sensitive people	A7	49.20	82	Satisfactory	Light green	May cause discomfort to sensitive people
A8	28.2	47	Good	Green	Minimal Impact	A8	38.30	64	Satisfactory	Light green	May cause discomfort to sensitive people
A9	32.5	54	Satisfactory	Light green	May cause discomfort to sensitive people	A9	42.50	71	Satisfactory	Light green	May cause discomfort to sensitive people
A10	27.8	46	Good	Green	Minimal Impact	A10	37.70	63	Satisfactory	Light green	May cause discomfort to sensitive people
						A11	37.50	63	Satisfactory	Light green	May cause discomfort to sensitive people
Name of the pollutant: SO_2 (µg/m³)											
A1	16.3	20	Good	Green	Minimal Impact	A1	24.70	31	Good	Green	Minimal Impact
A2	17.1	21	Good	Green	Minimal Impact	A2	24.80	31	Good	Green	Minimal Impact
A3	15.9	20	Good	Green	Minimal Impact	A3	26.50	33	Good	Green	Minimal Impact
A4	21.6	27	Good	Green	Minimal Impact	A4	26.60	33	Good	Green	Minimal Impact
A5	25.1	31	Good	Green	Minimal Impact	A5	33.30	42	Good	Green	Minimal Impact
A6	23.8	30	Good	Green	Minimal Impact	A6	35.10	44	Good	Green	Minimal Impact
A7	22.8	28	Good	Green	Minimal Impact	A7	31.80	40	Good	Green	Minimal Impact
A8	20.7	26	Good	Green	Minimal Impact	A8	30.20	38	Good	Green	Minimal Impact
A9	23.4	29	Good	Green	Minimal Impact	A9	32.80	41	Good	Green	Minimal Impact

	March to May 2021						October to Dec 2021				
Site	Conc.	Sub-Index	Category	Color	Health Impact		Conc.	Sub-Index	Category	Color	Health Impact
A10	15.9	20	Good	Green	Minimal Impact	A10	25.70	32	Good	Green	Minimal Impact
						A11	29.20	37	Good	Green	Minimal Impact
Name of the pollutant: NO_2 (µg/m³)											
A1	23.6	30	Good	Green	Minimal Impact	A1	17.30	22	Good	Green	Minimal Impact
A2	23.9	30	Good	Green	Minimal Impact	A2	17.90	22	Good	Green	Minimal Impact
A3	25.4	32	Good	Green	Minimal Impact	A3	16.80	21	Good	Green	Minimal Impact
A4	25.5	32	Good	Green	Minimal Impact	A4	22.60	28	Good	Green	Minimal Impact
A5	34.2	43	Good	Green	Minimal Impact	A5	20.30	25	Good	Green	Minimal Impact
A6	32.2	40	Good	Green	Minimal Impact	A6	26.30	33	Good	Green	Minimal Impact
A7	30.9	39	Good	Green	Minimal Impact	A7	23.80	30	Good	Green	Minimal Impact
A8	29.1	36	Good	Green	Minimal Impact	A8	21.10	26	Good	Green	Minimal Impact
A9	31.5	39	Good	Green	Minimal Impact	A9	24.60	31	Good	Green	Minimal Impact
A10	24.9	31	Good	Green	Minimal Impact	A10	18.00	23	Good	Green	Minimal Impact
						A11	20.40	26	Good	Green	Minimal Impact
Name of the pollutant: CO (mg/m³)											
A1	418	21	Good	Green	Minimal Impact	A1	0.51	26	Good	Green	Minimal Impact
A2	419	21	Good	Green	Minimal Impact	A2	0.52	26	Good	Green	Minimal Impact
A3	439	22	Good	Green	Minimal Impact	A3	0.54	27	Good	Green	Minimal Impact
A4	378	19	Good	Green	Minimal Impact	A4	0.48	24	Good	Green	Minimal Impact
A5	487	24	Good	Green	Minimal Impact	A5	0.57	29	Good	Green	Minimal Impact
A6	472	24	Good	Green	Minimal Impact	A6	0.59	30	Good	Green	Minimal Impact
A7	415	21	Good	Green	Minimal Impact	A7	0.52	26	Good	Green	Minimal Impact
A8	335	17	Good	Green	Minimal Impact	A8	0.44	22	Good	Green	Minimal Impact
A9	437	22	Good	Green	Minimal Impact	A9	0.53	27	Good	Green	Minimal Impact
A10	418	21	Good	Green	Minimal Impact	A10	0.47	24	Good	Green	Minimal Impact
						A11	0.45	23	Good	Green	Minimal Impact

	March to May 2021						October to Dec 2021				
Site	Conc.	Sub-Index	Category	Color	Health Impact		Conc.	Sub-Index	Category	Color	Health Impact
Name of the pollutant: O3 (µg /m³)											
A1	8.3	8	Good	Green	Minimal Impact	A1	10.40	10	Good	Green	Minimal Impact
A2	8.9	9	Good	Green	Minimal Impact	A2	10.80	11	Good	Green	Minimal Impact
A3	7.9	8	Good	Green	Minimal Impact	A3	9.80	10	Good	Green	Minimal Impact
A4	8.6	9	Good	Green	Minimal Impact	A4	10.60	11	Good	Green	Minimal Impact
A5	9.6	10	Good	Green	Minimal Impact	A5	11.60	12	Good	Green	Minimal Impact
A6	9.8	10	Good	Green	Minimal Impact	A6	11.80	12	Good	Green	Minimal Impact
A7	9.4	9	Good	Green	Minimal Impact	A7	18.80	19	Good	Green	Minimal Impact
A8	7.9	8	Good	Green	Minimal Impact	A8	9.90	10	Good	Green	Minimal Impact
A9	8.9	9	Good	Green	Minimal Impact	A9	10.90	11	Good	Green	Minimal Impact
A10	8.2	8	Good	Green	Minimal Impact	A10	10.20	10	Good	Green	Minimal Impact
						A11	9.10	9	Good	Green	Minimal Impact

Source: Primary On-site Data and Analysis

5.1.3 Sustainability of Mine

The emissions from the mining operations can be estimated either by sampling or direct measurement or using emission factors. An emission factor is a representative value that attempts to relate the quantity of pollutant released in the atmosphere with an activity associated with the release of that pollutant. The ground level concentrations are computed for high 1st high 24-hr concentration values for all the baseline air quality monitoring stations by selecting them as discrete Cartesian receptors in the modeling area so that 16 receptors points taken for computation 24 -HR. Average concentrations of particulate matter and the predicted increment of PM_{10} and $PM_{2.5}$ concentration at receptors for peak production capacities of the project are furnished in the Table Below:

Table 5.2: Predicted Increment of PM_{10} and $PM_{2.5}$ Concentration (March to May 2021)

Location Code	AAQM Location Name	Max Baseline Conc. (µg/m3)					Predicted GLC AERMOD					Cumulative GLC				
		PM10 (µg/m3)	PM2.5 (µg/m3)	SO2 (µg/m3)	NO2(µg/m3)	CO (mg/m3)	PM10 (µg/m3)	PM2.5 (µg/m3)	SO2 (µg/m3)	NO2(µg/m3)	CO (mg/m3)	PM10 (µg/m3)	PM2.5 (µg/m3)	SO2 (µg/m3)	NO2(µg/m3)	CO (mg/m3)
A1	Mine Site (Dhirauli South)	49.5	29.2	16.3	23.6	0.418	63.3979	38.03879	0.05718	0.00953	0.0000076	112.8979	67.23879	16.35718	23.60953	0.41800760
A2	Mine Site (Dhirauli North)	52.3	30.3	17.1	23.9	0.419	50.7567	30.45405	0.0182	0.00303	0.0000024	103.0567	60.75405	17.1182	23.90303	0.41900240
A3	Bhaiyatola	49.3	27.9	15.9	25.4	0.439	4.87011	2.92206	0.00379	0.00063	0.0000005	54.17011	30.82206	15.90379	25.40063	0.43900050
A4	Budheri	48.9	26.7	21.6	25.5	0.378	4.83641	2.9018	0.00459	0.00077	0.0000006	53.73641	29.6018	21.60459	25.50077	0.37800060
A5	Khairahi	58.6	33.6	25.1	34.2	0.487	4.08843	2.45306	0.00317	0.00053	0.00000042	62.68843	36.05306	25.10317	34.20053	0.48700042
A6	Churwani	61.3	40.2	23.8	32.2	0.472	7.92812	4.75687	0.00193	0.00032	0.0000002	69.22812	44.95687	23.80193	32.20032	0.47200020
A7	Berdaha	51.3	39.2	22.8	30.9	0.415	29.9382	17.96297	0.0119	0.002	0.0000016	81.2382	57.16297	22.8119	30.902	0.41500160
A8	Bansi	44.6	28.2	20.7	29.1	0.335	9.1029	5.46179	0.00566	0.00094	0.0000007	53.7029	33.66179	20.70566	29.10094	0.33500070
A9	Majholipath	51.8	32.5	23.4	31.5	0.437	13.9159	8.34955	0.00341	0.00057	0.00000045	65.7159	40.84955	23.40341	31.50057	0.43700045
A10	Bijauri	48.9	27.8	15.9	24.9	0.418	7.60681	4.564	0.00259	0.00043	0.0000003	56.50681	32.364	15.90259	24.90043	0.41800030

Source: Primary On-site Data and Analysis

Table 5.3: Predicted Increment of PM_{10} and $PM_{2.5}$ Concentration (October to December 2021)

Location Code	AAQM Location Name	Max Baseline Conc. (µg/m3)					Predicted GLC AERMOD					Cumulative GLC				
		PM10 (µg/m3)	PM2.5 (µg/m3)	SO2 (µg/m3)	NO2(µg/m3)	CO (mg/m3)	PM10 (µg/m3)	PM2.5 (µg/m3)	SO2 (µg/m3)	NO2(µg/m3)	CO (mg/m3)	PM10 (µg/m3)	PM2.5 (µg/m3)	SO2 (µg/m3)	NO2(µg/m3)	CO (mg/m3)
A1	Mine Site (Dhirauli South)	51.6	39.4	24.7	17.3	0.51	55.12933	32.66923	0.01291	0.00215	0.0000017	106.7293	72.06923	24.71291	17.30215	0.51000170
A2	Mine Site (Dhirauli North)	54.3	40.2	24.8	17.9	0.52	37.03876	21.9488+	0.00706	0.00118	0.00000094	91.33876	62.1488	24.80706	17.90118	0.52000094
A3	Bhaiyatola	51.3	37.9	26.5	16.8	0.54	17.32793	10.2684	0.0112	0.00187	0.00000149	68.62793	48.1684	26.5112	16.80187	0.54000149
A4	Budheri	50.3	37.1	26.6	22.6	0.48	13.91629	8.24669	0.00475	0.00079	0.00000063	64.21629	45.34669	26.60475	22.60079	0.48000063
A5	Khairahi	63.8	50.4	33.3	20.3	0.57	12.42902	7.3653	0.00686	0.00114	0.00000093	76.22902	57.7653	33.30686	20.30114	0.57000093
A6	Churwani	61.7	43.7	35.1	26.3	0.59	13.38395	7.93123	0.00437	0.00073	0.0000058	75.08395	51.63123	35.10437	26.30073	0.59000580
A7	Berdaha	53.4	49.2	31.8	23.8	0.52	29.13751	17.2667	0.01396	0.00233	0.0000018	82.53751	66.4667	31.81396	23.80233	0.52000180
A8	Bansi	46.8	38.3	30.2	21.1	0.44	18.97575	11.24489	0.01272	0.00212	0.0000017	65.77575	49.54489	30.21272	21.10212	0.44000170
A9	Majholipath	53.8	42.5	32.8	24.6	0.53	25.45246	15.08294	0.04591	0.00765	0.0000061	79.25246	57.58294	32.84591	24.60765	0.53000610
A10	Bijauri	50.9	37.7	25.7	18	0.47	22.1821	13.145	0.01411	0.00235	0.0000018	73.0821	50.845	25.71411	18.00235	0.47000180
A11	Tal Near Sanjay Ntaional park	52.2	37.5	29.2	20.4	0.45	9.188	5.4447	0.00441	0.00074	0.000005	61.388	42.9447	29.20441	20.40074	0.45000500

Source: Primary On-site Data and Analysis

The mining operation will, generate high levels of particulate matter (PM) and to very limited extent of SO_2, NO_x, and CO due to blasting for Coal mining and OB removal (using explosives), fuel oil combustion, etc. All vehicles and their exhausts will be well maintained and regularly tested for pollutants concentration.

(March to May 2021)

PM_{10}: Max Incremental GLC will be 63.397 µg/m^3 and maximum cumulative GLC will be 112.897 µg/m^3 at Mine Site (Dhirauli South) A1 location, this is due to the major mining activity in this area.

$PM_{2.5}$: Max Incremental GLC will be 38.038 µg/m^3 and maximum cumulative GLC will be 67.238 µg/m^3 at Mine Site (Dhirauli South) A1 location, this is also due to the major mining activity in the nearby area.

Sox : Max Incremental GLC will be 0.05718 µg/m^3 and maximum cumulative GLC will be 25.10317µg/m^3 at (Khairahi) A5 location, this is due to the Industrial area.

Nox: Max Incremental GLC will be 0.00953 µg/m^3 and maximum cumulative GLC will be 34.20053 µg/m^3 at (Khairahi) A5 location, this is due to the Industrial area.

CO: Max Incremental GLC will be 0.0000076 µg/m^3 and maximum cumulative GLC will be 0.48700042 µg/m^3 at (Khairahi) A5 location.

(October to Dec 2021)

PM_{10}: Max Incremental GLC will be 55.12933 µg/m^3 and maximum cumulative GLC will be 106.7293µg/m^3 at Mine Site (Dhirauli South) A1 location, this is due to the major mining activity in this area.

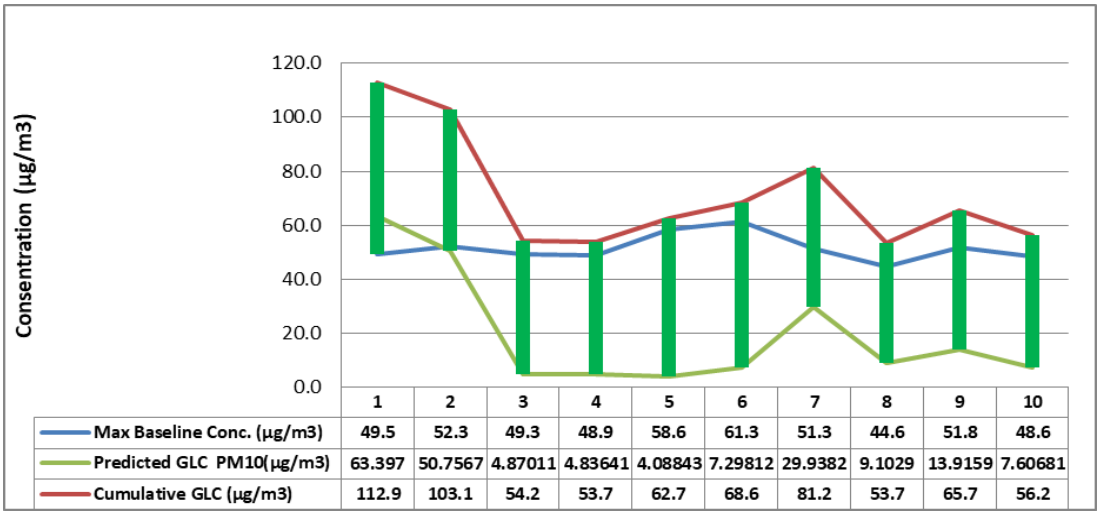
$PM_{2.5}$: Max Incremental GLC will be 38.038 µg/m^3 and maximum cumulative GLC will be 72.06923 µg/m^3 at Mine Site (Dhirauli South) A1 location, this is also due to the major mining activity in the nearby area.

Sox : Max Incremental GLC will be 0.0459 µg/m^3 and maximum cumulative GLC will be 35.10 µg/m^3 at (Churwani) A6 location, this is due to the Industrial area.

Nox: Max Incremental GLC will be 0.00765 µg/m^3 and maximum cumulative GLC will be 26.30073µg/m^3 at (Churwani) A6 location, this is due to the Industrial area.

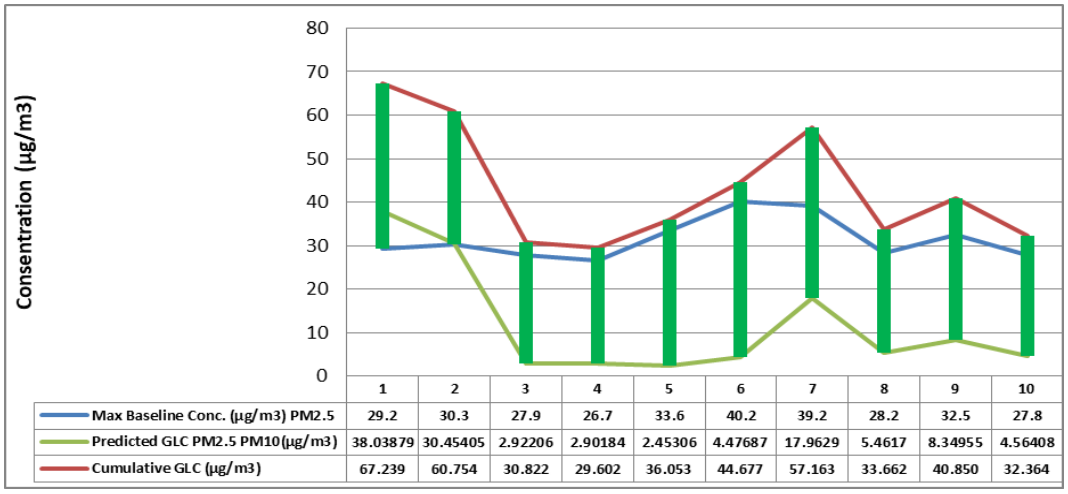
CO: Max Incremental GLC will be 0.00000149 µg/m^3 and maximum cumulative GLC will be 0.59000580 µg/m^3 at (Churwani) A6 location.

.



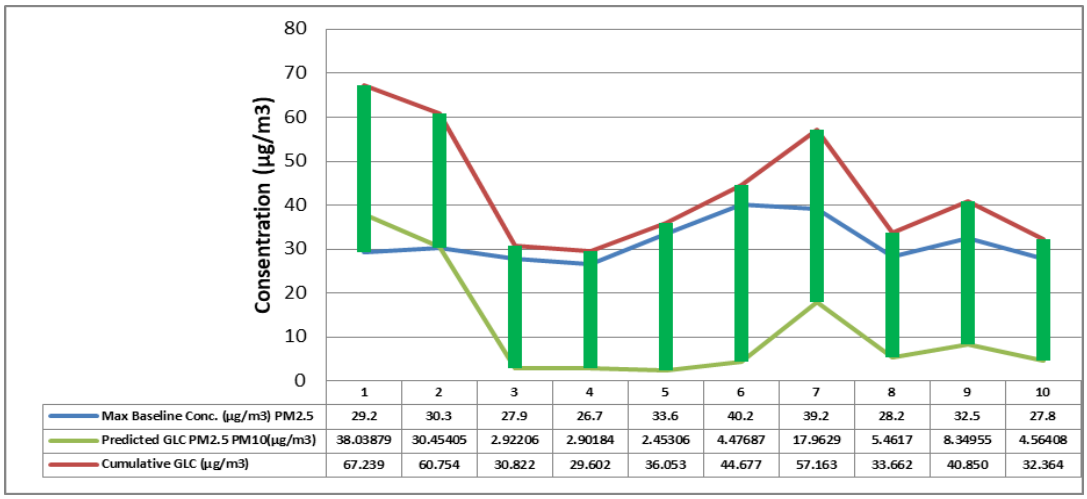
	1	2	3	4	5	6	7	8	9	10
Max Baseline Conc. (µg/m3)	49.5	52.3	49.3	48.9	58.6	61.3	51.3	44.6	51.8	48.6
Predicted GLC PM10(µg/m3)	63.397	50.7567	4.87011	4.83641	4.08843	7.29812	29.9382	9.1029	13.9159	7.60681
Cumulative GLC (µg/m3)	112.9	103.1	54.2	53.7	62.7	68.6	81.2	53.7	65.7	56.2

Figure 5.1: Predicted GLC of PM_{10} at Ambient Air Quality Monitoring Stations (March to May)



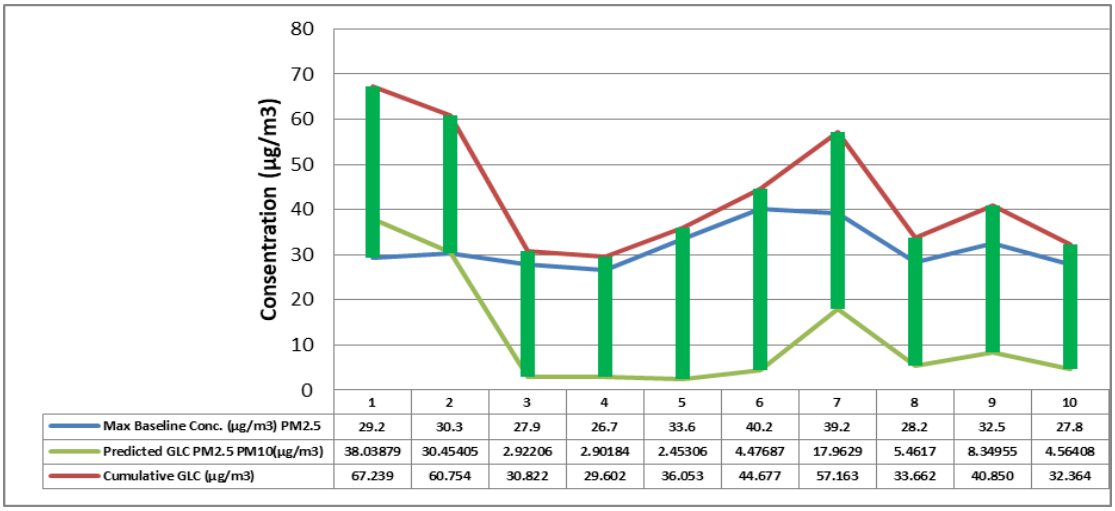
	1	2	3	4	5	6	7	8	9	10
Max Baseline Conc. (µg/m3) PM2.5	29.2	30.3	27.9	26.7	33.6	40.2	39.2	28.2	32.5	27.8
Predicted GLC PM2.5 PM10(µg/m3)	38.03879	30.45405	2.92206	2.90184	2.45306	4.47687	17.9629	5.4617	8.34955	4.56408
Cumulative GLC (µg/m3)	67.239	60.754	30.822	29.602	36.053	44.677	57.163	33.662	40.850	32.364

Figure 5.2: Predicted GLC of $PM_{2.5}$ at Ambient Air Quality Monitoring Stations (March to May 2021)



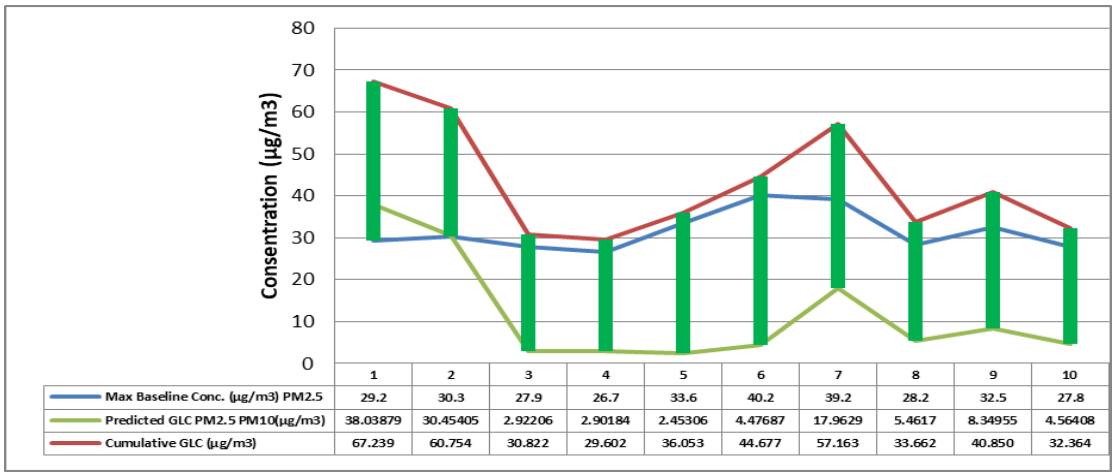
	1	2	3	4	5	6	7	8	9	10
Max Baseline Conc. (µg/m3) PM2.5	29.2	30.3	27.9	26.7	33.6	40.2	39.2	28.2	32.5	27.8
Predicted GLC PM2.5 PM10(µg/m3)	38.03879	30.45405	2.92206	2.90184	2.45306	4.47687	17.9629	5.4617	8.34955	4.56408
Cumulative GLC (µg/m3)	67.239	60.754	30.822	29.602	36.053	44.677	57.163	33.662	40.850	32.364

Figure 5.3: Predicted GLC of Sox at Ambient Air Quality Monitoring Stations (March to May 2021)



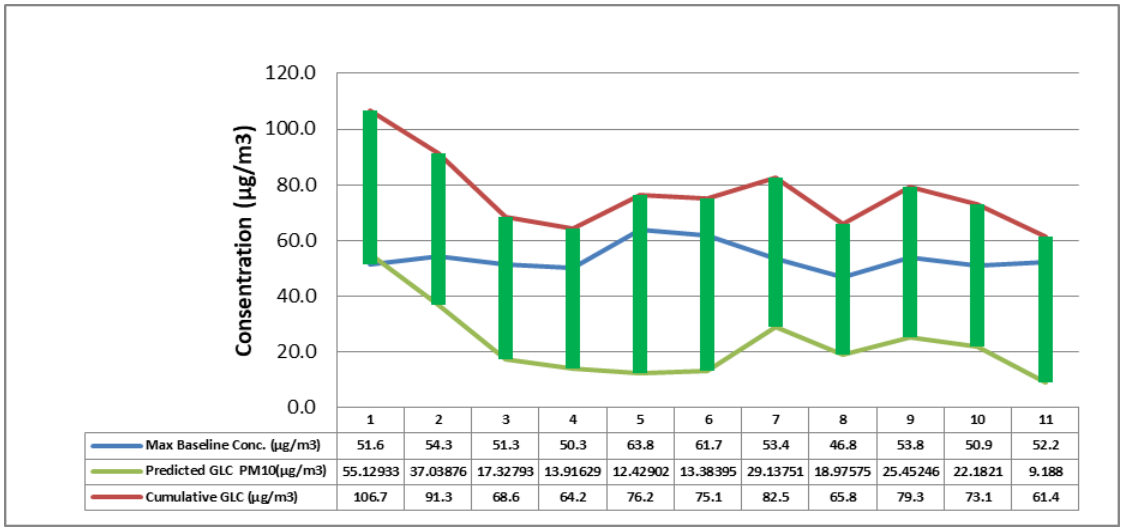
	1	2	3	4	5	6	7	8	9	10
Max Baseline Conc. (µg/m3) PM2.5	29.2	30.3	27.9	26.7	33.6	40.2	39.2	28.2	32.5	27.8
Predicted GLC PM2.5 PM10(µg/m3)	38.03879	30.45405	2.92206	2.90184	2.45306	4.47687	17.9629	5.4617	8.34955	4.56408
Cumulative GLC (µg/m3)	67.239	60.754	30.822	29.602	36.053	44.677	57.163	33.662	40.850	32.364

Figure 5.4: Predicted GLC of Nox at Ambient Air Quality Monitoring Stations (March to May 2021)



	1	2	3	4	5	6	7	8	9	10
Max Baseline Conc. (µg/m3) PM2.5	29.2	30.3	27.9	26.7	33.6	40.2	39.2	28.2	32.5	27.8
Predicted GLC PM2.5 PM10(µg/m3)	38.03879	30.45405	2.92206	2.90184	2.45306	4.47687	17.9629	5.4617	8.34955	4.56408
Cumulative GLC (µg/m3)	67.239	60.754	30.822	29.602	36.053	44.677	57.163	33.662	40.850	32.364

Figure 5.5: Predicted GLC of CO at Ambient Air Quality Monitoring Stations (March to May 2021)

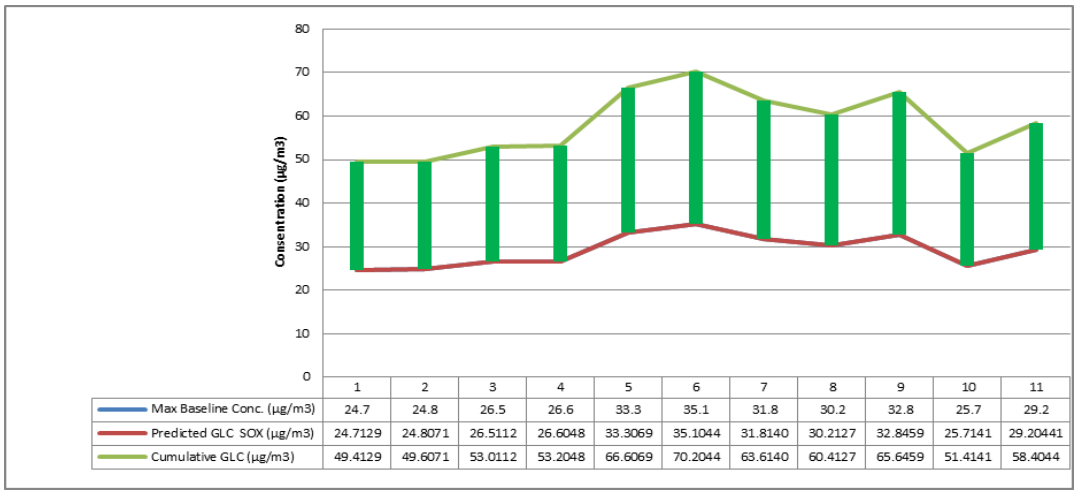


	1	2	3	4	5	6	7	8	9	10	11
Max Baseline Conc. (µg/m3)	51.6	54.3	51.3	50.3	63.8	61.7	53.4	46.8	53.8	50.9	52.2
Predicted GLC PM10(µg/m3)	55.12933	37.03876	17.32793	13.91629	12.42902	13.38395	29.13751	18.97575	25.45246	22.1821	9.188
Cumulative GLC (µg/m3)	106.7	91.3	68.6	64.2	76.2	75.1	82.5	65.8	79.3	73.1	61.4

Figure 5.6: Predicted GLC of PM10 at Ambient Air Quality Monitoring Stations (Oct-Dec)

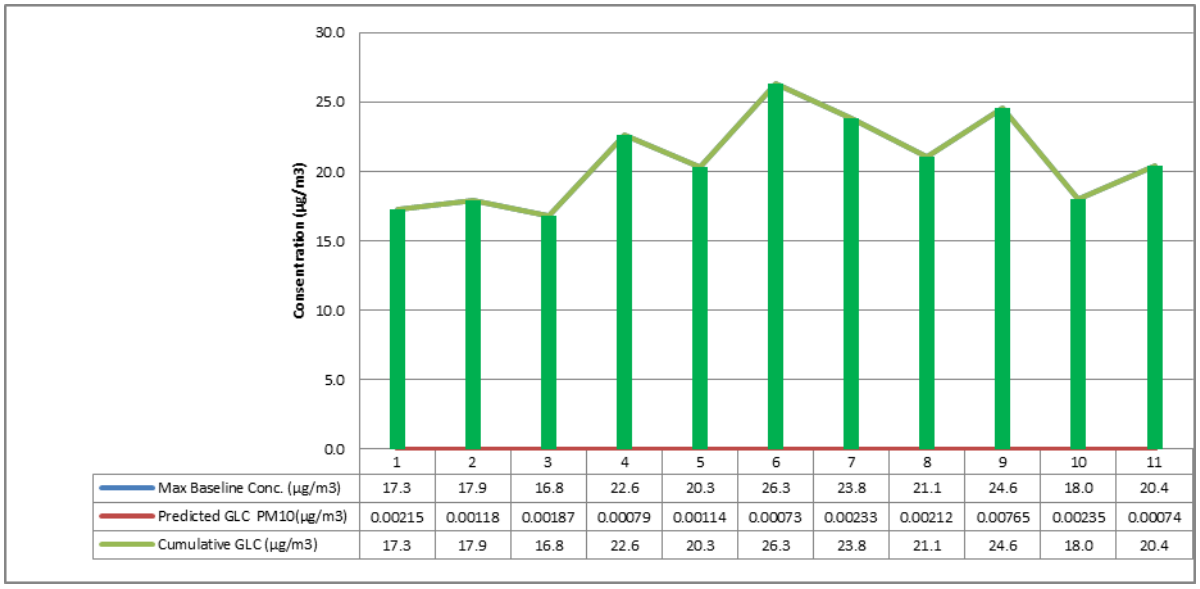
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
Max Baseline Conc. (µg/m3) PM2.5	39.4	40.2	37.9	37.1	50.4	43.7	49.2	38.3	42.5	37.7	37.5
Cumulative GLC (µg/m3)	111.469	102.349	86.068	82.447	108.165	95.331	115.667	87.845	100.083	88.545	80.445
Cumulative GLC (µg/m3)	111.469	102.349	86.068	82.447	108.165	95.331	115.667	87.845	100.083	88.545	80.445

Figure 5.7: Predicted GLC of PM2.5 at Ambient Air Quality Monitoring Stations (Oct-Dec)



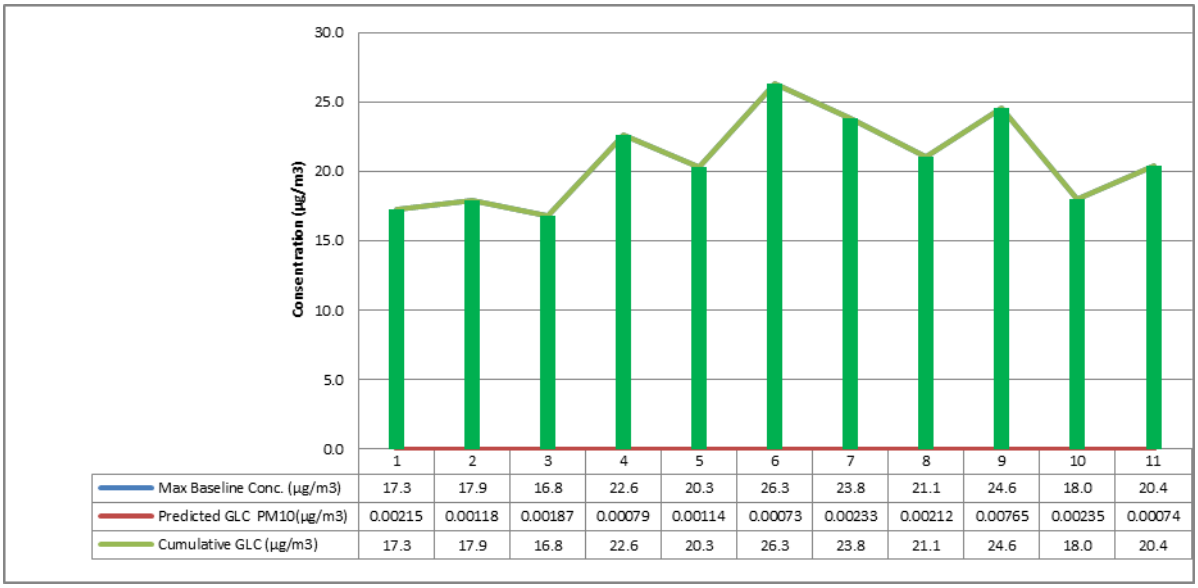
	1	2	3	4	5	6	7	8	9	10	11
Max Baseline Conc. (µg/m3)	24.7	24.8	26.5	26.6	33.3	35.1	31.8	30.2	32.8	25.7	29.2
Predicted GLC SOX (µg/m3)	24.7129	24.8071	26.5112	26.6048	33.3069	35.1044	31.8140	30.2127	32.8459	25.7141	29.20441
Cumulative GLC (µg/m3)	49.4129	49.6071	53.0112	53.2048	66.6069	70.2044	63.6140	60.4127	65.6459	51.4141	58.4044

Figure 5.8: Predicted GLC of Sox at Ambient Air Quality Monitoring Stations (Oct-Dec)



	1	2	3	4	5	6	7	8	9	10	11
Max Baseline Conc. (µg/m3)	17.3	17.9	16.8	22.6	20.3	26.3	23.8	21.1	24.6	18.0	20.4
Predicted GLC PM10(µg/m3)	0.00215	0.00118	0.00187	0.00079	0.00114	0.00073	0.00233	0.00212	0.00765	0.00235	0.00074
Cumulative GLC (µg/m3)	17.3	17.9	16.8	22.6	20.3	26.3	23.8	21.1	24.6	18.0	20.4

Figure 5.9: Predicted GLC of NOx at Ambient Air Quality Monitoring Stations (Oct-Dec)



	1	2	3	4	5	6	7	8	9	10	11
Max Baseline Conc. (µg/m3)	17.3	17.9	16.8	22.6	20.3	26.3	23.8	21.1	24.6	18.0	20.4
Predicted GLC PM10(µg/m3)	0.00215	0.00118	0.00187	0.00079	0.00114	0.00073	0.00233	0.00212	0.00765	0.00235	0.00074
Cumulative GLC (µg/m3)	17.3	17.9	16.8	22.6	20.3	26.3	23.8	21.1	24.6	18.0	20.4

Figure 5.10: Predicted GLC of CO at Ambient Air Quality Monitoring Stations (Oct-Dec)

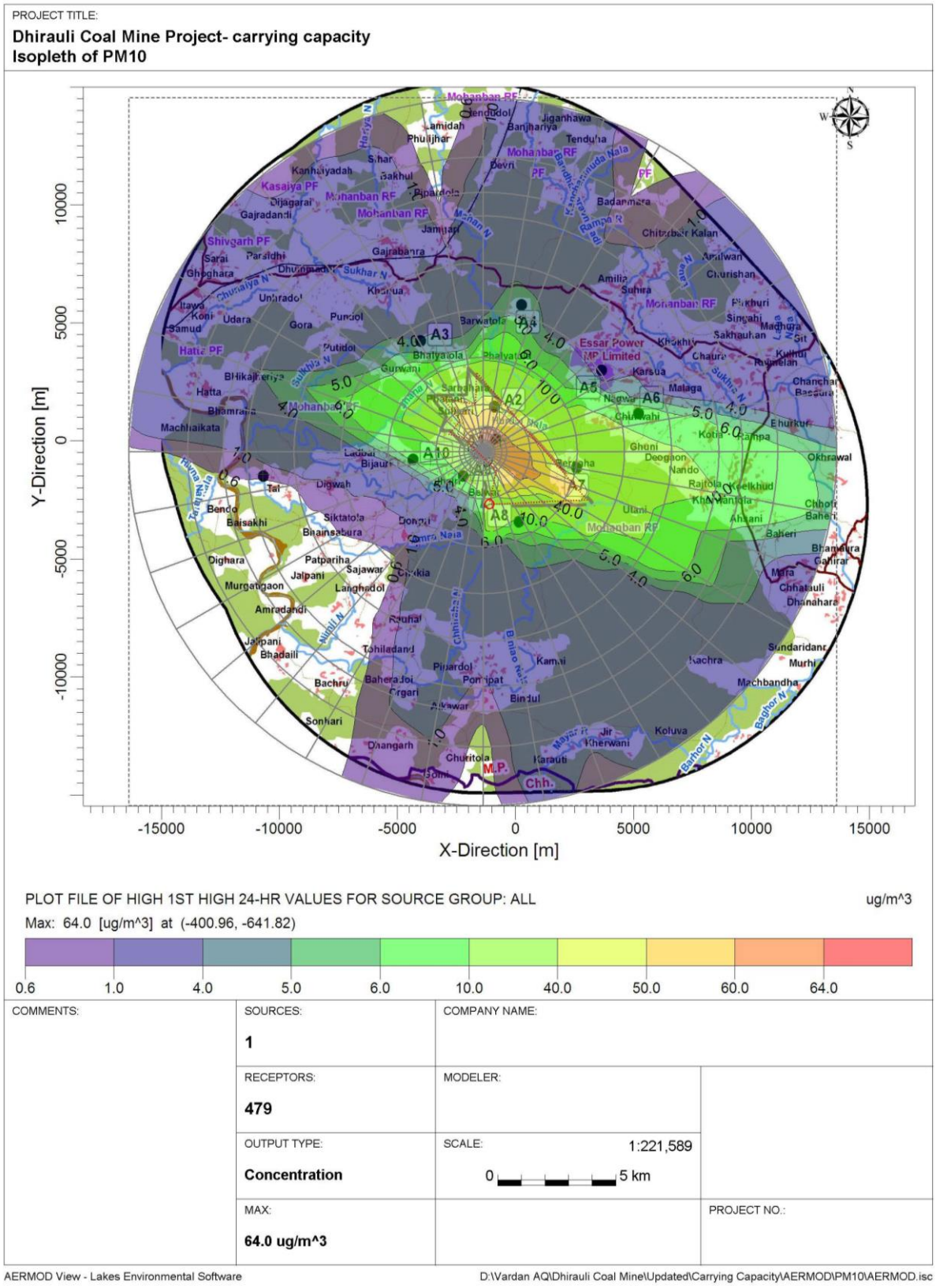


Figure 5.11: Spatial Distribution of Predicted GLCs of PM_{10} (Cluster) (March to May 2021)

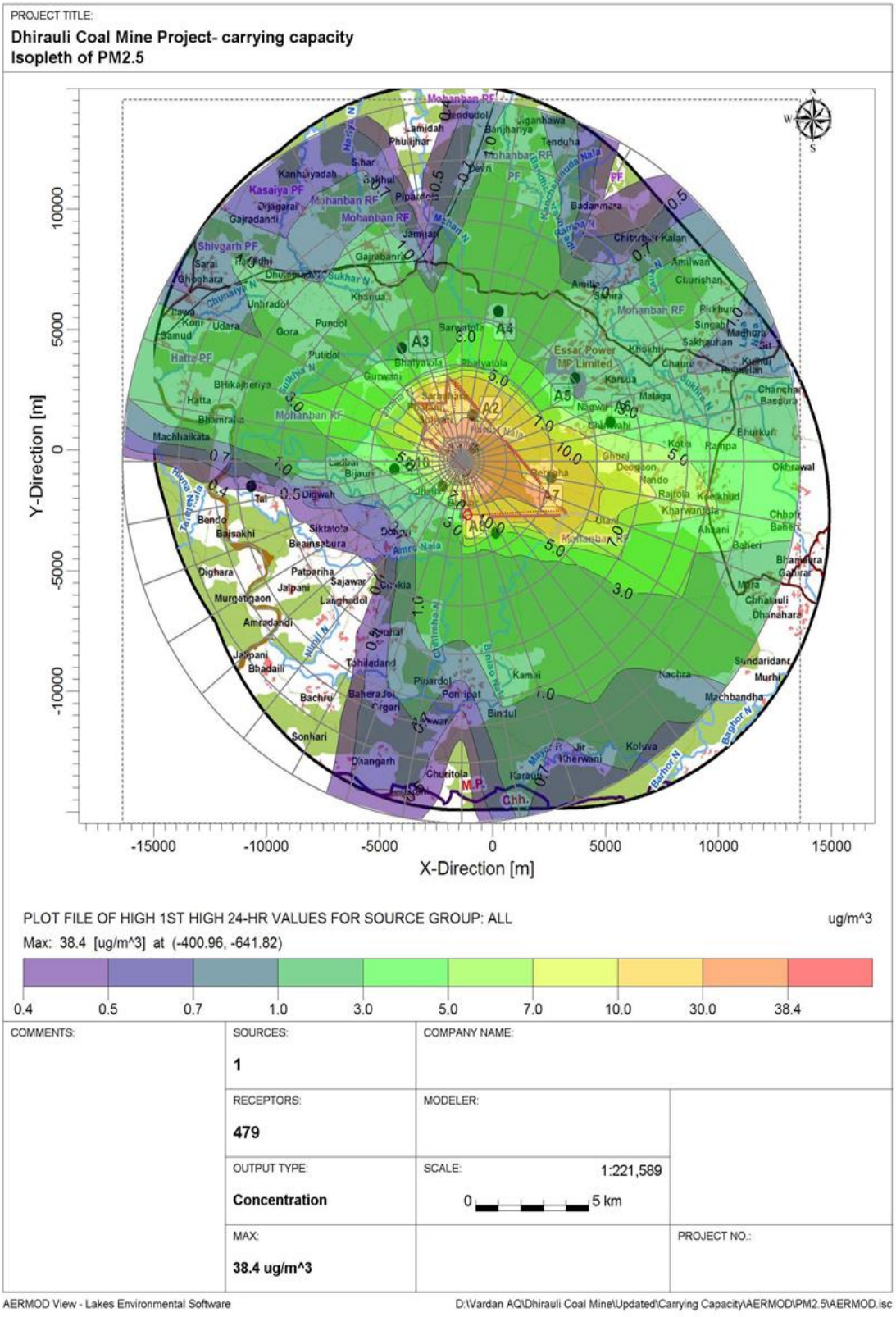


Figure 5.12: Spatial Distribution of Predicted GLCs of $PM_{2.5}$ (Cluster) (March to May 2021)

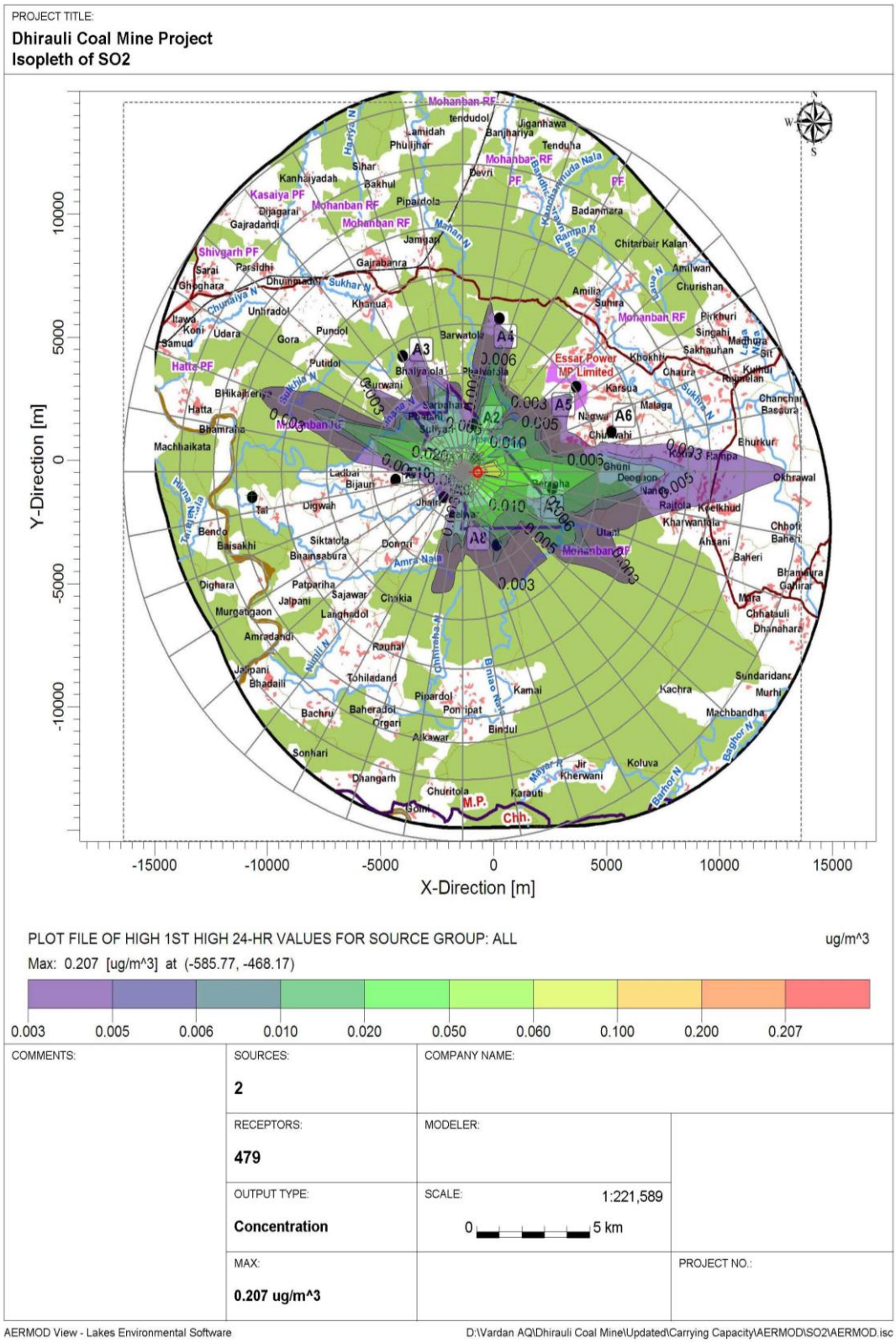


Figure 5.13: Spatial Distribution of Predicted GLCs of SO_2 (Cluster) (March to May 2021)

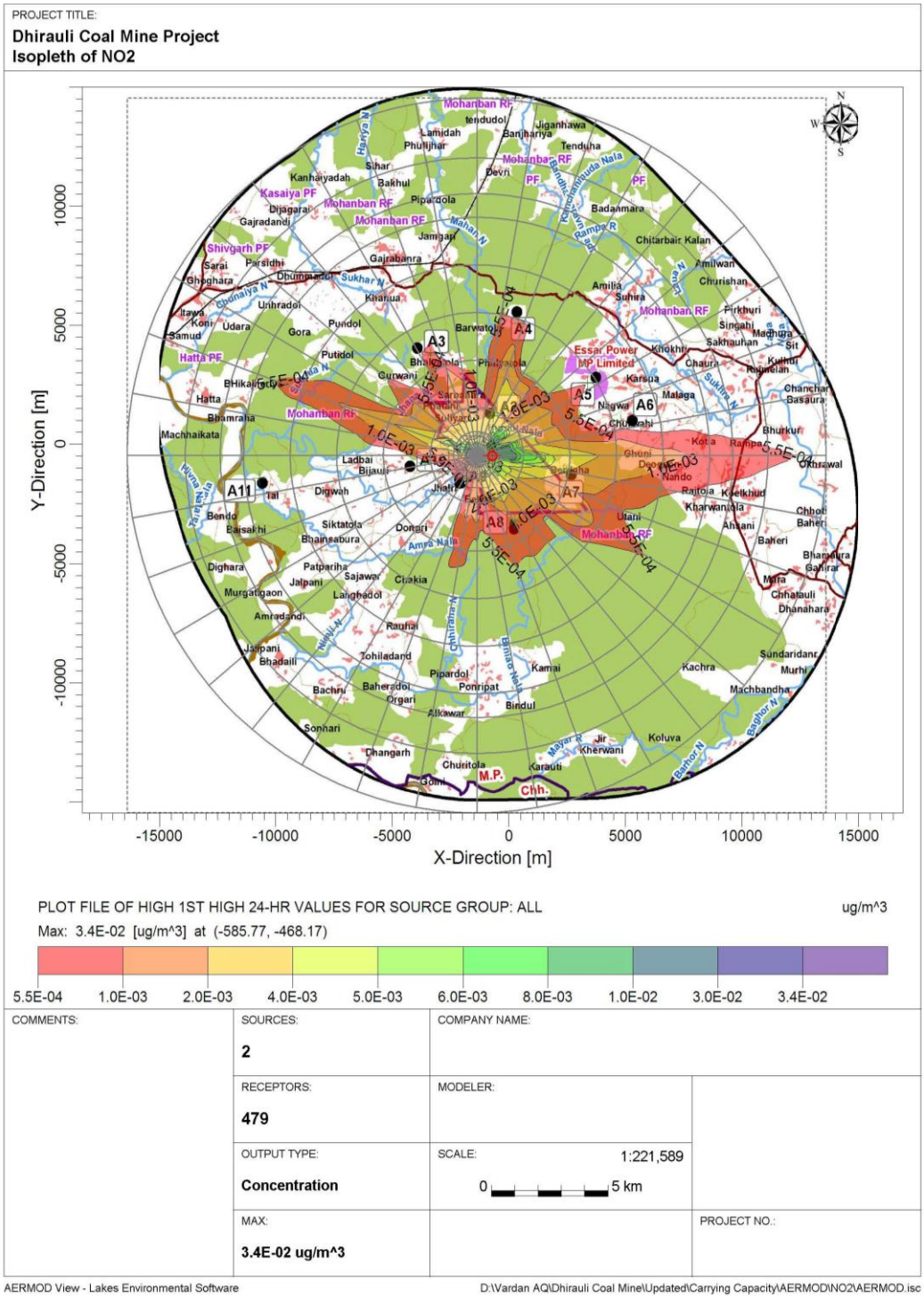


Figure 5.14: Spatial Distribution of Predicted GLCs of NO^2 (Cluster) (March to May 2021)

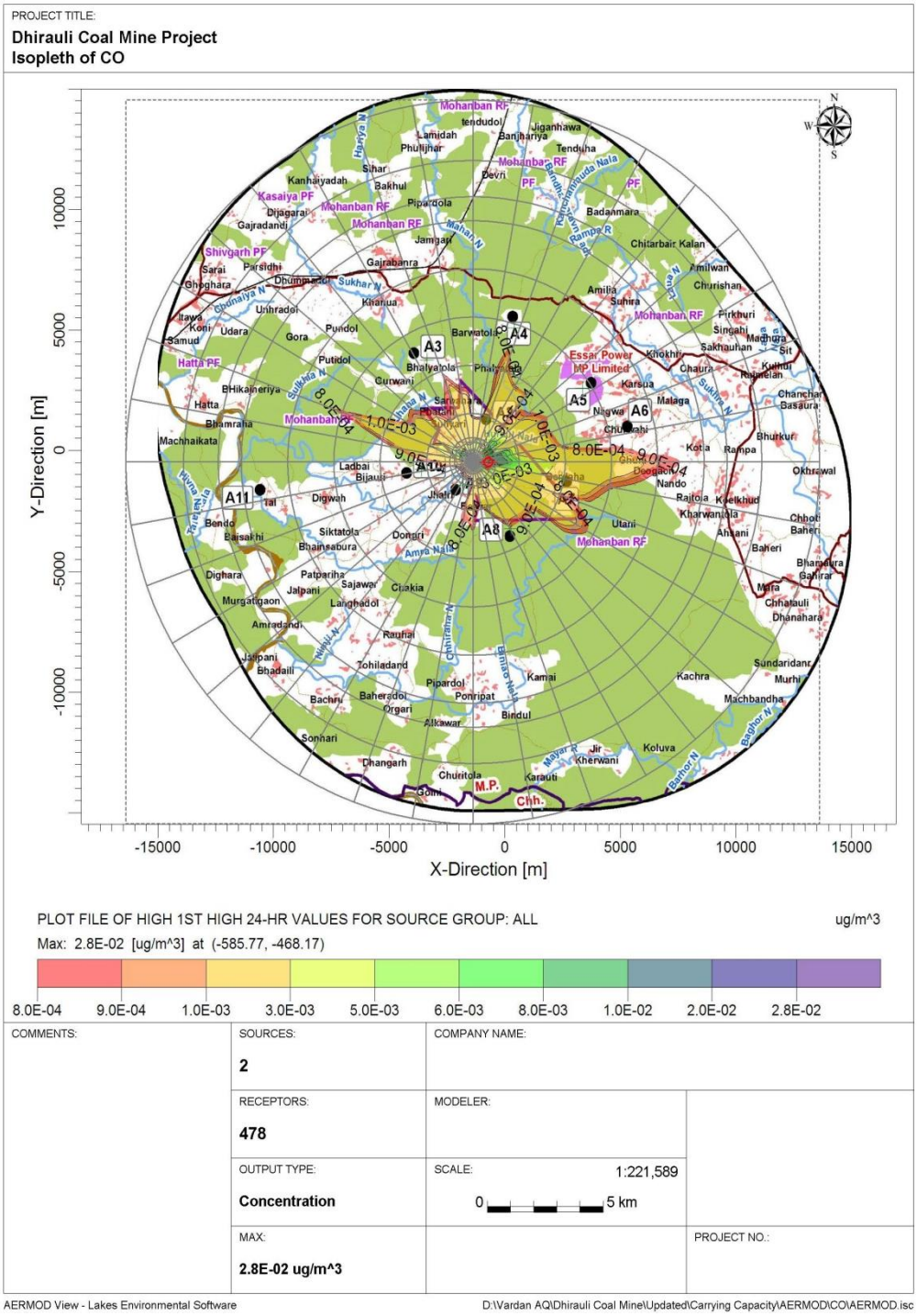


Figure 5.15: Spatial Distribution of Predicted GLCs of CO (Cluster) (March to May 2021)

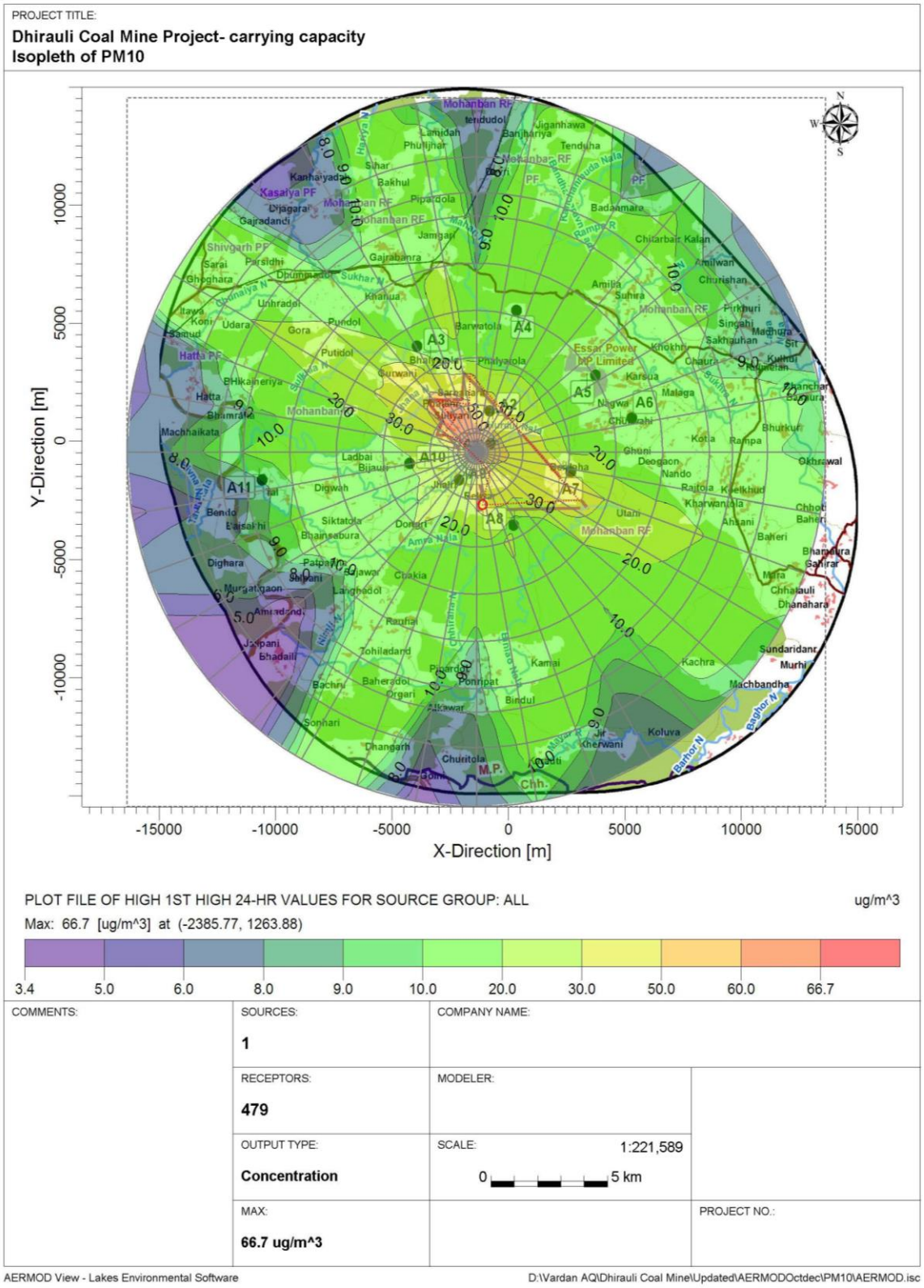


Figure 5.16: Spatial Distribution of Predicted GLCs of PM_{10} (Cluster) (October to December 2021)

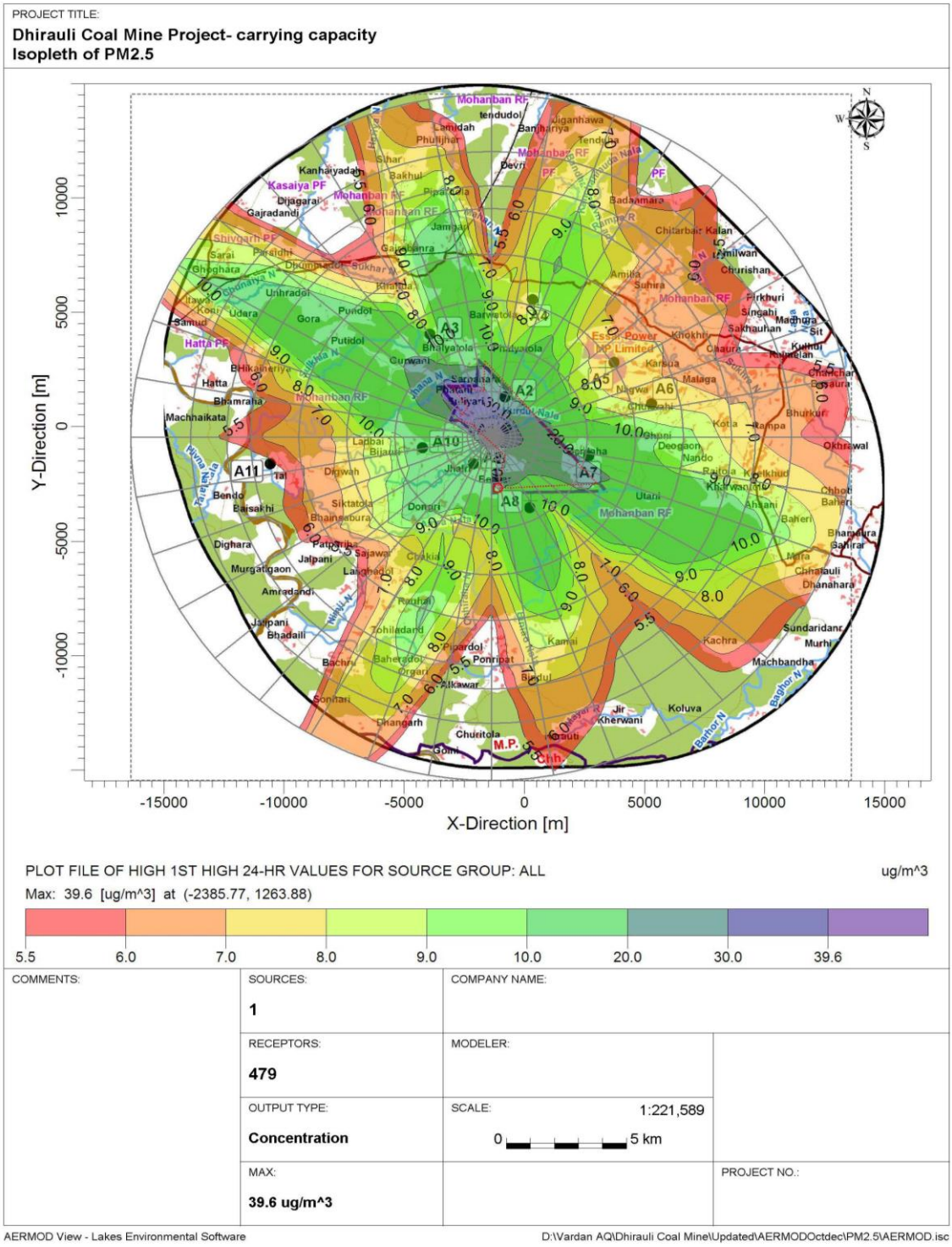


Figure 5.17: Spatial Distribution of Predicted GLCs of $PM_{2.5}$ (Cluster) (October to December 2021

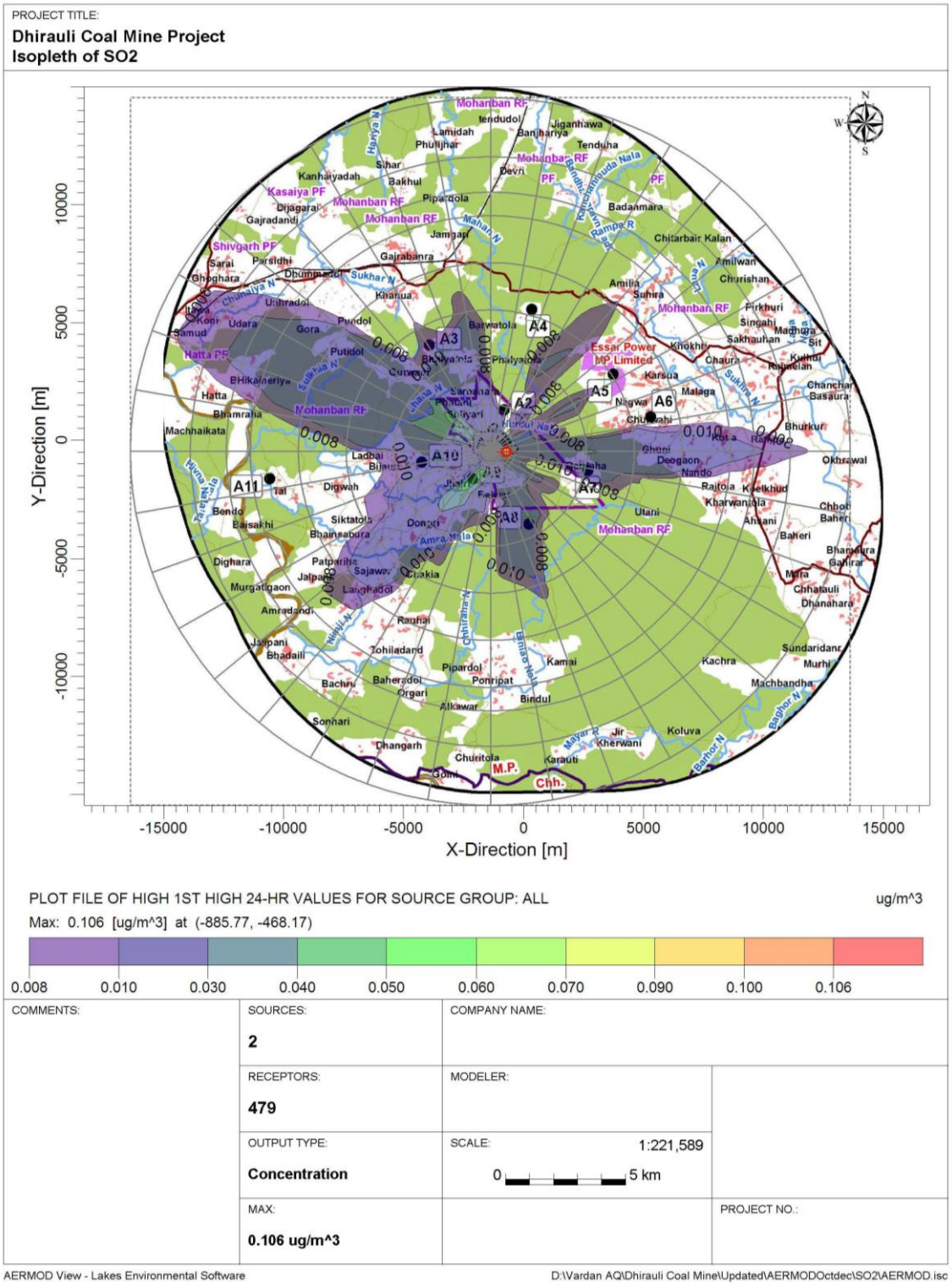


Figure 5.18: Spatial Distribution of Predicted GLCs of SO_2 (Cluster) (October to December 2021

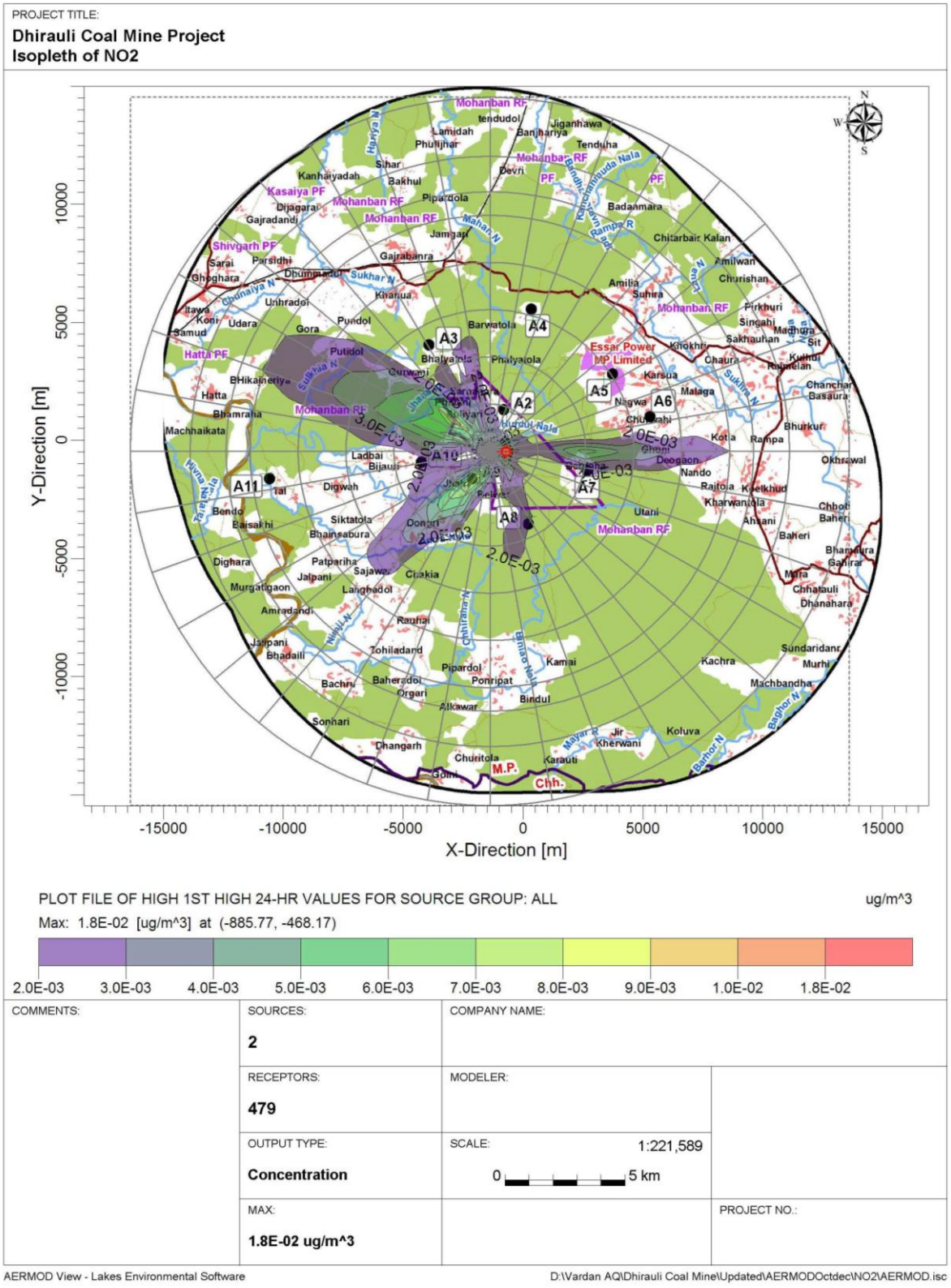


Figure 5.19: Spatial Distribution of Predicted GLCs of NO_2 (Cluster) (October to December 2021

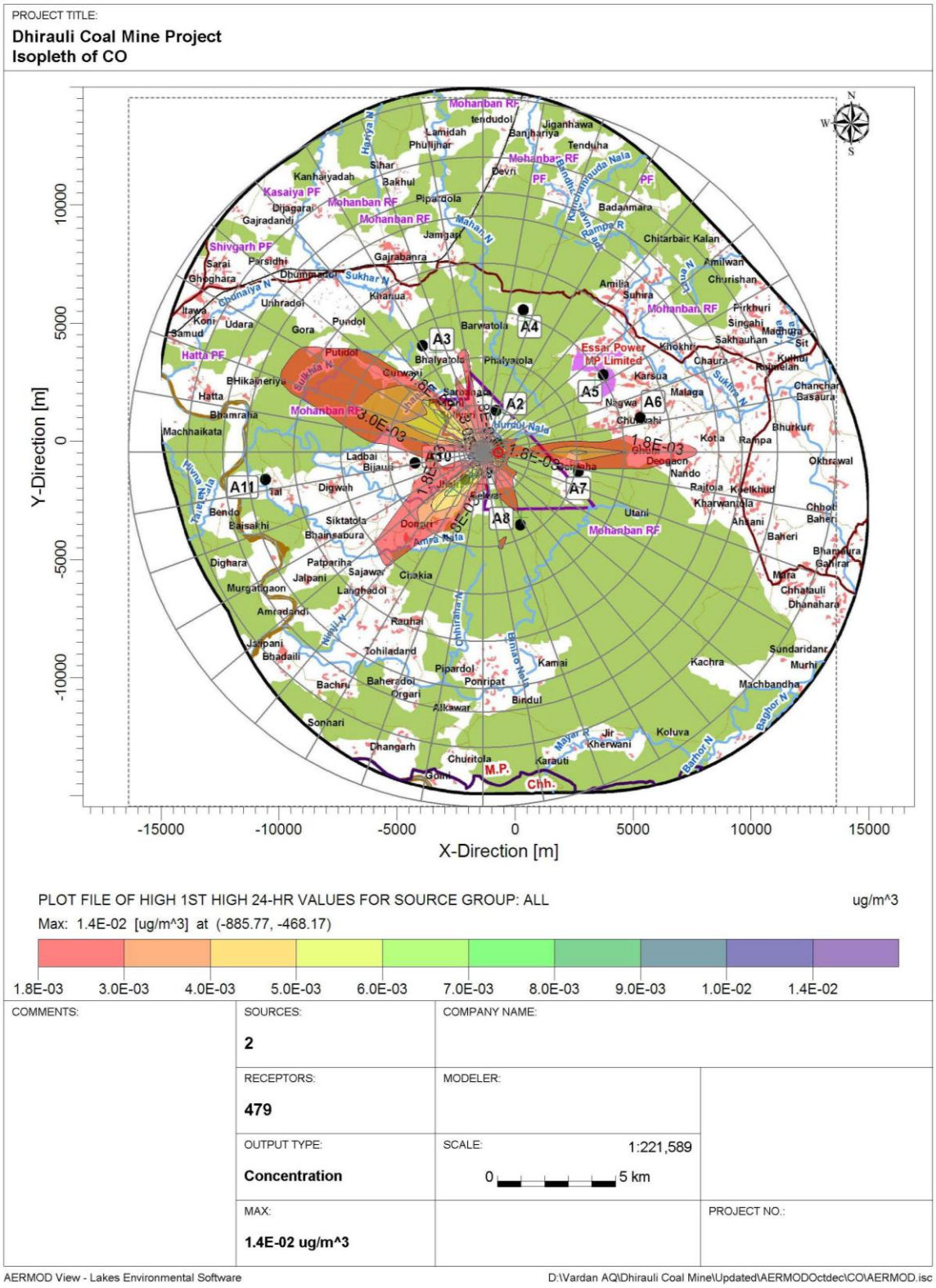


Figure 5.20: Spatial Distribution of Predicted GLCs of CO (Cluster) (October to December 2021

Table 5.4: Cumulative Effect on AQI Values (with Predicated GLC) (March to May 2021)

Site	Conc.	AQI value	Category	Color	Health Impact
A1	Baseline	50	Good	Green	Minimal Impact
	Cumulative	112.89	Moderate	Pink	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults
A2	Baseline	52	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	103.05	Moderate	Pink	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults
A3	Baseline	49	Good	Green	Minimal Impact
	Cumulative	54.17	Satisfactory	Light green	May cause Discomfort to sensitive people
A4	Baseline	49	Good	Green	Minimal Impact
	Cumulative	53.73	Satisfactory	Light green	May cause Discomfort to sensitive people
A5	Baseline	59	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	62.68	Satisfactory	Light green	May cause Discomfort to sensitive people
A6	Baseline	67	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	69.22	Satisfactory	Light green	May cause Discomfort to sensitive people
A7	Baseline	65	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	81.23	Satisfactory	Light green	May cause Discomfort to sensitive people
A8	Baseline	47	Good	Green	Minimal Impact
	Cumulative	53.70	Satisfactory	Light green	May cause Discomfort to sensitive people
A9	Baseline	54	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	65.71	Satisfactory	Light green	May cause Discomfort to sensitive people
A10	Baseline	49	Good	Green	Minimal Impact
	Cumulative	56.50	Satisfactory	Light green	May cause Discomfort to sensitive people

Source: Primary On-site Data and Analysis

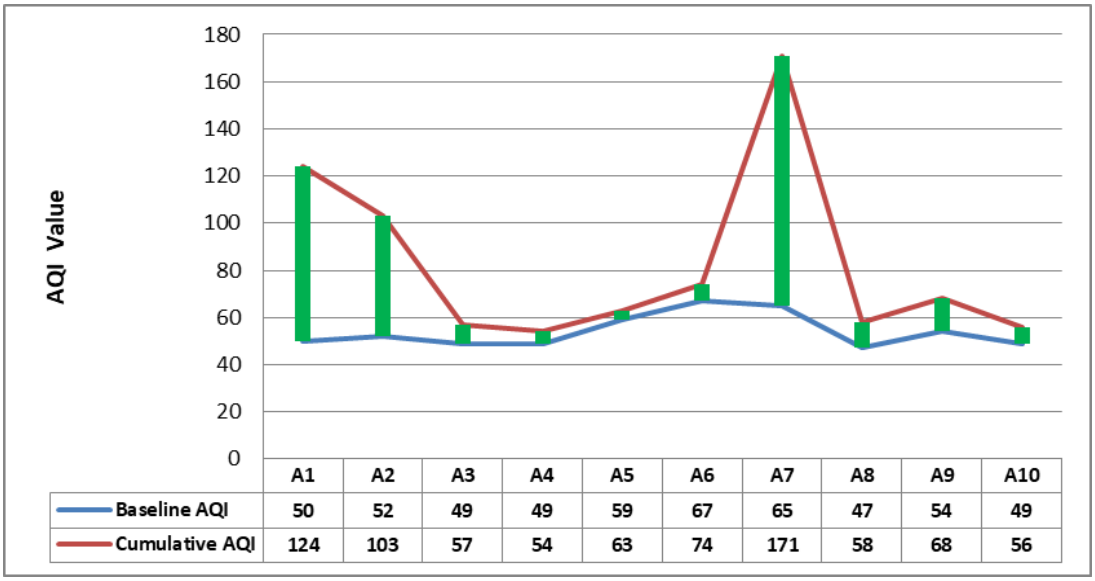


Figure 5.21: Comparision of AQI values with or without predicated GLC

As per the analytical reports of the project site and the surrounding areas, after the addition of cumulative GLC due to the proposed project and existing mining activity the ambient air quality exceding the NAAQS limits, EMP will be taken to mitigate the air pollution.

From the above interpretation of Air Quality Index for study area falls under good, satisfactory and moderate categorization as per the data obtained during baseline studies. Due to implementation of the project and activity of cluster mine the AQI index of the area will cahge from satisfactory to moderate on few locations. The health impact due to this AQI is very less and it may only cause discomfort to sensitive people.

Table 5.5: Cumulative Effect on AQI Values (with Predicated GLC) (October to December 2021)

Site	Conc.	AQI value	Category	Color	Health Impact
A1	Baseline	66	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	106.72	Moderate	Pink	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults
A2	Baseline	67	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	91.33	Satisfactory	Light green	May cause Discomfort to sensitive people
A3	Baseline	63	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	68.62	Satisfactory	Light green	May cause Discomfort to sensitive people
A4	Baseline	62	Satisfactory	Light green	May cause Discomfort to sensitive

					people
	Cumulative	64.21	Satisfactory	Light green	May cause Discomfort to sensitive people
A5	Baseline	84	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	76.22	Satisfactory	Light green	May cause Discomfort to sensitive people
A6	Baseline	73	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	75.08	Satisfactory	Light green	May cause Discomfort to sensitive people
A7	Baseline	82	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	82.53	Satisfactory	Light green	May cause Discomfort to sensitive people
A8	Baseline	64	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	65.77	Satisfactory	Light green	May cause Discomfort to sensitive people
A9	Baseline	71	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	79.25	Satisfactory	Light green	May cause Discomfort to sensitive people
A10	Baseline	63	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	73.08	Satisfactory	Light green	May cause Discomfort to sensitive people
A11	Baseline	63	Satisfactory	Light green	May cause Discomfort to sensitive people
	Cumulative	61.38	Satisfactory	Light green	May cause Discomfort to sensitive people

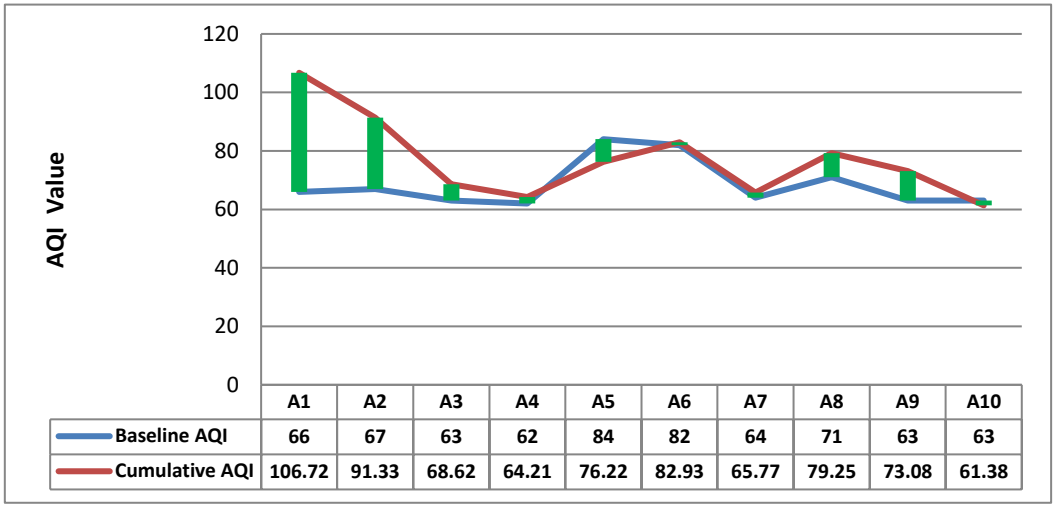


Figure 5.22: Comparision of AQI values with or without predicated GLC (Oct-Dec)

As per the analytical reports of the project site and the surrounding areas, after the addition of cumulative GLC due to the proposed project and existing mining activity the ambient air quality exceding the NAAQS limits, EMP will be taken to mitigate the air pollution.

From the above interpretation of Air Quality Index for study area falls under good, satisfactory and moderate categorization as per the data obtained during baseline studies. Due to implementation of the project and activity of cluster mine the AQI index of the area will cahge from satisfactory to moderate on few locations. The health impact due to this AQI is very less and it may only cause discomfort to sensitive people.

5.2 Water Environment

5.2.1 Baseline (March To May)

The results of the parameters analysed for the 08-ground water and 05 surface water samples are compared with the standards for drinking water as per IS: 10500-2012 "Specifications for Drinking Water (Ground water)" and as well as with the IS: 2296-1986 to compare the result of surface water.

Ground Water

The analysis results indicate that the pH ranges in between 6.61 to 7.54 which are well within the specified standard of 6.5 to 8.5.

Total Dissolved Solids (TDS) concentrations were found to be ranging in between 162 to 389 mg/l.

Total Hardness was observed to be ranging from 77.9 to 263.4 mg/l.

Chlorides were found to be in the range of 27.4 to 66.4 mg/L, and Sulphates were found to be in the range of 8.7 mg/l to 32.6 mg/l.

Bacteriological studies revealed the absence of E.coli in ground water. Total coliform count is nil, whereas the standard permissible limit shall not be detectable in any 100 ml sample.

Surface Water

The analysis results indicate that the pH ranges in between 7.34 to 7.67 which are well within the specified standard of 6.5 to 8.5. The maximum pH of 7.67 was observed at (SW1) and the minimum pH of 7.34 was observed at (SW1).

The Total Dissolved Solids (TDS) concentrations were found to be ranging in between 97 to 152 mg/l, the maximum concentration 152 mg/l was observed Pond near (SW5).

Total Hardness was observed to be ranging from 48.1 to 93.1 mg/l. The maximum hardness concentration 481 mg/l was recorded at (SW2).

Chlorides were found to be in the range of 7.8 mg/l to 23.1 mg/l, the maximum

concentration 23.1 mg/l was observed at (SW5).

The baseline results of ground and surface water were compared with the data for Singrauli district provided by CGWA and was found to be in course with the same.

5.2.2 Baseline (October to December 2021)

The results of the parameters analysed for the 08-ground water and 05 surface water samples are compared with the standards for drinking water as per IS: 10500-2012 "Specifications for Drinking Water (Ground water)" and as well as with the IS: 2296-1986 to compare the result of surface water.

Ground Water

The analysis results indicate that the pH ranges in between 7.32 to 7.58 which are well within the specified standard of 6.5 to 8.5.

Total Dissolved Solids (TDS) concentrations were found to be ranging in between 376 to 473 mg/l.

Total Hardness was observed to be ranging from 170.12 to 325.12 mg/l. Chlorides were found to be in the range of 46.89 to 81.53 mg/L, and Sulphates were found to be in the range of 8.7 mg/l to 32.6 mg/l.

Bacteriological studies revealed the absence of E.coli in ground water. Total coliform count is nil, whereas the standard permissible limit shall not be detectable in any 100 ml sample.

Surface Water

The analysis results indicate that the pH ranges in between 7.45 to 7.64 which are well within the specified standard of 6.5 to 8.5. The maximum pH of 7.64 was observed at (SW4) and the minimum pH of 7.45 was observed at (SW1).

The Total Dissolved Solids (TDS) concentrations were found to be ranging in between 995 to 1051 mg/l, the maximum concentration 1051 mg/l was observed Pond near (SW4).

Total Hardness was observed to be ranging from 336.25 to 436.89 mg/l. The maximum hardness concentration 436.89 mg/l was recorded at (SW4).

Chlorides were found to be in the range of 210.53 mg/l to 231.56 mg/l, the maximum concentration 231.56 mg/l was observed at (SW4). The baseline results of ground and surface water were compared with the data for Singrauli district provided by CGWA and was found to be in course with the same

5.2.3 Pollution Load and Sustainability of Mine

Overall the three coal blocks will not have any negative impact in and around the mine site and study for the same is attached in table no **Table 5.6.**

Table 5.6: Pollution Load Due to Water and Sustainability of Mine

S. No.	Particulars	Dhirauli
1.	**Topography**	Western part of Dhirauli block is characterized by almost plain topography, while, north-eastern and south-central part are highly undulating and have rugged topography as evident from the topographical plan. The north-eastern and south-central part of the block have forest cover and is occupied by hillocks of elevation up to a maximum of 638 m above MSL.
2.	**Drainage**	The coal block (2672 HA) area is drained by Hurdul Nala. The minor nallas and tributaries present in the block shows dendritic to sub-dendritic drainage pattern.
3.	**Water Requirement**	Total water requirement for the project is 1936 m^3/day including mining activities & potable water.
4	**Geology**	**Core Zone-** The Dhirauli block is traversed by 11 normal gravity faults designated as F1-F1 to F11-F11. There are two sets of faults - one trending NW-SE and the other trending NE-SW. **Buffer zone-** The geology of the district reveals that the Occurrence of various work formation as old as granites of Achaean age to the Alluvium of Recent age. The other important formations Outcropping in the district are Deccan trap of cretaceous – Eocene, Gondwanas of Paleozoic to Mesozoic Sandstone and other ranks of Vindhayans and Phyllites. Quartzites, Schist Gneisses and Granites of Archeans age
6.	**Hydrogeology**	As per CGWA the project location comes under the non-Notified, safe zone.
7.	**Groundwater Flow Direction**	Hurdul Nala traverses the block and passes almost through central part of the block. Many small seasonal nallas originating from elevated topography of north-

S. No.	Particulars	Dhirauli
		eastern and south-central part of the block drain its water into Hurdul Nala.
8.	**Pumping Test**	Pumping tests are conducted to determine the performance characteristics of a well and to determine the hydraulic properties of the aquifer such as permeability/hydraulic conductivity, transmissivity and storage coefficient.
9.	**Water Level**	Pre-Monsoon: 5 m to 10 m bgl, post-monsoon: 8 m to 13 m bgl, Average Fluctuation: 4m.
10.	**Ultimate Depth of Mining**	280m
11.	**Intersection**	The intersection of groundwater occurs in the range of 5 m below ground level.
15.	**Category of Ground water as per CGWB**	Non-Notified, Safe

Source: Primary On-site Data and Analysis

The area in which project site is falling under **'Safe'** category (CGWB) indicating no deficit in groundwater resources of the area and availability of groundwater resources for future utilization and development. However, rainwater-harvesting measures will be practiced for betterment and augmentation of groundwater resources in long run. The combined project has proposal for 30% recharge in and around the study area. Therefore, there will be no impact in the ground water quality as well as ground water level due to coal mining.

5.3 Soil Environment (March to May 2021)

5.3.1 Baseline

Based on the results obtained from the different soil samples, it is evident that the soil samples are predominantly sandy type. The pH of the soil samples ranged from 4.89 to 7.06 indicating the slightly acidic in nature.

The electrical conductance of the soil samples varied from 51 mS/cm to 130 mS/cm based on the Conductivity results it can be concluded that the ionic content of the soil samples is within the limits that does not harm the crops. Bulk densities of the soil samples varied from 1.1 to 1.3 gm/cc.

Available nitrogen in the soil samples varied from 53.9 Kg/ha to 155.3 Kg/ha which is indicating beter quantities in the soil samples. Available phosphorus in the region varied from 63.7 kg/ha to 109.1 kg/ha revealing the distribution from medium to average sufficient quantities.

Available potassium levels in the samples ranged from 120.3 Kg/ha to 378.1 Kg/ha, which is indicating average quantities in the soil samples.

Soluble chlorides in the region varied from 85.0 mg/l to 148.9 mg/l. Organic matter concentrations ranged from 0.43 %to 1.34 % on an average sufficient content is noticed in the soil samples.

5.4 Soil Environment (October to December 2021)

Based on the results obtained from the different soil samples, it is evident that the soil samples are predominantly sandy type. The pH of the soil samples ranged from 7.43 to 7.76 indicating the Neutral in nature.

The electrical conductance of the soil samples varied from 0.225 mS/cm to 0.342 mS/cm based on the Conductivity results it can be concluded that the ionic content of the soil samples is within the limits that does not harm the crops. Bulk densities of the soil samples varied from 1.33 to 1.51 gm/cc.

Available nitrogen in the soil samples varied from 102.35Kg/ha to 152.85 Kg/ha which is indicating beter quantities in the soil samples. Available phosphorus in the region

varied from 6.96 kg/ha to 14.92 kg/ha revealing the distribution medium quantities.

Available potassium levels in the samples ranged from 74.14 Kg/ha to 135.57 Kg/ha, which is indicating average quantities in the soil samples.

Soluble chlorides in the region varied from 29.66 mg/l to 41.25 mg/l. Organic matter concentrations ranged from 0.26 %to 0.51 % on an average sufficient content is noticed in the soil samples.

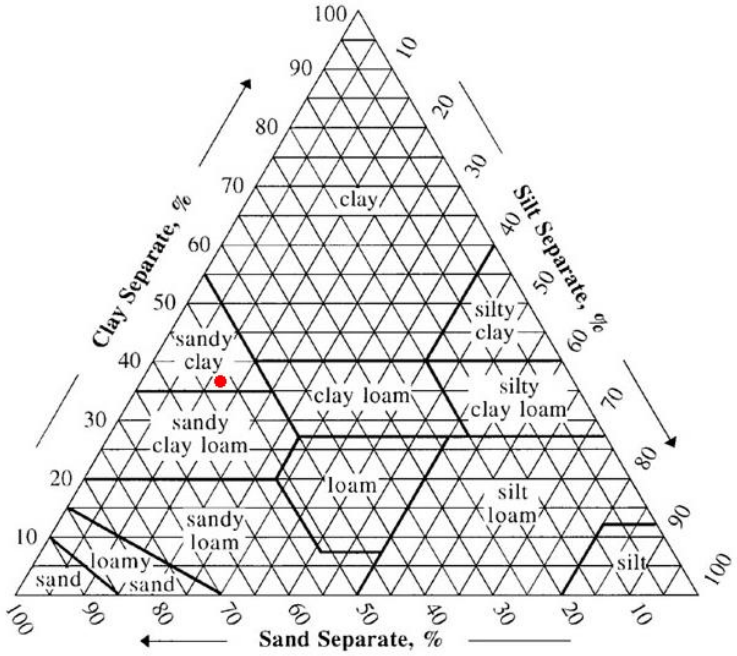


Figure 5.23: Type of Soil

5.4.1 Pollution Load and Mine Sustainability

The coal mine developmental activities will result in loss of topsoil to some extent in the facilities in mine lease area. In addition to that preparation of coal excavation area also leads to loss of topsoil within the lease area. The topsoil will be managed by separate stacking so that, it will be used for green belt development. Apart from much localized impacts at the CHP and washery site, no significant adverse impact on soil in the surrounding area is anticipated. No other impact will be taken on soil quality.

5.5 Noise Environment (March to May 2021)

5.5.1 Baseline

Out of all 10 locations measured for noise levels, the sample collected at Khairahi (N4) was found to be on slightly higher side.

The Leq and Ldn values at this location was observed to be 64.6 and 69.1 dB (A)

respectively, which can be attributed to local prevailing environment (Essar Power MP limited Power Plant and vehicular movement). However the recorded noise levels were found to be within the industrial zone limits (75 dB (A)).

Apart from this the noise levels recorded at Churwani (N5) were found to be of higher level, which can be attributed to presence of Power Plant, nearby roads. However these levels are found to be well within the permissible residential limits (55 dB(A) for day time).

The noise levels recorded at all locations were within the NAAQS limits.

With the operation of mine, the noise levels inside the project site will have some impacts on the nearby areas.

However, with suitable control measures and EMP, the noise levels will be reduced and the impacts will be minimized.However, with suitable control measures and EMP, the noise levels will be reduced and the impacts can be minimized.

5.5.2 Noise Environment (Oct-Dec 2021)

Out of all 10 locations measured for noise levels, the sample collected at Khairahi (N4) was found to be on slightly higher side.

The Leq and Ldn values at this location was observed to be 54.30 and 44.35 dB (A) respectively, which can be attributed to local prevailing environment (Essar Power MP limited Power Plant and vehicular movement). However the recorded noise levels were found to be within the industrial zone limits (75 dB (A)).

Apart from this the noise levels recorded at Churwani (N5) were found to be of higher level, which can be attributed to presence of Power Plant, nearby roads. However these levels are found to be well within the permissible residential limits (55 dB(A) for day time).

The noise levels recorded at all locations were within the NAAQS limits.

5.5.3 Pollution Load and Mine Sustainability

5.5.3.1 Noise Impact Assessment during construction phase

The areas affected are those close to the site. At the peak of the construction, marginal increase in noise levels is expected to occur but they are temporary. During the construction phase, noise generated from various construction activities are listed below:

Movement of vehicles carrying materials and loading & unloading activities.

Excavation machines, concrete mixer and other construction machines including

pneumatic tools and compressors.

Operation of DG sets.

Concreting, hammering.

Mechanical operations, like, drilling, fitting, etc.

All the above mentioned sources will be intermittent and would be experienced occasionally. It may also be noted that, most of the construction activities will be carried out only during the daytime. The expected noise levels from these activities are as per given hereunder.

Table 5.7: Details of Noise levels from construction

Description	*Noise Levels dB(A)	Combined Effective Noise levels dB(A)	Combined Effective Noise levels dB(A) (With the EMP implementation)
Earth Movers			
Front End Loaders	85	89	79
Tractors	84		
Scrapers, Graders	85		
Material Handlers			
Concrete mixers	85	91	82
Cranes (movable)	83		
Trucks	88		
Stationary Equipment			
Pumps	76	84	75
Generators	81		
Compressors	80		
Total		**94**	**84**

(Source: FHWA & NIOSH manual)

The resultant maximum noise level for the above sources as calculated using combined equivalent noise equation (http://noisetools.net/noisecalculator) is 94 dB(A) at source. This result is calculated considering that all the construction machineries are operated at once. Sound pressure level generated by construction activities decreases with increasing distance from the source due to wave divergence. An additional decrease in sound pressure level from the source is expected due to atmospheric effect or its interaction with objects in the transmission path.

The Noise levels when calculated considering the EMP implementation and Green belt attenuation during construction phase is observed to be 84 dB(A).

Sound from an ideal point source (i.e. non-directional source) will spread out

spherically and sound pressure levels would decrease 6 dB for each doubling of distance from the source (OSHA Technical Manual). So the Noise levels will be negligible beyond the boundary of the mine site.

The noise produced during construction phase will have temporary impact on the existing ambient noise levels at the project site but restricted to small distance.

Table 5.8: Predicted Noise Propagation Values

Sl. No.	Noise Levels dB(A)	Distance from source (m)
1	84	1
2	78	2
3	72	4
4	66	8
5	60	16
6	54	32

5.5.3.2 Noise Impact Assessment during operation phase

The proposed mine will be mechanized opencast cum underground mining with deep hole drilling & blasting for Overburden and Coal extraction. The mine will have following source of noise

Drilling
Blasting
Operation of HEMM & Vehicular Movement
Crushing & Screening plant

The impact of this airborne noise will be more on the operating personnel and on the persons working nearby and not so much on the surroundings. The noise of activities may also disturb animals/birds living in the surroundings forcing them to change their habitat. In the present case, the noise caused will be mainly restricted to the core zone. The noise level data recorded at various places in the study area is well within the desired limit. But, the future increment in noise levels due the proposed project activity may pose some problem if project management does not adopt appropriate control measures.

Noise Dispersion from the Mine

The noise generation from the mine will be from various sources, which will be originating from various locations within the site. Hemispheical sound propagation has been assumed. For the purpose of noise dispersion for worst case scenario, it is assumed that all the noise generating sources from the quarry are located within the mine site and will operate at the same time and can move within the mine boundary.

Hence, the Center point is taken as the starting point of noise. The dispersion of this noise is computed by using the noise dispersion model.

Table 5.9: Expected Noise levels from mine operations

S.No.	Machines/Units	Expected Noise Levels
Mining		
1	Drilling	85
2	Shovel/Loader	75
3	Dumpers	80
4	Dozers	78

As blasting noise is instantaneous and causes an overpressure, it is not put as input to day-night model

The combined noise level when the above mentioned machineries are operated at once is calculated to be 87.4 dB(A). Noise propagation model was used to calculate noise pressure levels from these activities to various distances from the project boundary. The Atmospheric Conditions and Ground effects were also considered as mentioned in ISO:9613. The boundary plantation around the mine area was also considered while modelling.

Table 5.10: Incremental Noise Level at Different Locations (Without EMP)

Location Codes	Distance from the project site (km)	Baseline Leq Values in dB(A)	Incremental Sound Pressure level in dB(A)	Resultant Sound pressure Level in dB(A)	Remarks
N1	--	47.8	67.8	68.3	Major Impact
N2	2.0	44.9	52.4	53.1	Major Impact
N3	3.9	46.9	54.5	55.2	Minor Impact
N4	4.5	64.6	54.8	65.1	Minor impact
N5	4.6	60.9	52.4	61.5	Minor Impact
N6	0.5	42.8	57.5	57.9	Major Impact
N7	0.8	41.7	59.1	59.8	Major Impact
N8	1.5	49.6	62.1	63.4	Major Impact

Table 5.11: Incremental Noise Level at Different Locations (With EMP)

Location Codes	Distance from the project site (km)	Baseline Leq Values in dB(A)	Incremental Sound Pressure level in dB(A)	Resultant Sound pressure Level in dB(A)	Remarks
N1	--	47.8	59.1	59.4	Major Impact
N2	2.0	44.9	39.1	45.9	Minor Impact
N3	3.9	46.9	41.1	47.9	Minor Impact
N4	4.5	64.6	41.3	64.9	Minor impact
N5	4.6	60.9	39.9	61.3	Minor Impact
N6	0.5	42.8	50.8	51.4	Major Impact
N7	0.8	41.7	45.6	47.1	Minor Impact
N8	1.5	49.6	48.5	52.1	Minor Impact

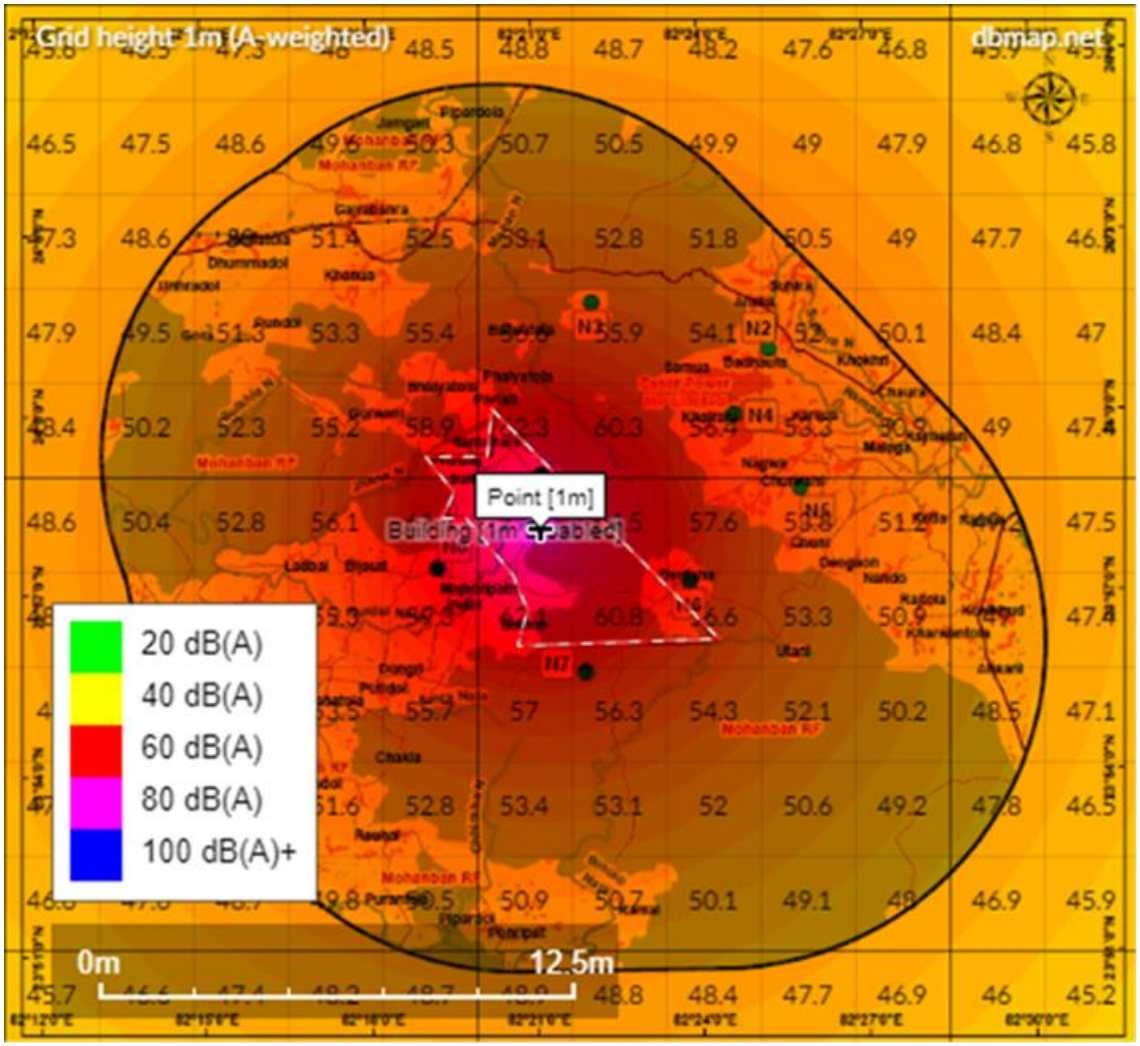


Figure 5.24: Noise contours for 10 km radius study area (without EMP)

The combined noise level when the machineries are operated in shift wise time duration along with implementation of EMP is calculated to be 79.6 dB(A).

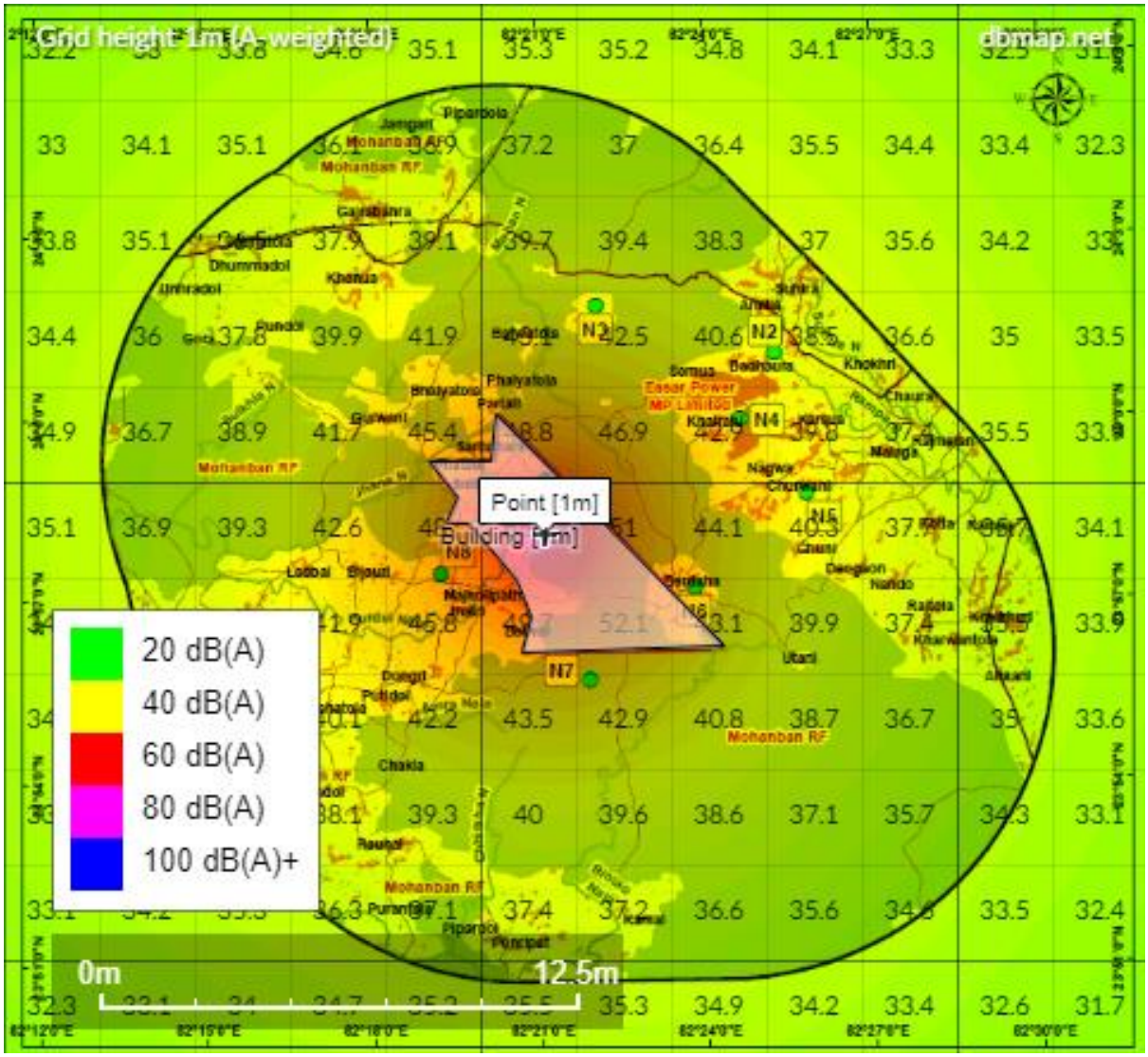


Figure 5.25: Noise contours for 10 km radius study area (With EMP)

Incremental noise level in nearest habitation Berdaha at a distance of 500 m from site is 51.40 dB (A).

The noise levels are further reduced when the implementation of EMP and shift wise operation of machineries is considered.

Beyond 500 m from the project area, increase in noise level, due to proposed activities, will be negligible.

Noise level does not exceed the CPCB limit at any location due to mining activity.

When attempting to attenuate noise, it should be borne in mind that noise radiates from most machinery as both airborne and as structure-borne sound at the same time. Followings will be adopted:

Provision of sound-insulated chambers for workers deployed on machines producing higher levels of noise like bulldozers, drills, etc.

Selection of new low-noise equipment from the manufactures failing which use of additional retrofits if available.

Providing silencers or enclosures for noise generating machines such as DG sets, compressors, etc.

Attenuation of Structure-Borne Sound : Preventing transmission of vibration from machines to the load-bearing structure can considerably reduce structure-borne sound:

Large heavy machines should be mounted on foundations which are completely separated from buildings or other structures

Placing other machines on a stable foundation and where possible using an elastic separation such as rubber blocks or steel springs.

Severely vibrating machines may require separate foundations and isolation joints between floor slabs to prevent propagation of structure-borne noise.

Attenuation by Using Absorbents: Hard surfaces on the ceiling, floor and walls of an enclosed site office or workshop will reflect back nearly all the sound reaching them. Noise absorbents will absorb and reduce noise.

Sound Insulated Rooms: Cabins should be constructed of materials with good sound attenuation properties and ideally will have:

Double glazed windows - (two 6 mm glass panes with 50 mm air space can give 10 dB(A) attenuation). Ventilation openings with attenuators such as acoustic louvers. An adequate air conditioning system, to avoid doors being left open.

5.6 Landuse Environment

5.6.1 Baseline

As per the interpretation of satellite data and field observations during the ground truthing in the project area, the Land use Land cover categories observed are mainly forest cover, Builtup, Agricultural Land, Opten scrub, Waste land, Waterbody, industry and sandy area.

About 50.55% of the area is covered by forest of various categories, about 18.79% of the area by open Scrub Land, 21.73% Agricultural land, 2.63% Builtup area, 5.39% Waste land, waterbody 0.19% , Industry area 0.30% and Sandy area 0.42%.

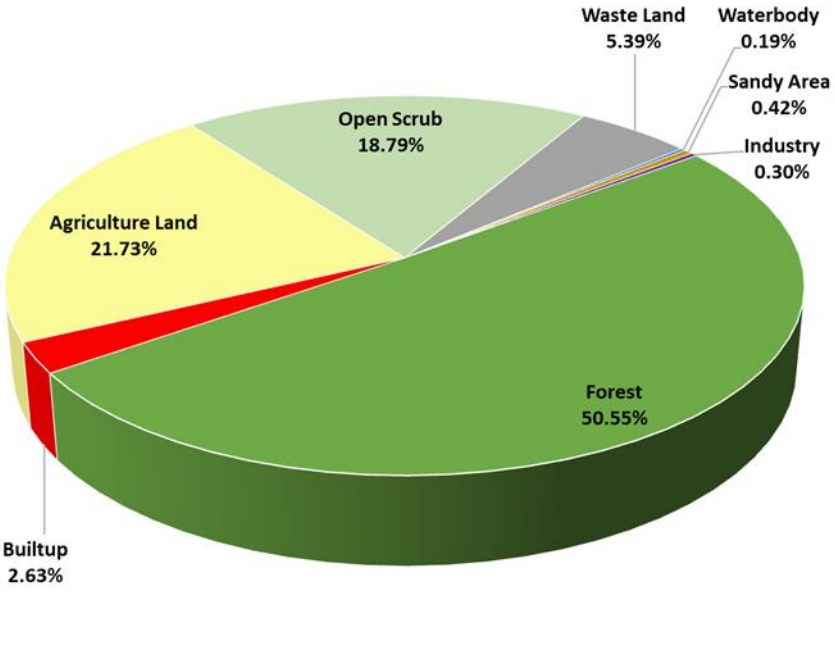


Figure 5.26: Pie Diagram Showing Distribution of Land Use/ Land Cover Categories

Mining Plan including Mine Closure Plan has been prepared within the existing mining lease area of 2672 Ha.. Class / type of different land uses as are given below:

Table 5.12: Existing Land Use of Coal Mining Blocks

S. No.	Particular	Area in Ha.
1	Government Land	548.841
2	Tenancy Land	684.431
3	Forest Land (RF/PF)	1438.729
Total		**2672.001**

Source: Mining Plan

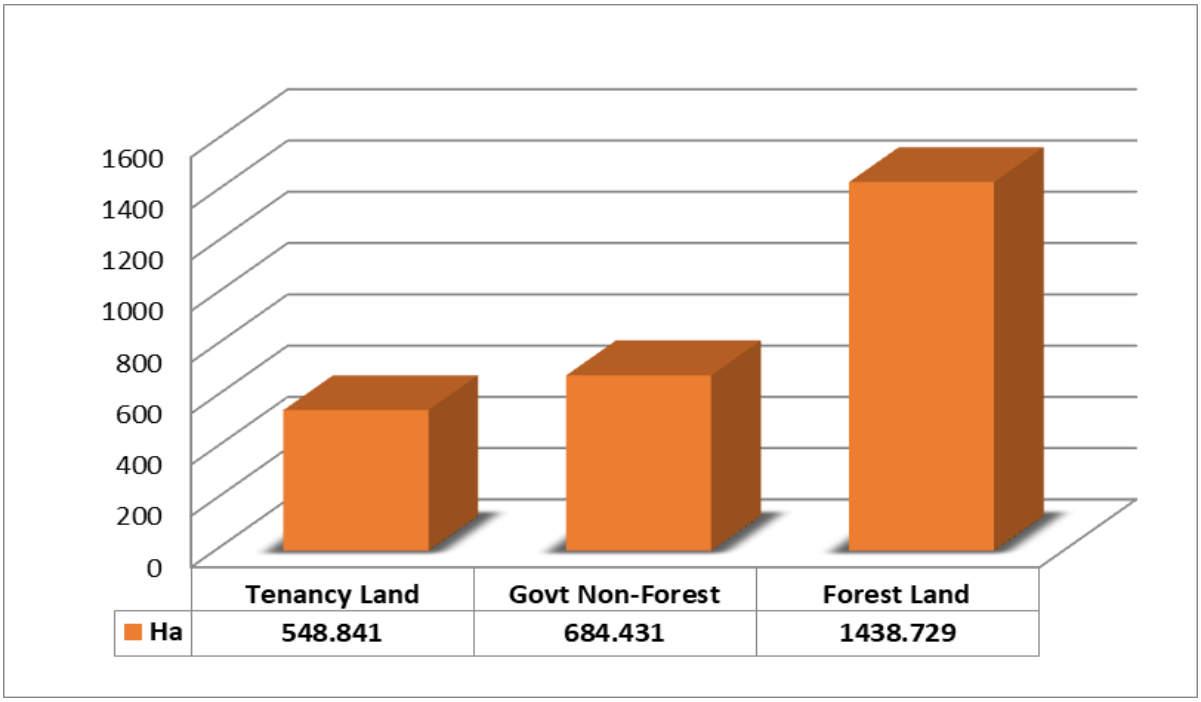


Figure 5.27: Bar Diagram Showing Distribution of Land by Ownership

5.6.2 Mine Sustainability (in Terms of Land)

The open cast coal mining will impact the present land use of the area. In the project report i.e. Mining Plan and Environment Impact Assessment Report, mitigation measures have been proposed for reclamation of the mine degraded land and plantation in the available areas to increase the forest area/green area.

The Board of Directors has passed resolution for faithful implementation of the Mine Closure Plan and for opening the ESCROW accounts with any schedule bank and has also authorized the Director, SMRPL for dealing with all matters related to the mine. Mine closure plan has been prepared with provision of ESCROW fund to be deposited with the Coal Controller Organization (on behalf of the Central Govt.). The project will undertake progressive and final mine closure activities as proposed in the Environmental Management Plan. This will help in restoration of the mine degraded land like excavated pits and OB and convert the post mining land use for sustainable livelihood generation for the local communities.

Table 5.13: Post Mining Land Use of Coal Mining Blocks

Mining Activity	Proposed Land Use Area (Ha)	Land Use (End of Life) Area	Agriculture Land	Plantation	Water Body	Public Use	Forest land (Returned)	Undisturbed	Total
Excavation Area	2,096.59	2,096.59	-	1,843.03		-	1943.03	-	1843.03

Backfilled Area (in Excavation Area	1,796.23	1,796.23	-	1,843.03	-	-	18743.03	-	1843.03
Excavated Void (in Excavation Area)	300.36	300.36	-	-	253.56	-	-	-	253.56
Top Soil Dump	35.34 (Upto 5th Year)	35.34 (Upto 5th Year)	-	-	-	-	-	-	0.00
External Dump	387.55	387.55	-	387.55	-	-	387	-	387.55
Safety Zone	19.73	19.73	-	19.73	-	-	19.73	-	19.73
Haul Road between quarries	-	-	-	-	-	-	-	-	0.00
Road diversion	4.13	4.13	-	-	-	4.13	-	-	40.13
Settling pond	2.20	2.20	-	-	2.20	-	-	-	2.20
Road & Infrastructure area	20.80	20.80	-	20.80	-	-	20.80	-	20.80
CHP & Washery	8.10	8.10	-	8.10	-	-	8.10	-	8.10
Coal Evacuation Route & Approach Road	1.15	1.15	-	1.15	-	-	1.15	-	1.15
Garland drains	5.34	5.34	-	5.34	-	-	5.34	-	5.34
Embankment	7.50	7.50	-	7.50	-	-	7.50	-	7.50
Green Belt	46.80	46.80	-	46.80	-	-	46.80	-	46.80
Water Reservoir	-	-	-	-	-	-	-	-	0.00-
Rationalization area	72.11	72.11	-	72.11	-	-	72.11	-	72.11
Total (exclude back filled void & Topsoil area)	**2672.0**	**2672.0**	**-**	**2412.1**	**255.7**	**4.1**	**2412.11**	**-**	**2672.0**

Source: Mining Plan

In this project, about 1438.729 hectares of forest land is involved. For diversion of forest land, Application has be filled. With these measures, it is evident that the project will not have adverse impacts on the carrying capacity of the mining area.

5.7 Socio Economic Environment

5.7.1 Baseline

- More than 90% of the main workforce is engaged in agriculture and its agriculture Labourers in rural area of the study area.
- Majority of workers are practicing farming activities without any irrigation source; it means that area under irrigation is very low and maximum area is covered by unirrigated land
- About 17% of the working population in the surveyed villages are engaged as marginal workers i.e they are engaged for temporary work or the job is seasonal in nature
- Maximum populations in the region are scheduled tribes and follow their own tradition and culture and their economy is mostly depended on forest produce.
- Most of the villages have Primary School while in some villages it is extended up to Middle School. While for further education villagers go to the town places that are to Khanua Nawa, Chalari, Baidhan and in Raj Milan town.
- Literacy level in the villages of the study area is very poor only 43% people in the area are literates
- The main source of drinking water supply is through hand pump and tube well while few villages have untreated tap water facility. But majority of respondents expressed unsatisfactory opinion regarding the availability of drinking water facility as the villages mainly have open wells which are not portable for drinking
- Government medical facility is poor in the villages and villagers expressed unsatisfactory opinion regarding the facilities available at the centre.
- Power supply is available in mostly all the sampling villages. Street Lights are also available in all villages but frequent power cut/ load shedding problem is experienced by the people in the area
- Wood, kerosene and LPG gas is a major fuel used for cooking purpose
- Post office is available in the surveyed villages few have sub post offices and banking facility is available within the villages

5.8 Biological Environment

5.8.1 Baseline

Terrestrial Ecosystem

A total of 74 tree species representing terrestrial ecosystem of the study area followed by 9 climbers, 36 Shrubs, 60 Herbes, 14 Grasses, 9 Climbers and 2 epiphyte,. The biodiversity did not vary greatly from plot to plot on the whole of the study area including core zone, buffer zone and reserve forest area.

Aquatic Ecosystem

All the water bodies (Lentic & Lotic) have strong self-purification system which controls the entire functioning of the ecosystem. All kinds of aquatic biota, their composition and distribution dependent upon the geo-morphological and physico-chemical characteristics of the water bodies. Aquatic biodiversity of any water body reflects its potential to carry the external pollution load from the nearby catchment area. During the present study, physico-chemical and biological characteristics of all water bodies situated in the study area of Dhirauli Coal Block indicates it's healthy and productive nature. Surface water at all the sampling sites located nearby the proposed project is suitable for drinking, aquaculture practices, irrigation and other usage of domestic purpose.

5.8.2 Pollution load and mine sustainability

Efforts are therefore required to plan and implement reclamation of mined out areas, avenue and block plantations having diverse native plant species in order to improve the diversity index in the core zone and to bring them at par or even better than the one existing in the reserve forest area in the surrounding.

On the other hand, entire ecological status (water quality and biological components) of these water bodies and their adjoining streams can be protected against further deterioration through the following points:

- Siltation wetland should be constructed at sewage entering sites at every village located on the river bank.
- Desilting and cleaning work should be conducted at the shallow sites of the river.
- Public awareness program can be organized to create awareness for cleaning, conservation and management of riverine ecosystem.
- Plantation can be done at riparian zone of the river to reduce the soil erosion of the river bank, which may enhance the natural habitat of local faunal species.

5.9 Status of Mining Practices in Proposed Coal Blocks Including Reclamation Method Proposed

Table 5.14: Status of Mining Practices in Proposed Coal Blocks

Mining Practices	Dhirauli
Status	Under EC process
Technology adopted for OB removal, Coal extraction & washing	(i) OB removal through controlled blasting. (ii) Coal extraction from underground and opencast.
Reclamation method	Progressive Mine Closure with technical and biological reclamation.
Area to be reclaimed through plantation / grass /agriculture	2416.24 ha
Area reclaimed	2416.24 Ha (Year 45)

CHAPTER-5
RECOMMENDATIONS & CONCLUSIONS

6. RECOMMENDATIONS & CONCLUSIONS

6.1 Recommendations for Common Mitigation Measures

Component	Study component / Action Plan	Responsibility
Physical	Annual Third-Party Audit for compliance of Environmental Clearance conditions	User Agency
	Stringent Air pollution control measures shall be undertaken including development of greenbelt along boundary, wind break at storage yards, washery, automated continuous dust suppression arrangements at loading points, crushers etc. Online Ambient Air Quality Stations to be connected with servers of monitoring agencies etc.	Respective User agencies monitored by concerned Govt. agency
	Zero discharge condition for mining activity implemented. Third Party Annual Audit of surface water management measures including drainage network, sedimentation pond, rain water harvesting etc.	Respective User agencies monitored by concerned Govt. agency
Biological	Annual Third-Party Audit for compliance of Forest Clearance conditions including compensatory afforestation, wildlife conservation plan etc.	State forest department & wildlife department
	Annual Third-Party audit of plantation in ongoing mines.	
	Plantation plans to be prepared in consultation with Forest Department and shall replicate the biodiversity of the land being used for mining.	Respective User agencies monitored by concerned Govt. agency
Socio-Economic	Need Base Assessment, HDI & SROI studies to be undertaken through repurted organizations of the field for implementation of CSR Activities.	Respective User agencies monitored by concerned Govt. agency
	Audit on Implementation of R&R Plans to be done Annually through third party organization.	Respective User agencies monitored by concerned Govt. agency
Mining Technology	Coal extraction shall be done using Eco-friendly Surface Miners. Controlled Balsting Technique (only daytime) shall be done for OB removal.	Respective User agencies
	Coal Washing Technology-Wet washing confirming zero discharge condition and water recycling arrangements.	Respective User agencies
	Coal Transportation shall include- (I) Pit to surface through in-pit conveyor belts. (II) Surface to CHP closed conveyor belts. (III) Transportation of Coal/reject coal to end users through Railway.	Respective User agencies

Component	Study component / Action Plan	Responsibility
	Progressive Mine Closure measures including technical & biological reclamation shall be implemented religiously with Third Party Audit through agency recognised by Coal Controller.	

6.2 Recommendation & Conclusion for cumulative impact of the Area

6.2.1 Air Environment

The opencast mining operation will, generate high levels of particulate matter (PM) and to very limited extent of SO2, NOx, and CO due to blasting for OB removal (using explosives), fuel oil combustion, etc. Heavy and light vehicles are the major sources of CO in the mine. All vehicles and their exhausts will be well maintained and regularly tested for pollutants concentration.

Outcome of the study clearly indicates that levels of all the parameters for Air quality are within the permissible limit. Mining activities can be continued sustainably with mitigation measures already imposed as part of Environmental Clearance keeping in view the recommendations mentioned at para 5.1 above. The ground level concentrations are computed for high 1st high 24-hr concentration values for all the baseline air quality monitoring stations by selecting them as discrete Cartesian receptors in the modeling area so that 10 receptors points taken for computation 24 - HR. Air Quality Index for study area falls under good, satisfactory and moderate categorization as per the data obtained during baseline studies. Due to implementation of the project and activity of cluster mine the AQI index of the area will Change from satisfactory to moderate on few locations.

Following measures are recommended to mitigate the fugitive dust from different operations:

• To avoid the dust generation from the drilling operations, wet-drilling will be adopted.

• Use of appropriate explosives for blasting and avoiding overcharging of blast holes.

• The volume of dust rising from dumps by the action of wind will be controlled significantly by planting grasses on slopes and native plants on dumps soon after their formation / attaining final profile.

• Haul roads will be the major source of dust in the opencast mines. To overcome the problems of dust generation from mine haul roads, Water spraying on haul roads and permanent transport routes at required frequencies.

Avenue plantation along roads.

Taking up plantation around the quarry and OB dumps in three rows, which will serve as a barrier to prevent the dispersion of dust.

• Effective dust suppression measures will be taken up at pit head coal handling plant (CHP). The crusher house will be enclosed to the extent possible and dust suppression arrangement will be provided at suitable locations in the CHP. All conveyors, screens, crusher etc. will be provided with covers to avoid fugitive dust during operation. Some of the measures proposed to be adopted at CHP in order to control dust emission include:

i) Height of Coal fall to be minimized at all coal transfer points,

ii) Internal lining of chutes and bins will be done to take care of abrasion & dust and

iii) Continuous water spraying arrangements will be made for dust suppression

• The additional control measures on dump like thick plantation, stabilization and additional green belt along the boundary is recommended to control the dust concentrations.

6.2.2 Water Environment

Baseline data as well as outcome of the study clearly shows that all the parameters of the water are well within the permissible limit. Outcome of the study clearly outline that coal blocks will not have any negative impact over ground water in and around the mine site in view of the ground water recharge measures as well as natural recharge phenomenon due to mining activities. In view of the same, it can be concluded that the study has sufficient & sustainable capacity in terms of groundwater.

Hurdul Nala flows from east to west from the center of block, to mitigate the water pollution following measures are recommened to the proposed project:

Mitigation Measures for Abating Water Pollution

(a) Effluent from mine

To prevent surface water contamination, following control measures are proposed in Environmental Management Plan:

- Mine water should be pumped to settling tank for settling and then the clean water will be pumped out and discharged.
- Leak proof containers should be used for storage and transportation of oil/grease.
- To avoid oil/grease spillage in the store, the container containing oil/grease should be kept in empty open containers of higher volume than these containers.
- The area over which oil/grease is handled should be kept effectively impervious.
- Any wash off from the oil/grease handling area or workshop should be drained through impervious drains, collected in specially constructed pit and treated appropriately.

- The sewage waste will be discharged to appropriately designed septic tanks and soak pits to prevent any pollution of surface or ground water.
- All the effluent tested regularly before discharging into the natural drains should meet the applicable standards and need regular monitoring.
- The surface and ground water in and around the mine, loading plant and infrastructure should be tested as per the monitoring schedule and appropriate control measures should be adopted, if required.
- All stacking and loading areas should be provided with proper garland drains equipped with baffles to prevent wash offs from reaching the downstream natural channels.

(b) Storm water

Control measures to be adopted are briefly discussed below:

- Check dams should be provided to prevent solids from wash off and screen, if any, from the mine related activities.
- Peripheral bunds should be erected on the outer edge of the abandoned benches before reclamation so that the soil is not carried away by storm water.
- A water gradient of about 1 in 100 will be kept at every bench towards inside of the bench to prevent formation of gullies in the bench slopes causing serious erosion.
- Chutes should be constructed by using local stone masonry to guide the water in areas with loose soil to prevent suspended solid load in run-off and uncontrolled descent of water wherever necessary.
- Construction of garland drains around freshly excavated and dumped areas so that flow of water with loose material is prevented.
- The mine water should be passed through specially constructed catch pits to arrest any loose material being carried away with water.
- Any areas with loose debris within the leasehold should be planted.
- Garland drains should be constructed surrounding the waste dumps and should be connected to the surface water reservoir to avoid the run-off mixing directly to natural water channels before settling.
- Run-off water from mine pit should be directed to the settling pond.

(c) Riverine Ecology Management

The planktonic population of the stream is inherently poor due to constant change in water flow as (Hurdul Nala is seasonal in mine lease area), habitat structure and thus

has a less role to play in ecological niche. The aquatic species of Jharia/ Jhana Nala is similar to Hurdul nala.

During the post impoundment period following measures shall be followed:

- Periodic monitoring of the changes taking place in the geomorphology and aquatic ecology and suggesting appropriate improvement measures for enrichment of fisheries and aquatic ecology as whole.
- Habitat / Eco-region-based improvement & management
- The diverted Nala route shall be vegetated to improve the habitat / landscape and to overcome soil erosion.
- Regular monitoring of water quality of Diverted Nala in upstream & downstream shall be undertaken.

Thus, the proposed projects will not have adverse impacts on the carrying capacity of the mining area.

6.2.3 Land Environment

Outcome of the study highlights the project-wise land use, reclamation measures undertaken/proposed etc. Total area of core zone is 2672 ha including forest & non-forest area. As per reclamation measures proposed in Mining & Mine Closure Plan about 2416.24 ha of area will be reclaimed through plantation, however, total forest area diverted/to be diverted is 1438.729 ha. It is eveident that these measures will increase the net forest area and a good vegetation cover will be available by end of the mine life.

Depend on the drainage pattern of the area where waste dumps are located, retaining walls, Garland drain and Settling Pits will be provided. A series of settling pits along with a main settling tank at the outlet of the garland drains will be provided to arrest the wash-off solid particles. The settling tank will be provided with three compartments each of with adequet width to arrest the suspended solids followed with the chamber to arrest any oil particles. The last chamber shall contain the clean water which will be ultimately discharged.

The effluent coming out from HEMM washing in base Workshop will contains suspended solids, TSP, oil and grease and the same will be sent to a grease trap. After removal of grease, the effluent from the Grease Trap will be fed to a settling tank with oil skimming arrangement in the Effluent Treatment Plant (ETP). The effluent of the settling tank will be utilized in haul road dust suppression.

Thus, the proposed projects will not have adverse impacts on the carrying capacity of the mining area.

6.3 Justification for Requirement of Opening of New Coal Mine vis-à-vis Demand

Coal is the most important and abundant fossil fuel in India. It accounts for 55% of the country's energy need. The country's industrial heritage was built upon indigenous coal The proposed production of Dhirauli coal mine is 6.5 MTPA (5.0 MTPA capacity through open cast and 1.5 MTPA production will be achieved by underground mining) to supply coal for open market.

Commercial primary energy consumption in India has grown by about 700% in the last four decades. The current per capita commercial primary energy consumption in India is about 350 kg/year which is well below that of developed countries. Driven by the rising population, expanding economy and a quest for improved quality of life, energy usage in India is expected to rise. Considering the limited reserve potentiality of petroleum & natural gas, eco-conservation restriction on hydel project and geo-political perception of nuclear power, coal will continue to occupy center-stage of India's energy scenario. Indian coal offers a unique eco-friendly fuel source to domestic energy market for the next century and beyond.

ANNEXURES

ANNEXURE-1
ALLOTMENT LETTER

ANNEXURE-2
TERMS OF REFERENCES ISSUED BY MOEF&CC

ANNEXURE-3
LAB DATA (BOTH SEASON)