DRAFT ENVIRONMENTAL IMPACT ASSESSMENT REPORT

of

EXPANSION OF THERMAL POWER PLANT
4 x 600 MW
TAMNAR, Tehsil GHARGHODA , Dist RAIGARH (CHHATTISGARH)

by

JINDAL POWER LIMITED

EMTRC

JUNE 2009

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4 X 600 MW = 2400 MW
TAMNAR, Tehsil GHARGHODA , Dist RAIGARH (CHHATTISGARH)

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FOR PUBLIC HEARING

This draft EIA report has been prepared for the purpose of Public Hearing to be organized by Chhattisgarh Environment Conservation Board as per the provisions of EIA Notification dated 14th September 2006. The Terms of Reference for this EIA was approved by the Ministry of Environment & Forests, Government of India vide Letter No. J-13012/117/2008-IA-II (T) dated 31-3-2009.

Process details mentioned in this report have been taken from the Project Report of JPL. Baseline data has been collected and collated from authentic government sources and assessed using scientific tools and methods, analytical reasoning and professional judgment. Every possible due diligence has been done to verify and place the facts and figures.

This document has been prepared for the above titled project and it should not be relied upon or used for any other project without the written authority of EMTRC Consultants Pvt. Ltd and JPL.

Issue Record:

Ref.	Date	EMTRC Consultants Private Limited	Jindal Power Limited	Remarks
		Checked and Approved by	Checked and Approved by	
67	12. 6. 2009	Dr. J. K. Moitra	Mr. Atul Garg	Draft Report

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LIST OF ABBREVIATIONS

AAQ	Ambient Air Quality
CGWB	Central Ground Water Board
CECB	Chhattisgarh Environment Conservation Board
CO	Carbon Monoxide
CPCB	Central Pollution Control Board
CSR	Corporate Social Responsibility
DSH	District Statistics Handbook
EF	Exceedance factor
EMP	Environmental Management Plan
GOI	Government of India
GLC	Ground Level Concentration
JPL	Jindal Power Limited
MOEF	Ministry of Environment and Forests, New Delhi GOI
NAMP	National Air Quality Monitoring Program
NAAQS	National Ambient Air Quality Standards
NOC	No Objection Certificate
NO_x	Nitrogen Oxides
PTS	Public Transport System
RSPM	Respirable Suspended Particulate Matter
SO_2	Sulphur Dioxide
SPM	Suspended Particulate Matter
STP	Sewage Treatment Plant

Units Used

l	Liter
kl	Kilo liter
m^3	Cubic meter
t	ton
kmph	Kilometer per hour
ppm	Parts per million
$\mu g/m^3$	microgram per cubic meter of air
mg/Nm^3	milligram per normal cubic meter of air
MCM	Million Cubic Meter (per annum)
MLD	Million Litres per day
MTPA	Million Tons Per Annum
TPH	Tons per hour
m/s	Meters per second
dB(A)	Decibels (A-Weighted)

CHAPTER 1 – INTRODUCTION

1.1 Purpose of the Report

As a step towards augmentation of power supply to meet the growing power demand in India, Government of Chhattisgarh and Jindal Power Limited (JPL) has entered into an understanding to enhance the power generation capacity by installing, operating and maintaining power plants in the State. JPL has already established 1000 MW (4 x 250 MW) power plant at Tamnar in Raigarh district. JPL proposes to set up additional 2400 MW (4 x 600 MW) thermal power plant adjacent to the existing power plant.

The Draft Environmental Impact Assessment report is prepared for the proposed 2400 MW (4 x 600 MW) expansion of the thermal power plant for Public Hearing. The Terms of Reference for the EIA study has been prescribed by the Ministry of Environment and Forests, Government of India vide letter J.13012/ 117/ 2008-IA.II (T) dated 31st March 2009. The final EIA report will include the observation and comments of the public hearing and presented to the MOEF for obtaining Environmental Clearance

Environmental Impact Assessment (EIA) serves as useful tool in prediction of potential impacts on the surrounding environment due to developmental project. It helps the project proponent, impact assessment authorities, regulatory agencies and other stakeholders in understanding the project and mitigation measures, environmental impact and establishing emission requirements and other measures early in the project cycle. This report describes the project location, baseline environmental scenario, potential impacts of the project on the environment and proposed measures for effective environment management during the project cycle (Environmental Management Plan during construction and operation stage of the project).

1.2 Nature and Size of the Project

The proposed coal based thermal power plant of capacity 2400 MW (4 x 600 MW), based on conventional technology is a mega power project. The total land requirement for the expansion project is 1041 hectares, which includes 491 ha for ash dyke, 100 ha for water

reservoir and 100 ha for colony as per CEA norms. The coal requirement for 2400 MW plant is 11.7 MTPA. JPL has applied for the long term coal linkage to the Ministry of Coal which is in the final stage of approval. JPL has already existing captive coal bock Gare Palma Block IV/2 and IV/3, and in the event, coal linkage and transportation system of coal gets delayed, JPL would request Government of India permit using this coal for the proposed expansion. Coal will be transported through rail and pipe conveyor. The water requirement for 2400 MW is 8000 m^3/hr will be met from Mahanadi River and brought to the site by means of pipelines. The pipeline will follow the road route. The project cost is Rs.9600 crores. The funding of the project cost is proposed at a debt to equity ratio of 75 : 25.

1.4 Project Proponent

Jindal Power Limited (JPL), a subsidiary of M/s Jindal Steel and Power Ltd. (JSPL), was formed in 1995 under the Companies Act, 1956 with an intention to establish, operate and maintain power plant in India. JPL already established 1000 MW (4 x 250 MW) thermal power plant near village Tamnar in Raigarh District of Chattisgarh State. The plant is operating at more than 90% PLF for last 2 years. M/s Jindal Steel and Power Ltd. (JSPL) have proven experience in installation, operation and maintenance of power plants and thermal power plants. JSPL owns and operates 2.4 MTPA integrated power plant at Raigarh in Chattisgarh.

1.5 Project Location

The proposed thermal power plant will be located adjacent to the existing 1000 MW thermal power plant near Village Tamnar, Tehsil Gharghoda in Raigarh District of Chattisgarh State. The location map of the site is provided in **Figure 1.1.**

The project site is located more than 25 km north of Raigarh city in the State of Chhatisgarh. National / State Highway 216 (Raigarh – Gharghoda) is located about 10 km from proposed site in west direction. The site is approachable from this highway through a metalled road going upto the Gare Mines. Kelo river flows from east side of the plant. A distance of 500 m from the river bank to the boundary wall of the site has been maintained.

The river bank is also the High Flood Level, because the river flows much below the bank. The Mumbai - Howrah railway line is located about 30 km south east of the site (at Raigarh). The nearest railway station is Raigarh. There are no ecologically sensitive habitats like national parks, biosphere reserves, wildlife sanctuary, wetlands, archaelogically notified monuments and defence installations within the 10 km radius of the site. Several small – medium sponge iron plants, rolling mills, ferroalloy plants, induction furnaces and industrial park are present within 10 km of the site. The coal mines of Gare-Palma block are also located within 10 km of the site. The region is identified as a seismic zone III in accordance with the IS:1893, Part 3. Climatic condition of the area is hot and humid.

The proposed power plant site is shown in **Figure 1.2**. The coordinates are as follows

A - 83^{o}26’33”, 22^{o}6’12”
B - 83^{o}26’52”, 22^{o}6’12”
C - 83^{o}26’52”, 22^{o}5’53”
D - 83^{o}27’27”, 22^{o}5’49”
E - 83^{o}27’19”, 22^{o}5’39”
F - 83^{o}26’33”, 22^{o}5’40”
G - 83^{o}26’24”, 22^{o}5’29”
H - 83^{o}26’14”, 22^{o}5’33”
I - 83^{o}26’28”, 22^{o}5’49”

The proposed water reservoir is also shown in **Figure 1.2**. The coordinates are as follows

A - 83^{o}26’01”, 22^{o}4’48”
B - 83^{o}26’33”, 22^{o}4’45”
C - 83^{o}25’57”, 22^{o}4’09”
D - 83^{o}26’39”, 22^{o}4’06”

The proposed locations of ash pond site are also shown in **Figure 1.2**. Five locations have been identified to locate the ash pond site. The coordinates of all the five sites are shown in Tables below.

Based on detailed analysis and presentation before the Expert Committee, the following Site I and Site II have been selected to locate the ash pond for the 2400 MW expansion project. The coordinates are shown in the Table 1.1.

Table 1.1 Alternate Analysis of Ash Pond Sites

	Parameters	**Alt Site I**	**Alt Site II**
1	Location	South of Dolesara village	South of Rodopali village
2	Coordinates	A-83^{o}25'32", 22^{o}8'14" B-83^{o}26'51", 22^{o}8'13" C-83^{o}25'32", 22^{o}7'35" D-83^{o}26'54", 22^{o}7'37"	A-83^{o}26'24", 22^{o}9'30" B-83^{o}27'44", 22^{o}9'30" C-83^{o}26'24", 22^{o}8'49" D-83^{o}27'44", 22^{o}8'49"
3	Land area, ha	250	275
4	Displacement	Nil	Nil
5	Forest land	Nil	Nil
6	Type of land	40% fallow, 60% single crop land	60% fallow, 40% single crop land
7	Hydrology	2 km away from Kelo river. 3 small nallas crossing the site	2 km away from Kelo river. 2 small nallas crossing the site
8	Nearby villages (population in bracket)	Dholesara (1061), Mauhapalli (670) Population - 1731	Rodopali (686), Mudagaon (520), Pata (1189) Population-2395
10	Ecologically sensitive area in 10 km area	None	None
11	Nearby Forests	None	None
12	Approach	Approach road exists	Approach road exists
13	Ash transport	By pipeline	By pipeline
14	Distance from TPP	1.5 km	2 km
15	Advantage	Located adjacent to existing ash pond	Located near to existing ash pond
16	Disadvantage	None	None
17	Status	Best site	2nd best site

The following Site III, Site IV and Site V have been found unsuitable to locate the ash pond.

	Parameters	Alt Site III	Alt Site IV	Alt Site V
1	Location	East of Patrapali village	East of Jharna village	West of Devgaon village
2	Coordinates	A-83°22'57", 22°9'29" B-83°24'7", 22°9'26" C-83°22'56", 22°8'36" D-83°24'4", 22°8'33"	A-83°29'20", 22°6'19" B-83°30'58", 22°6'13" C-83°29'19", 22°5'32" D-83°30'57", 22°5'48"	A-83°27'30", 22°4'13" B-83°28'48", 22°4'3" C-83°27'27", 22°3'28" D-83°28'44", 22°3'17"
3	Land area, ha	250	210	260
4	Displacement	Nil	Nil	Nil
5	Forest land	Nil	Nil	Yes
6	Type of land	20% fallow, 60% single crop land	50% fallow, 50% single crop land	30% fallow, 70% single crop land
7	Hydrology	1 km away from Pajhar river. 6 small nallas crossing site	1 km away from Kelo river. 4 small nallas crosses the site	0.5 km away from Kelo river. 8 nallas crosses the site
8	Nearby villages (population in bracket)	Jharlapali (747), Patrapali (425) Jhankadarba (317) Population-1489	Libra (1181), Jharna (1265), Jhinkapani, Bagbari (379) Population-2825	Devgaon (1079) Population-<500
10	Ecologically sensitive area	None	None	None
11	Nearby Forests	None	None	Reserve forest
12	Approach	Approach road exists	Approach road exists	Approach road exists
13	Ash transport	By pipeline	By pipeline	By pipeline
14	Distance from TPP	4 km	3 km	1.5 km
15	Advantage	Land availability	Located near coal mines	Land availability & low population
16	Disadvantage	Located opposite river	Located opposite river	Located opposite river
17	Status	4th best site	3rd best site	Rejected by MOEF

The Satellite Imagery Map of the project area and ash pond area, showing surrounding landforms (land use) has been procured from National Remote Sensing Agency. The map has been geo-referenced by the NRSA. The latitude and longitude of all the sites has been obtained from this geo-referenced NRSA imagery. The Satellite Imagery is shown in **Figure 1.3.**

Several forests are present within 10 km area of the proposed project site. Name of the Forests are Taraimal RF, Kharidungri RF, Rabo PF, Lakha PF, Barachhar RF, Durgapani-

Chhirwani PF, Punjipatra PF, Suhai RF, Silot RF, Samaruma RF, Tolge East RF, Jamkani RF, Bhawarkhol RF, Jamkani RF, Osakothi RF, Garjanjgor RF, Kalatpali RF, Dandpani RF, Maghat PF, Gare PF, Rampur PF and Gidhapahar RF.

Kurket river, Kelo river, Pajhar nadi and Digi nala and their minor tributaries are the watercourses present within 15 km radius of the site. Dam on Kurket river, Rabo Dam, some small dams / irrigation weirs and village ponds are the water bodies present within 10 km area.

The forests, rivers, streams and other water bodies are also seen in the Survey of India Toposheet shown in **Figure 1.2**.

1.5 Importance of the Project

With the aim to achieve Power for all by the year 2012 and considering the high growth rate of economy, the Govt. of India has envisaged capacity addition of 1,00,000 MW in next 6 years. This translates to almost doubling the existing capacity. Considering the fact that at present there is around 13% overall deficit of power availability with the present installed capacity, there is an immediate need to install power projects to achieve the economic growth projection which has been planned to meet the supply and demand equilibrium.

To meet the future power demand of the country and as a part of its expansion program, Jindal Power Limited is contemplating to set up 2400 MW (4 x 600 MW) coal based power plant adjacent to the existing 1000 MW O.P.Jindal Super Thermal Power Plant, near village Tamnar in Raigarh District of Chhattisgarh State. Coal blocks are available in plenty in the Raigarh - Mand and Gare Palma Coalfields, where the estimated reserves are of the order of 1500 -1800 million tons. Presently about 8 - 10 coal mines are under operation and about 20 other mines have been allotted by the Government of India for development.

The proposed thermal power project shall bridge the power demand - supply gap of the country and serve as a catalyst for industrial development of Chhattisgarh State. Apart from the above benefit there is a large scope of employment opportunities in the region.

1.6 Scope of EIA Study

The Environmental Impact Assessment report has been prepared for the proposed 2400 MW (4 x 600 MW) thermal power plant expansion to be set up near village Tamnar, in Raigarh District of Chattisgarh State by Jindal Power Ltd, a O.P Jindal Group Company. The Terms of Reference for the EIA study has been prescribed by the Ministry of Environment and Forests, Government of India vide letter J.13012/ 117/ 2008-IA.II (T) dated 31st March 2009. Point-wise compliance of the TOR conditions is provided in Appendix 1.

Chapter 1. Introduction (This chapter will describe the purpose of the report, Identification of nature, size and location of the project (with latitude and longitude) and its proponent, Description of site and surrounding environment, Location maps, Importance of project to the country and region and finally the Scope of the REIA study, as per TOR approved by MOEF)

Chapter 2. Project Description (This chapter will describe the Type and Need of the project, Magnitude of operation, Schedule for approval and implementation, Land requirement, Water requirement and flow scheme, Technology and Process description, Site plan, Layout of project location, boundary and site, Description of mitigation measures to meet the environmental standards)

Chapter 3. Description of the existing Environment (This chapter will describe the study area, period of study, components and methodology, Establishment of baseline data for valued environmental components and base maps of all environmental component like Meteorology, Ambient air quality, Ambient noise quality, Hydrology and water quality, Land use, Agriculture, Soil quality, Ecology, Demography, Occupational pattern and Socio-economics.)

Chapter 4. Anticipated Environmental Impacts and Mitigation Measures (This chapter will describe the details of investigated impacts due to project location, Possible accidents, Project design and construction, regular operation, Measures for minimizing and / or offsetting adverse impacts identified, Irreversible and Irretrievable commitments of environmental components, Assessment of significance of impacts [criteria for determining significance, Assigning significance] and Mitigation Measures.

Chapter 5. Environmental Management Plan (This chapter will describe the administrative aspects of ensuring that mitigation measures are implemented and their effectiveness monitored after approval of the EIA).

Chapter 6. Risk Assessment (Additional Studies) (This chapter will describe outcome of Public Hearing, Risk Assessment and DMP, Social impact assessment and Rehabilitation and Resettlement Action Plan)

Chapter 7. Environmental Monitoring Program (This chapter will include the technical aspects of monitoring the effectiveness of mitigation measures including measurement methodologies, frequency, location, data analysis, reporting schedules, emergency procedures)

Chapter 8. Project Benefits (This chapter will include improvement in physical infrastructure, Improvement in social infrastructure, Employment potential of skilled, semi-skilled and unskilled persons, other tangible benefits derived from the proposed project)

Chapter 9. Summary and Conclusion (This chapter will describe the overall justification for implementation of the project, and explain methods by which adverse affects of the proposed action have been mitigated)

Chapter 10. Disclosure of Consultant Engaged

The purpose of Environmental Impact Assessment (EIA) is to determine as precisely as possible, within the present limits of knowledge and expertise, the likely environmental impacts of the proposed project. The objective will be to establish a clean unit whose

waste, if any, can be recycled / reused to the maximum extent feasible. Feasibility of reuse and disposal of liquid and solid wastes generated from the project will be explored.

1. The study area covers an area of 10 km radius around the proposed power plant site. Baseline environmental quality of the study area has been assessed based on secondary data collected from various sources supplemented by data generated at site during the period 1st December 2008 to 28th February 2009.

a) **Land Environment**: Data on land use of the study area generated from secondary information collected from district / tehsil statistical records and using satellite imagery.

b) **Meteorology**: Meteorological data for wind speed, wind direction, relative humidity and ambient temperature generated within the study area. Readings were noted on hourly basis. Historical met data from IMD – Raigarh obtained to assess the climatic trend. Data on mixing height and stability class obtained from CPCB publication and used for mathematical modeling.

c) **Ambient Air**: AAQ data of the study area generated by following the guidelines for ambient air quality monitoring published by CPCB (Guidelines for Ambient Air Quality Monitoring: NAAQMS/25/2003-04-July 2003). Respirable and suspended particulate matter, sulphur dioxide and nitrogen dioxide monitored for the full season. Mercury and ozone levels were also monitored. The monitoring locations selected based on historical wind speed and direction data obtained from IMD and stack emission dispersion modeling using screen model. Monitoring stations located in downwind direction where maximum / significant ground level concentrations from the project are anticipated, in upwind and crosswind directions.

d) **Noise**: Baseline noise levels generated at locations where AAQ monitoring will be conducted. Noise readings taken thrice during the study period using sound level meter during the study period as per CPCB procedure.

e) **Water Quality**: Surface and groundwater sampling location within the study area identified based on drainage pattern, water utilization and location of borewells / dugwells. Ground water quality of the ash pond location and villages around the ash pond also tested. Parameters recommended by CPCB / IS 10500 analysed following the standard methods (APHA Procedure). Sampling done thrice during the study period.

f) **Soil**: Soil samples collected from agriculture fields that are likely to be impacted from the project related air emissions, land disposal of wastewater and solid wastes. Soil quality analysis done for parameters like texture, moisture, organic matter, conductivity, pH, bulk density, water holding capacity and NPK values. Infiltration rate of soil samples collected from the ash pond site will be analyzed.

g) **Flora and Fauna**: The listing of flora and fauna carried out using the Working Plan of Raigarh Forest Division and observations noted during field visits by the experts of the consultant. .

h) **Socio-economic Environment:** Baseline information collected through secondary sources, mainly District Statistics Handbook / Tehsildar's Office: date on population distribution, occupational pattern, agriculture and cropping pattern, educational facility, health care facilities, literacy rate, infrastructure facility, etc collected.

4. Topography of the project site seen with contours. Filling / earth excavation quantified. Strategies suggested to reuse the excavated earth generated from the project site. The impact of the project on the existing drainage pattern addressed and mitigation measures suggested to counter the adverse impact on the existing drainage pattern.

5. Quantification of air pollution load from the proposed project done. Potential environmental impacts assessed qualitatively and quantitatively. The changes in the quality of the environment predicted using ISCST3 Model.

6. Availability of water and impact on other users on account of water drawl for the proposed power plant assessed using historical flow data of streams. Permission from competent authority to draw the required quantity of water obtained. The water consumption for the proposed power plant optimized by considering improvement in COC of CT. 100% wastewater reuse option provided. Strategies suggested ensuring that the wastewater does not contaminate the environment in any manner.

7. Utilization potential of the coal ash explored based on Flyash Utilization Notification of MOEF and considering the existing market demand and supply of flyash in the region. Mitigation measures to prevent leaching, groundwater contamination and prevention of ash from blowing away with wind suggested.

8. Greenery development plan prepared to enhance the aesthetic quality of the environment. The plan also concentrated on measures that will be helpful in attenuating air and noise pollution levels from the project. CPCB guidelines followed to design the green belt. Indigenous species and those having long-term economic value considered for greenbelt development. 20% of the project area reserved to design and develop the greenbelt, landscaping and greenery / gardens / lawns, etc.

9. Rainwater harvesting strategies within the project premises suggested as a measure to augment the available water resources of the area.

10. Based on standard procedures prescribed by the National Safety Council and provisions mentioned in the Factories Act, occupational health and safety aspects of the project identified and discussed.

11. Environmental Management Plan drawn up to maintain and enhance the environmental quality in and around the project area. The EMP earmarked specific staff, instruments and finances for routine environmental management as well as collection, collation and examination of various environmental data. Post-project monitoring plan suggested to monitor the changes in the environmental quality after

implementation of the project. All necessary administrative measures incorporated in the EMP to achieve the following objectives:

- Reduction of adverse environmental impacts
- Improvement of environmental quality of the surrounding area
- Waste minimization, reuse and resource recovery
- Waste segregation to make the treatment and disposal cost-effective
- Establish proper monitoring mechanism with adequate infrastructure

13. Risk assessment study undertaken to tackle any accident that may occur due to the activity. Potential hazards that may arise out of storage / transportation of hazardous chemicals / materials or due to operation of various processes systematically identified using standard hazard identification procedures.

14. Consequence scenarios assessment using CAMEO (Computer Aided Management of Emergency Operations developed by USEPA) carried out for the credible hazards to find out the end points in terms of radiation. Active and passive risk mitigation measures recommended to ensure that the risks are within the 'ALARP' level. Structural plant level Emergency / Disaster Management Plan prepared.

15. Social impact assessment carried out by assessing the various developmental potential of the proposed project in the field of employment generation, improvement in physical and social infrastructure base.

16. All environmental concerns directly related to the project activity, when raised by the General Public, State Administration and NGO during the public hearing process would be duly addressed in the Final EIA along with the commitments of the project promoter.

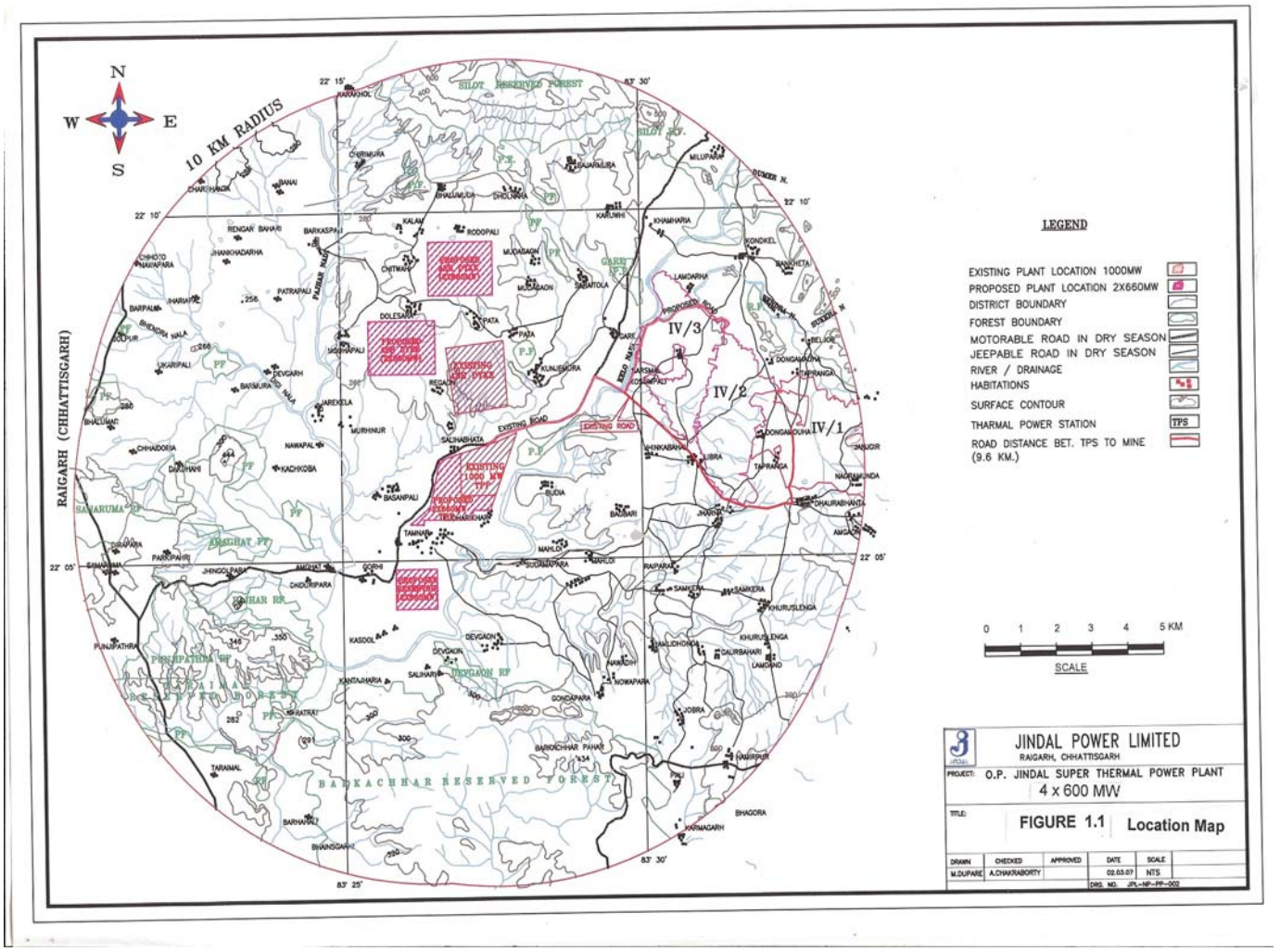


Figure 1.1 Location Map of the Site

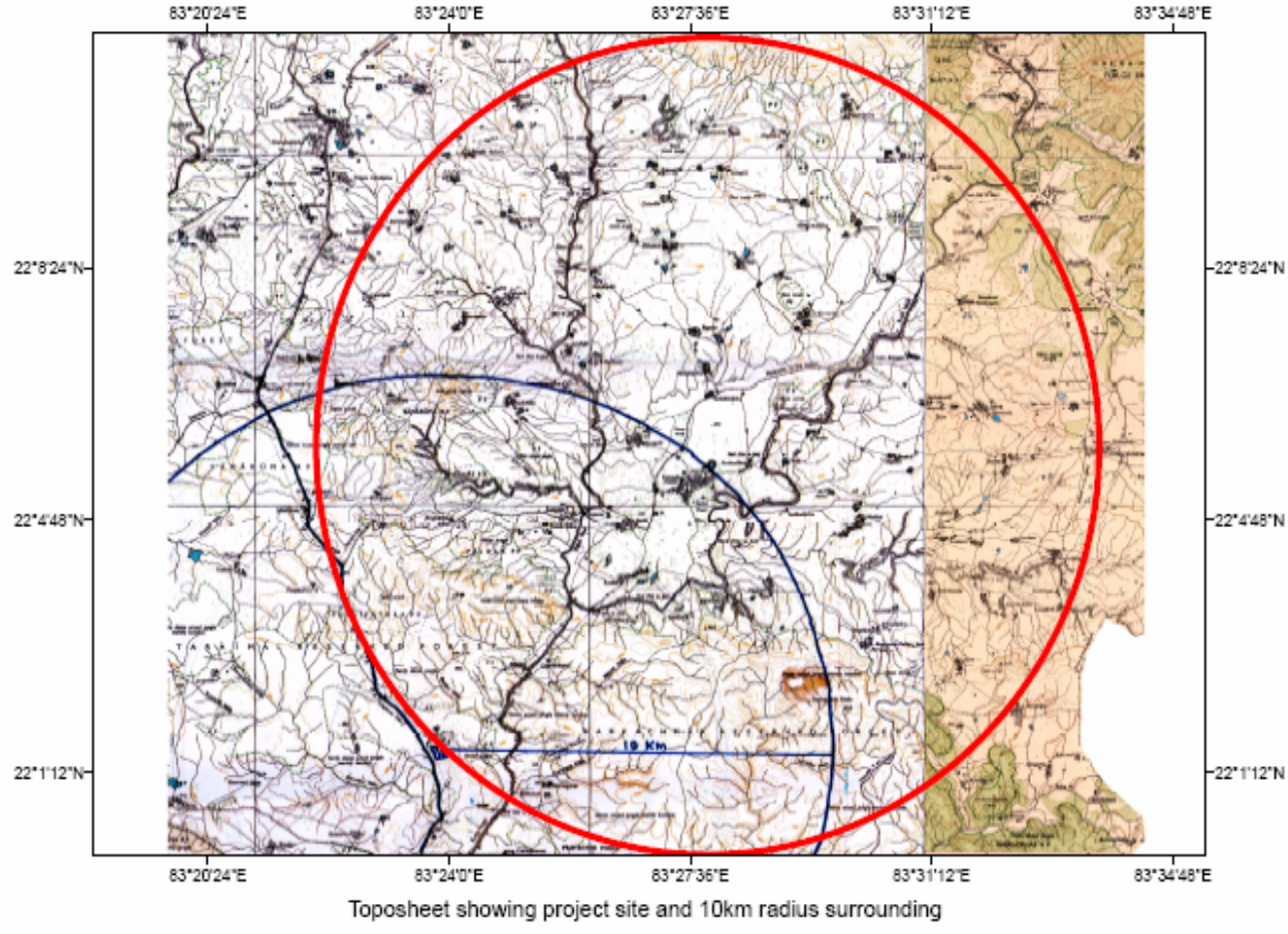


Figure 1.2 10 km Radius Topomap around Proposed Power Plant

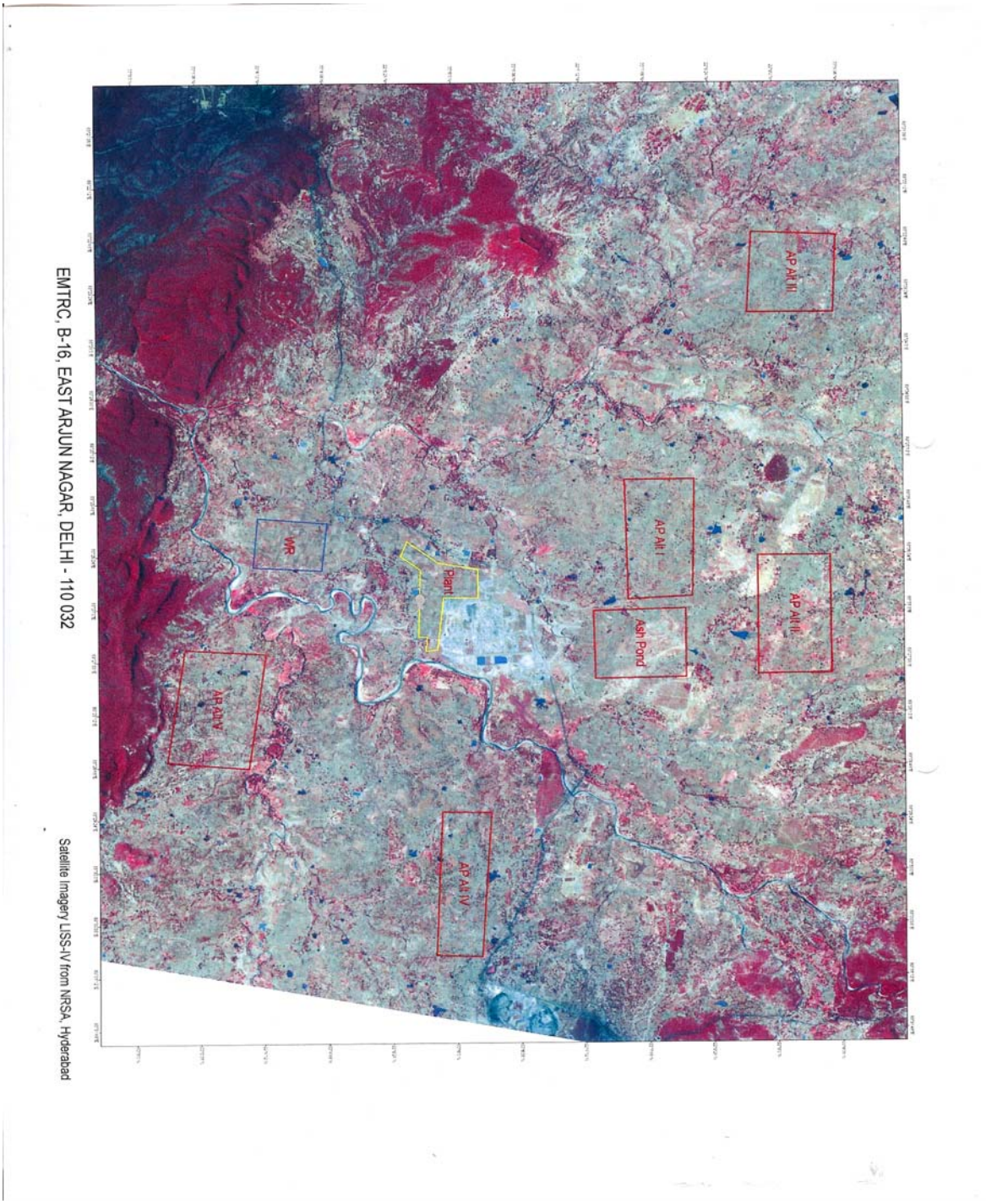


Figure 1.3 Satellite Imagery of the Project Site

CHAPTER 2 : PROCESS DESCRIPTION

2.1 Need of the Project

With the aim to achieve Power for all by the year 2012 and considering the high growth rate of economy, the Govt. of India has envisaged capacity addition of 1,00,000 MW in next 6 years. This translates to almost doubling the existing capacity. Considering the fact that at present there is around 13% overall deficit of power availability with the present installed capacity, there is an immediate need to install power projects to achieve the economic growth projection which has been planned to meet the supply and demand equilibrium.

Considering the future power requirement and as a part of expansion plan of the company, Jindal Power Limited (JPL) is contemplating to set up an additional 2400 MW (4 X 600 MW each) coal based power plant within and adjacent to 1000 MW Power plant of JPL, at Tamnar in Raigarh District of Chhattisgarh State. Due to abundant availability of coal and water, the Chhattisgarh state is currently being developed as “Power Hub” of the Nation, from where the power will be exported to the needy states and to the national capital. Therefore putting up an additional 2400 MW coal fired power plant at this location will be certainly justifiable

2.2 Project Site

The proposed power plant site is located adjacent to the existing 1000 MW (4 X 250 MW) O.P. Jindal Super Thermal Power Plant (OPJSTPP) near the Village Tamnar in Raigarh District of Chhattisgarh State. The site is situated at about 25 km (aerial) north of Raigarh town and it falls in toposheet Nos. 64(N) and 64(O) of Survey of India. The site is approachable from Raigarh by the State Highway which branches off at Punjipathra, about 12 km from the site and 22 km from the Raigarh town. The nearest Railway Station is Raigarh at about 35 km (by road) from the site. The nearest Airport is at Raipur, which is about 280 km and the nearest seaport is Haldia/ Kolkata, which is about 550 km from the site.

2.3 Plant Layout

The plant layout (preliminary) developed for the selected site, is shown in **Figure 2.1.** The layout shows location of main plant equipment, stack, balance of plant, coal yard, CHP, etc.

2.4 Land Requirement

The land identified for the proposed 2400 MW project is 1041 hectares. The land requirement meets the criteria fixed by Central Electricity Authority. The break-up of land requirement, name of villages involved and the number of owners identified till date are shown in the Table 2.1. Most of the land belongs to private landowners. No human settlements or forest land is present on the identified land. Land purchase is being done through mutual negotiation and mutually acceptable terms, as per the Policy of Chhattisgarh and Central Government.

Table 2.1: Land Identified for 2400 MW TPP

S. No.	Description	Area, ha	Name of villages	No. of Owners
1	Plant Area	350	Tamnar, Kunjemura and Kasdol	448 owners
2	Ash Dyke Area	491	Regaon and Dolesara	262 owners
3	Water reservoir	100	Kasdol, Gorhi & Devgaon	50 owners
3	Colony	100	Jinkabahal & Tehlirampur	59 owners
Total		**1041**		**819 owners**

Topography of the project site is more or less flat. Therefore filling / leveling works are not required. Earthworks excavated during construction of civil foundations will be backfilled and also used for landscaping and gardening work within the plant premises. The site is naturally sloped towards Kelo River running on the eastern side. The details of earthworks (cutting and filling) involved at the plant site are given below.

	Terraced Grading		
	FGL (M)	Cutting (M^3)	Filling (M^3)
CT & WT Area	***254.55***	**-135,800**	**146,175**
BTG Area	***254.78***	**-195,260**	**193,425**
Switchyard	***252.89***	**-35,235**	**36,000**
Coal Yard	***253.85***	**-66,550**	**66,325**
	Total :	**-432,845**	**441,925**

2.5 Fuel Requirement

The requirement of coal is about 11.7 million tons per annum (1500 TPH). JPL has applied for the long term coal linkage to the Ministry of Coal. JPL has already existing captive coal bock towards the northeast side of the site (Gare Palma Block IV/2 and IV/3) from where coal is taken for the existing 1000 MW plant. In case coal linkage to this expansion project gets delayed, JPL would request Government of India to permit using coal from the captive mines for the proposed expansion. In this case coal will be continued to be transported through pipe conveyor. In case coal linkage is given from outside Raigarh area then coal will be transported by rail. At present no railway lines connects the project site at Tamnar. Nearest railway station is located at Raigarh, from where laying new railway lines is under active consideration by the Ministry of Railways. The coal analysis is given in Table 2.2.

Light Diesel Oil (LDO) will be used for boiler start-up as well as for flame stabilization during low load operation. The LDO quality data is given in Table 2.3. For the storage of LDO, 2 x 2000 kl capacity has be considered.

Table 2.2 : Coal Analysis

	For Boiler Design	Actual Analysis
Proximate Analysis (% by weight)		
Fixed Carbon	27	30
Volatile Matter	22	24
Moisture	12	12
Ash	39	40
Gross Calorific Value (kcal/kg)	3600	4200
Ultimate Analysis (% by weight)		
Carbon	37	32.18
Hydrogen	2.8	2.29
Sulphur	0.5	0.05
Oxygen (by diff.)	7.7	4.43
Nitrogen	0.9	0.6
Moisture	12	14
Ash	39	40
Hardgroove Grindability Index (HGI)	-	50
Initial Ash Deformation Temp ^{o}C		1200
Hemispherical Temp ^{o}C		1400
Mercury ppm		0.02
Lead ppm		7.63
Chromium ppm		87.5
Arsenic ppm		ND

Source: Central Institute of Mining and Fuel, CSIR (MST, GOI)

Table 2.3 : LDO Analysis

Parameter	Unit	Value
Acidity, Inorganic	-	-
Ash Content	% by weight (Max)	0.02
Kinemetic Viscosity	CSt	2.5 to 15.7 at 400 ^{o}C
Total Sulphur	% by weight (Max)	1.80
Flash Point (Penesky Martens)	^{o}C (Min)	66
Pour Point	^{o}C (Max)	15 to 21
Sediments	% by weight (Max)	0.10
Water Content	% by volume (Max)	0.25
Carbon Residue	% by weight (Max)	1.50

2.6 Water Requirement

Water requirement for the proposed 2400MW power plant will be 8000 m³/h. Water will be taken from Mahanadi River, located about 60 km from the plant site. Water Resource Department, Government of Chhattisgarh has given permission to JPL to draw 70 MCM water after satisfying that this quantity can be given to JPL after meeting the demand of

other users (letter dated 23-5-2008 and 25-6-2008). JPL has deposited the commitment charges and survey charges to WRD.

Pump house will be constructed for pumping water (3 Nos. Pumps, 2W + 1SB) from river to plant. Raw water reservoir will be located near the power plant site. Water pipelines will be laid for carrying water from river to plant site. The pipeline will follow the road route. The water treatment plant shall be consisting of clariflocculator, filtration unit, gravity filters, filtered water sump, activated carbon filters, Demineralising Water Treatment Plant etc.

Close-cycle cooling water system; either Induced Draft (ID) or Natural Draft (ND) cooling towers are proposed. It is estimated that 138000 m^3/hr water (2 x 600 MW) will be required for circulating through condenser and about 8800 m^3/hr (2 x 600 MW) will be required for the various auxiliary coolers, compressors, Evaporative Cooling & Ventilation System, Air Conditioning systems etc. Thus it is proposed to have 3 circulating water pumps (2 working and 1 standby for each unit), each of capacity 37,750 m^3/hr and suitable head and 2 Auxiliary Cooling Water Pumps (1 Working & 1 Standby for each unit), each of capacity 4800 m^3/hr and suitable head for each units. The detail of cooling tower for each unit is given below: -

a) Number of cooling tower	:	Two (2) for each unit in case of IDCT and one (1) for each unit in case of NDCT
b) Design inlet circulation	:	80,600 m^3/hr water flow
c) Cooling range of	:	9°C circulating water

Circulating water pipelines along-with butterfly valves, rubber expansion joints, man-hole etc. shall be provided from cooling towers to condensers and various other coolers.

The water from the boiler blow down and cooling tower blow down will be collected in ash water pond and shall be used for ash handling purpose. Clarifier sludge and filter back wash shall be pumped to ash slurry sump and from there it will be disposed to ash dyke along-with ash slurry.

The water flow diagram showing water requirement at various consumption points (in kl/hour) and wastewater generation points (in kl/hour) along with the management scheme is shown in **Figure 2.2.**

2.7 Plant Technology

The proposed 2400 MW power plant will be based on conventional pulverized technology. The proposed power plant will comprise of steam generators, steam turbines, turbo generators and other auxiliary equipments.

Steam Generator (Boiler)

The Steam Generator will be pulverized coal fired, dry bottom, natural / assisted circulation, single / double reheat, single drum, top supported, balanced draft, semi-outdoor type based on Subcritical technology. Each Steam Generator will be designed to continuous evaporating rating of approx. 1950 TPH with super heater outlet temperature of 540±5 Deg C at 170 ata steam pressure. The steam generating units will comprise of Boiler drum, water cooled furnace wall system, economizer, superheaters, air heater, ID, FD & PA fans, Milling & firing systems and start up fuel oil system. The Boilers will also be equipped with Electrostatic Precipitators (ESPs) of high efficiency above 99.88%.

It is proposed to provide 2 x 60% capacity FD, ID and PA fans with each boiler. It is proposed to use LDO for start-up and low load operation of the Boiler. The Electrostatic Precipitators will be designed for an outlet dust emission of <50 mg/Nm^3 under MCR conditions.

Steam Turbine Generator (STG) set

a) Each steam turbine shall be a multi cylinder, multistage, 3000 RPM, tandem compound, single/ double reheat, condensing regenerative feed heating type unit. Each turbine will be of MCR Capacity of 600 MW and shall be designed for main steam

parameters of 178 ata pressure and 540°C temperature at inlet emergency stop valve of turbine. The HP and IP Turbines shall be of single flow type while LP Turbine shall be of double flow. The turbine will also be designed to meet all safety requirements.

b) The exhaust steam from the Steam Turbine will be condensed in a double pass shell & tube type surface condenser. The condenser will be equipped with vacuum pumps for air evacuation and maintaining vacuum in the condenser.

c) There will be 3x50% capacity Condensate Extraction Pumps (CEP) with each turbine to pump the condensate from the condenser hot well into the Deaerator through gland steam condenser, drain cooler and LP Heaters. From the Deaerator, feed water will be pumped by 3 x 50% capacity Boiler Feed Pumps (BFP) (2x50% steam driven and 1x50% motor driven) into the economizer of the Boiler through HP Heaters.

Power Evacuation

The power from the proposed 2400 MW Power Project will be generated at around 21 KV and will be stepped up to 400 KV / 756 KV and will be connected to the national grid for further transmission of power to various consumers and utilities. The transmission voltage preferred would be 400 KV, which is well established in the country, or 765 kV, which has been planned in the country. The 400 KV switchyard of the existing and proposed plant will be interconnected for better flexibility.

2.8 Description of Major Systems

Milling and Firing System

The mills shall be either Ball & Race Mill or Tube Mill. The raw crushed coal from raw coalbunker will be fed to independent gravimetric feeders at controlled rate to deliver the coal for pulverization. From the mills, the pulverized coal will be transported by means of hot primary air into burners situated at different elevations. The boilers will be provided with attemperation arrangement for superheat and reheat steam temp control.

Each boiler will be provided with oil burners for warm up and stabilization of coal flame. The boilers will be designed to handle and burn LDO oil as a secondary fuel for startup and low load operation. High Energy Arc Igniters will be provided for light up purposes. 15 days storage capacity for LDO shall be provided.

Crushed coal (-20 mm) will be unloaded, stacked and reclaimed inside the power plant premises. Crushed coal stockpile for 30 days storage will be provided inside the plant area.

Ash Handling Plant

The ash generation from each boiler will be in the range of 4.563 MTPA (600 TPH), out of which around 0.913 MTPA (120 TPH) will be bottom ash and 3.65 MTPA (480 TPH) will be the Fly ash. The system envisages the following (i) Intermittent wet or dry removal and disposal of bottom ash (ii) Intermittent dry evacuation of fly ash (iii) Dry collection of fly ash in Silos (iv) Disposal of ash slurry.

In case of wet removal of bottom ash, Bed ash will be collected continuously in rectangular, water impounded storage type ash hopper. Each Bottom ash hopper will have effective 8 hours storage capacity. The bed ash collected in bottom ash hopper will be removed in 60 minutes once in every shift of 8 hours through jet pumps in the form of ash slurry. The ash slurry will be collected in slurry sump from there it will be pumped to ash dyke area through slurry pumps.

The fly ash from economizer, air pre heater and ESP hoppers will be automatically extracted one after another in sequence. Four streams of each boiler are envisaged to clear the collected fly ash in various hoppers through vacuum system. Eight (8) vacuum pumps (Four working + Four standby) each boiler are proposed for creating vacuum in the streams.

For dry fly ash collection, four (4) nos. steel / concrete Silos will be constructed. Fly ash will be discharged from the bottom of silo into trucks for utilizing the ash for various applications such as brick & aggregate making, road embankments, filling the low lying areas etc. Any left over fly ash in the silo will be converted into ash slurry by adding water in

it and the resultant ash slurry will be collected in ash slurry sump where it will be mixed with bottom ash slurry and will be pumped to ash dyke. All out efforts will be made for maximum utilization of ash in the dry form. The water from ash dyke through a decantation well will be collected in one or two clean water reservoir(s). The water from the reservoir(s) will be pumped to ash water pond located inside plant with the help of re-circulating water pumps. The water from the ash water pond will be used in ash handling system. 100% recirculation of water will be maintained.

2.9 Material Balance

Table 2.4 Material Balance of Power Plant

	Input	Quantity, MTPA	Output	Quantity, MTPA
1	Mixture of coal + middlings + fines (from coal washery)	11.7 MTPA	Power	2400 MW
2			Fly Ash	3.65 MTPA
3			Bottom Ash	0.913 MTPA

2.10 Pollution Mitigation Measures

Thermal power station contributes to environmental pollution; however use of subcritical technology will reduce pollution level considerably. The environmental pollution normally occurs in the following manner:

a) Atmospheric pollution through particulate and gaseous emissions
b) Thermal pollution of the surroundings
c) Wastewater generation and discharge
d) Pollution due to discharge of solid wastes
e) Noise pollution.

Air Pollution Control: The activity will create air pollution from following aspects

a) Particulate emission from the stack
b) Sulphur dioxide emission from the stack
c) NO_X emission from the stack
d) Fugitive emission form various sources

Particulate emission from the stack is governed by EPA Notification, which stipulates SPM emission limit of 150 mg/Nm^3. SPM levels of 50 mg/Nm^3 will be achieved from this project by the use of electrostatic precipitators having efficiency not less than 99.9%.

Sulphur dioxide and nitrogen oxides emission is dispersed over a wide area by discharging the flue gases at EPA notified height by constructing two 275 meter high, twin flue Chimney. Two chimney flues will be cased into a single stack. For controlling the NO_x, dry low NO_x burners (DLNB) shall be installed in the boiler.

Coal dust will be suppressed by water spraying arrangements using cooling tower blow down at suitable locations such as transfer points, loading and unloading stations, coal piles etc. Transfer towers and crusher houses will be provided with dust extraction systems. In addition, water sprinklers will be provided in the coal storage area to suppress the coal dust generated during stacking and re-claiming of coal. Coal bunkers will be provided with ventilation system and bag filters / cassette filter. Dry ash silos will be provided with bag filters / cassette filters.

Thermal Pollution Control: It is proposed to use closed cooling system for condenser cooling purposes using cooling towers where the heated water will be cooled down to the specified inlet water temperature. This will result in minimal thermal pollution as hot water shall not be released anywhere. The discharge of blow down will be used for ash slurry disposal. The cooling towers will be of induced draft / natural draft type to ensure sufficient plume height for wide dispersal of heat released into the atmosphere.

Water Pollution Control: This results primarily from the following areas:

a) Effluent from the water treatment plant
b) Run-off from coal handling area
c) Sewage from various buildings in the plant
d) Ash pond effluent.

Effluents from the DM plant resin regeneration circuits, generally acidic from the cation units and alkaline from the anion units, will be neutralized in a neutralizing pit. The neutralized effluent shall have less than 5 ppm suspended solids and a pH value of about 7.5 to 8.0 in line with CPCB standards. The neutralized effluents will be led into the central monitoring basin and ultimately to ash water pond for ash sluicing purpose.

The run-off from the coal handling area will flow into the drains, which will be suitably provided at various places in the coal yard. The run-off collected in this manner will be led to a coal settling pond from where it will be pumped to the ash slurry sump. It is proposed to dispose the sewage from the various buildings in the power plant through sewage treatment plant. The effluents from the sewage treatment plant will be reused for green belt development and other horticulture purpose.

Solid Waste Management: All efforts will be made for maximum utilization of fly ash produced from the power plant in the dry form. The bottom ash and remaining fly ash will be disposed off in slurry form into the ash dyke. The water from ash dyke through decantation well will be collected in one clear water reservoir. The water from the reservoir will be pumped to ash water pond located in the plant with the help of re-circulating water pumps. The water from the ash water pond will be used in ash handling system. Thus a 100% water recirculation system shall be maintained.

Noise Pollution: The major noise generating units in a power plant are turbines, turbo generators, compressors, pumps and fans. Low noise generating equipment and turbine will be procured. Turbine will be provided with acoustic enclosure and housed in a noise leak proof building. Operators will be provided with noise proof cabins. Ear muffs / plugs will be given to workers that are exposed to high noise levels (more than 85 dBA)

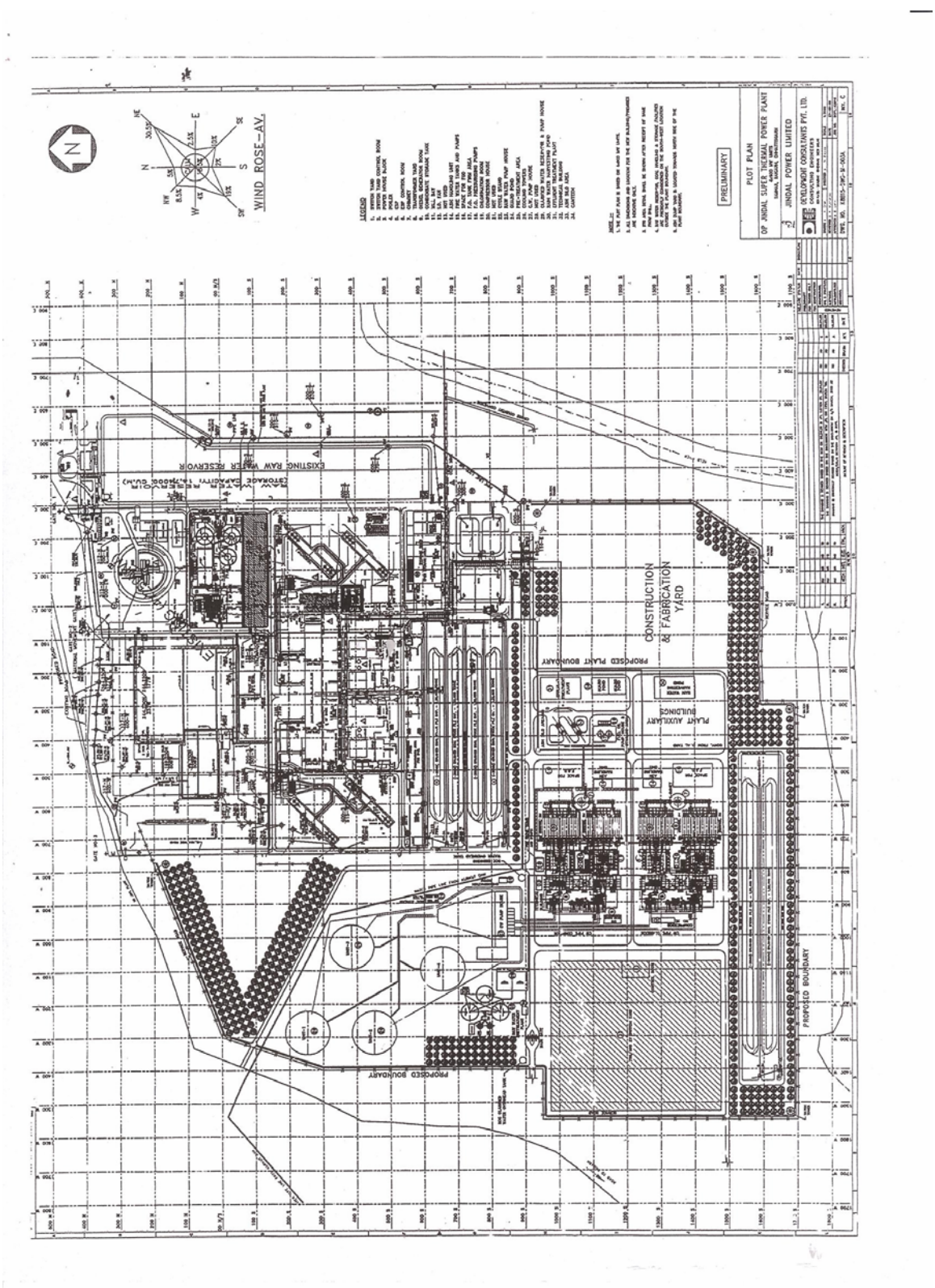


Figure 2.1 Lay Out Plan

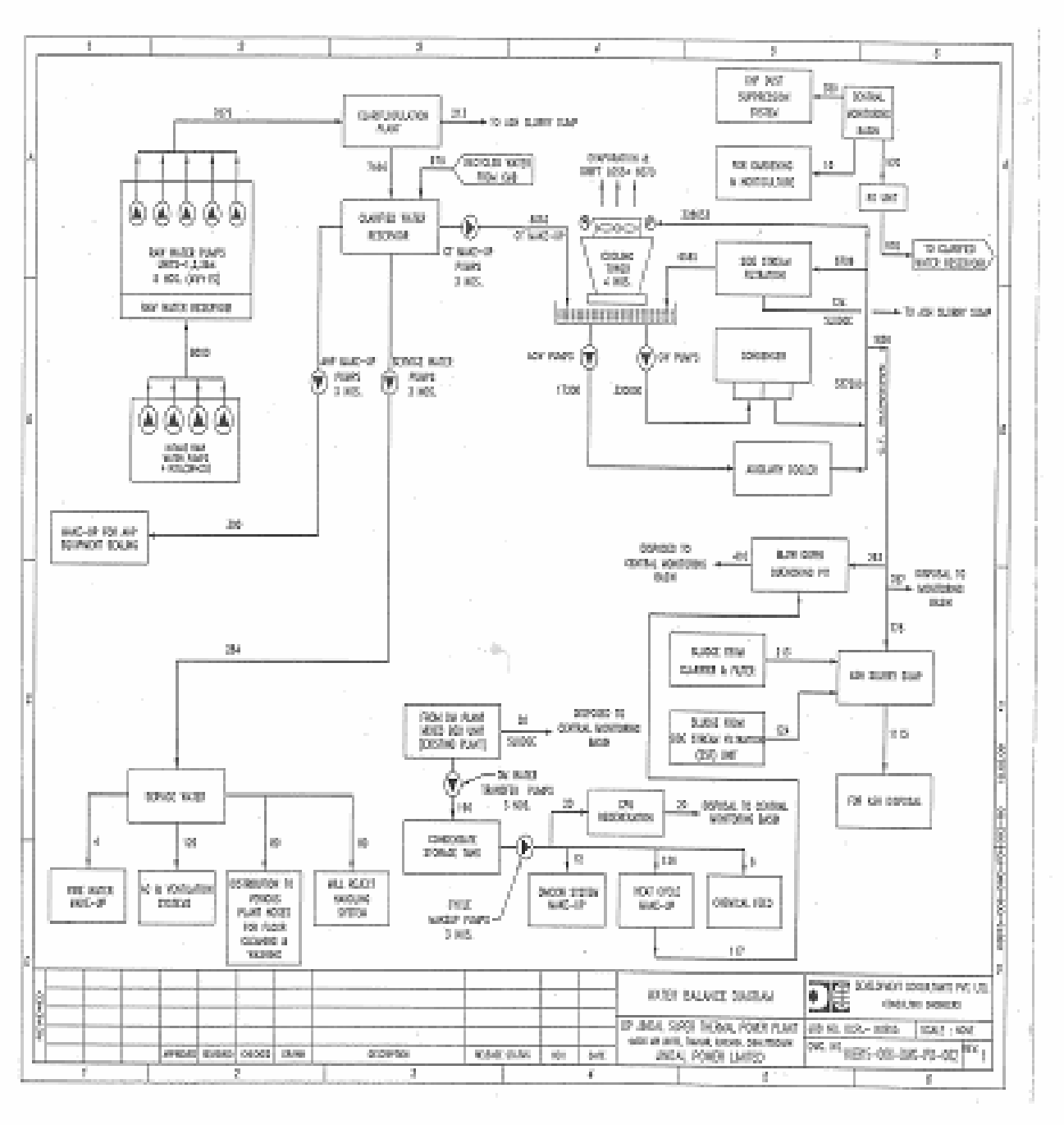


Figure 2.2 Water Flow Diagram

CHAPTER 3 – DESCRIPTION OF THE ENVIRONMENT

3.1 Study Area, Period and Methodology

Relevant information about the study area for the environmental components, study period and methodology is shown in Table 3.1. The study area comprises 10 km radial area around the proposed project site.

Table 3.1 Components, Study Area, Study Period and Methodology of EIA

Components	Area	Study Period	Methodology
Meteorology	At existing power plant site	Winter Season 1 -12 - 2008 to 28 – 2 - 2009	Wind speed and direction, humidity, and temperature were recorded on hourly basis. Long-term historical met data was obtained from Climatological Tables of IMD and trends were assessed.
Ambient Air Quality	Impacted and non-impacted area due to the air emission from project	Winter Season 1-12-2008 to 28-2-2009	AAQ monitoring was done at 8 locations by following the CPCB methods. RSPM, SPM, SO_2, NO_2 Hg and O_3 levels were determined. Sampling locations were established at site, at various downwind and upwind directions
Noise Quality	Locations covering all area category	Winter Season 15-12-2008 to 28-12-2008	Noise level monitoring was done at 10 locations using integrated sound level meter. Measurements were taken by following the CPCB procedure.
Surface & groundwater quality	U/s and d/s of streams and groundwater of nearby villages and ash pond.	Winter Season 11-12-2008 to 13-12-2008	Grab sampling was done and the samples were preserved and analysed for all relevant parameters following the methods prescribed by APHA. Six samples of surface and ten samples of ground water were collected.
Soil Quality	Agriculture fields of nearby villages	11-12-2008	Six soil samples were collected and analysed for all relevant parameters by following IARI Methods.
Flora & Fauna	Study area	Secondary data	Data was collected from Working Plan of Raigarh Forest Division and checked during field surveys.
Demography and Socio-economics	Study area	Secondary data	District Statistics Handbook and records from tehsildar office

3.1 Hydrogeology

Raigarh region falls in the eastern part of Chattisgarh basin. The intracratonic Chattisgarh basin is located within the Central Indian Shield, which comprises of a variety of rock types. The Archaean gneisses and schists are in juxtaposition with the Chattisgarh sediments with a prominent fault trending east-west. The basin shows centripetal dips and is free from any major structural disturbance. The basement has been subjected to weathering and erosion processes for millions of years as signified by a profound non-conformity. The sediments are therefore thin and widespread and the met sediments with associated volcanic, granites, gneisses, etc. have contributed the formation of sediments. The ground rocks of Raigarh region is mainly of 2500 million years Precambrian era. The main types of geological formations are Archaeans, Cuddapah, Gondwana, Deccan Trap recent and sub-recent formations.

The principle rocks are granites, schist, quartzite, limestone, laterites, sandstone and shales. The bottom rock at the base is crystalline without any trace of fossils. The rocks of surrounding area of Raigarh overlie the Archaeans type, composed of conglomerates, quartzites, arkose grits, quartzes slate, sandstone and mica but the specialty is the overlying calcareous sandstone that are red purple and grey in colour and medium grained in texture. The plains of Raigarh consist of shale interbedded with limestone and sandstone.

The Raigarh region falls under the Mahanadi River Basin and is located in the North-Eastern border of Chhattisgarh. As per the classification of CPCB (best designated uses), the existing use of Kelo, Kurket and Mand river in this basin is designated as Class C, that is, suitable for drinking water source with conventional treatment followed by disinfecting. **Figure 3.1** shows the map of Mahanadi River Basin showing Raigarh region. Most of the Raigarh district drains into Mahanadi, Ib, Mand and Kelo rivers. The Raigarh town is drained by Kelo river with series of stop dams constructed at Kharra ghat, Tipakhol, Khairpur and Bilaspur jalashay. The Kelo river arises from the Ludeg hills of north at 723 m altitude and flows to the south for 97 km. It drains the eastern part of Raigarh tehsil and central part of Ghargoda tehsil. The river forms the eastern boundary of Raigarh district for about 5 km and joins the Mahanadi river near Mahadevpali.

Hydro-geologically the area is classified under hard rock formation comprising mainly of weathered granite and gneiss of the Archaen age. The weathered granite layers constitute the potential aquifers. Ground water occurs under water table conditions in the weathered mantle and controlled mainly by the depth of the granite and gneiss. As per the records of Central Ground Water Board, Raigarh region falls under 'white grade belt' because there is no threat to the ground water resources. The ground water level is present at about 120 - 150 feet below and the water drawdown level is 26 - 30 feet.

The groundwater balance of the study area is shown in Table 3.2.

Table 3.2 Groundwater Balance

Description	Raigarh District	Ghargoda Block	Tamnar Block
Annual ground water recharge from all sources MCM	696.84	82.33	66.7
Irrigation potential of ground water MCM	861.51	109.24	87.97
Ground water draft for irrigation MCM	117.08	3.01	4.47
Available ground water resource MCM	639.93	78.10	63.31
Total extraction (irrigation & domestic)	145.92	4.65	6.2
Allocation for domestic and industrial use (2025) MCM	42.04	2.29	2.26
Allocation for Irrigation (2025) MCM	480.81	72.80	56.68
Percent groundwater development	22.8 (Safe)	5.95 (Safe)	9.79 (Safe)

All values are in MCM-(Million cubic meters)

Kelo river arises from the Ludeg hills, western part of Lailunga tehsil (22^{o}32' N and 83^{o}10' E) at 723 m height and flows towards southern direction for 112 km. It drains the eastern part of Raigarh tehsil and central part of Gharghoda tehsil. The river forms the eastern boundary of Raigarh district for about 5 km and joins the Mahanadi river near Mandapali, Sambalpur district in Orissa, 23 km away from Raigarh town. According to one estimate the available run off of Kelo river at proposed dam site G-D station (near Danote village) for 90% dependability is 281 MCM. The gauging of river Kelo at the proposed dam site started from 1952. Based on the 30 years monthly flow data available at this station, the

water inflow of river Kelo at 75% dependability is 385 MCM. The typical month-wise flow of Kelo river is given below (Source - Water Resource Division-Hasdeo Kachar).

	Month	Flow m^3/sec
1	January	3.160
2	February	0.964
3	March	0.665
4	April	0.204
5	May	0.230
6	June	0.557
7	July	23.537
8	August	120.845
9	September	103.835
10	October	50.056
11	November	10.804
12	December	4.581

The construction of Kelo dam is proposed across the river Kelo by the Water Resources Department - Bilaspur, Government of Chattisgarh (Minimata Bongo Project). Invitation for expressing interest by consultants to prepare various reports has been floated. The proposed dam site is located near village Danote (Latitude $21^0$75'07" N, Longitude $83^0$23'20" E), which is 8 km away from Raigarh town (outside our study area). The proposed project comprises 2462 m long earthen dam with maximum height 24.22 m for available water of 189.20 MCM in river Kelo. The length of main canal will be 26.62 km. The gross storage of the dam will be of 60.785 MCM and live storage of the dam will be 46.6 MCM. The catchment area of the Kelo dam will be 921 km^2 and water inflow of river Kelo at 75% dependability is 385 MCM. On completion the project will provide total irrigation to 26800 hectare land, in which 22800 hectare will be for Kharif and 4000 hectare will be for Rabi crops spread in 175 villages in the command area of Raigarh and Janjgir-Champa districts of Chattisgarh State. 4.44 MCM water will be allotted to industries and 4.44 MCM will be supplied to Raigarh town for drinking purpose.

3.3 Meteorology

Measurement techniques, instruments, specification of measurement standard and accuracy of instruments for meteorological parameters from the Indian Standard: 8829-1978 "Guidelines for Micrometeorological Techniques in Air Pollution Studies" were followed for data generation. Historical meteorological data were obtained from climatological tables pertaining to nearest representative IMD station located at Raigarh, which is presented in Table 3.3.

A meteorological station was also established near the site to generate site-specific meteorological data on hourly wind speed, wind direction, ambient temperature and relative humidity. The site-specific wind-rose is shown in **Figure 3.2.** Stability class data generated at Raigarh area using SODAR during winter season is shown in **Figure 3.3.**

Table 3.3 Meteorological Data of Raigarh (Source-IMD)

Month	Temperature (deg C) daily		Relative Humidity, %		Rainfall (mm)	Wind speed kmph	Pre-dominant wind direction (from)	Cloud cover (Oktas)
	Max	Min	Max	Min				
January	28.3	13.2	61	40	11.2	3.5	NE, NW	1.8
February	31.6	16.0	53	30	15.7	4.1	NE, NW	1.6
March	36.0	20.4	41	23	22.4	4.7	NE, NW	2.0
April	40.3	25.1	38	20	13.8	5.1	NE, SW	2.9
May	42.6	28.0	40	21	17.5	5.9	NE, SW	3.4
June	38.0	27.1	63	50	199.0	6.7	SW, NE	6.2
July	31.6	24.7	85	76	453.8	6.3	SW, NE	7.3
August	31.1	24.7	86	78	494.5	5.9	SW, SE	7.3
September	32.2	24.5	81	73	287.2	4.7	SW, NE	6.3
October	32.4	22.0	71	59	49.1	3.9	NE, SE	3.3
November	30.3	17.1	61	47	3.7	3.4	NE, N	2.1
December	28.2	13.3	62	44	4.1	2.9	NE, N	1.8
Annual	33.6	21.3	62	47	1602 (total)	4.8	NE, SW, NW	3.6

Temperature – December and January constitutes winter months with daily mean minimum temperature around 13.2^{o}C and daily mean maximum temperature around 28.3^{o}C. May is the hottest month with daily mean maximum temperature at 42.6^{o}C and daily mean minimum temperature at 28.0^{o}C. During the study period the daily mean minimum temperature was found to be 13.3^{o}C and daily mean maximum temperature around 31.6^{o}C.

Relative Humidity – The air is generally dry in the region except during monsoon. March and April are driest with relative humidity between 20-41%. The maximum humidity during rainy season is 86% and minimum was 73%. High humidity is found during daytime and low humidity values during nighttime in all the months. During the study period the humidity levels were found to be 43 – 65%.

Rainfall – The annual total rainfall is 1602 mm. Over 80% of the total annual rainfall is received during the monsoon period between June to September. 10.3 mm rainfall occurred during the study period.

Wind Speed– The wind speed was mostly between 2.9 – 6.7 km/hour for all the months. The wind speed during summer season was mostly between 4.7 - 6.7 km/hr, during rainy season it was between 4.7-6.3 km/hr and in winter months wind speed ranges between 2.9-4.1 km/hr.

Wind Direction – The predominant wind direction during summer season is from north east and south west direction during monsoon season. During post monsoon and winter season the wind flows from north east direction. The wind direction (dominant) during the study period was from north east direction.

Calm Periods – The calm period constitute an important factor in the dispersion of air pollution. The calm period is more during nighttime compared to daytime. The maximum calm period occur during September to January months. Monthly calm period is shown in Table 3.4. During the study period the observed calm period was 36%.

Table 3.4 Monthly Percentage of Calm Periods (IMD Raigarh)

Calm	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Day	10	7	10	10	6	4	3	5	10	13	12	11
Night	35	26	24	20	18	15	6	22	32	45	47	46

Cloud Cover – In the study area, clear weather prevails in most of the time during post monsoon, winter and summer seasons. Only during monsoon months of July, August and September, moderate to heavy clouds are observed. Relevant details about the number of days with zero oktas of cloud cover (all clouds) for all months are presented in Table 3.5. The daily cloud cover during the study period varied from 1 – 2 oktas.

Table 3.5 No. of Days with Zero Oktas of Cloud Cover (IMD Raigarh)

Cloud Cover	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Day	20	18	18	15	13	3	0	1	3	11	15	19
Night	17	18	17	11	10	1	1	0	1	10	15	17

Special Weather Phenomena - The occurrence of thunderstorm is 9 days per year, mostly spread across the months of June to September. Annual dust storm is 0.9 days during summer. On an annual average basis, 6 days have visibility in the range of 1 - 4 km, 26 days have visibility in the range of 4 -10 km, 333 days between 10 - 20 km and 100 days have visibility above 20 km. No thunderstorm or dust storm occurred during the study period.

Stability Class and Mixing Height:

The prevalent stability class was ‘A’ category (most turbulent) during summer, D category during monsoon, B and C category during post-monsoon and winter. Stable conditions prevailed during the night time in all seasons. The stability and mixing height rose during winter season is shown in **Figure 3.3.**

3.4 Ambient Air Quality

The ambient air quality monitoring network has been established on the following basis:

- Likely impact zones; maximum ground level concentration (glc).
- Impact free zone
- Crosswind zone
- Accessibility, electricity connection and willingness of premises owner

The study area represents predominantly rural environment. The sources of air pollution in the study area are industrial units like sponge iron plant, ferroalloy plant, rolling mills, induction furnaces, coal mines, vehicular traffic, re-suspension of road dust and domestic coal burning. Ambient air quality monitoring stations were set up at eight locations around the Jindal Power Plant site. Suspended Particulate Matter (SPM), Respirable Particulate Matter (RSPM), Sulphur Dioxide and Nitrogen Dioxide were analysed using High Volume Sampler with attachment for respirable dust and gases. Ground level ozone was monitored at project site (during afternoon) for one week during 11-2-2009 to 18-2-2009. The PM was also analysed for mercury level using cold vapour AAS. The monitoring locations are given in Table 3.6 and **Figure 3.4**. The results are shown in Table 3.7 (All values are 24-hour average in $\mu g/m^3$).

Table 3.6 Ambient Air Quality Monitoring Locations

Name of Location	Distance wrt site	Setting
Mohloi	3.0 km Southeast	Downwind direction
Parigaon	6.5 km Southwest	Downwind direction
Gorhi	2.5 km. Southwest	Downwind direction
Tamnar	1.0 km south	Downwind direction
Regaon	3.5 km NNW	Upwind direction wrt plant, downwind direction wrt ash pond
Devgaon	3.5 km. SSE	Downwind direction
Jhingolpara	8.0 km Southwest	Upwind direction
Dolesara	6.0 km NNW	Upwind direction (ash pond site)

Table 3.7 Ambient Air Quality of Study Area

Location	SPM (µg/m^3			RSPM µg/m^3			SO_2			NO_2		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
Mohloi	180	148	164	87	72	80	8.2	6.5	7.3	11.8	24.6	17.2
Parigaon	167	126	150	75	58	65	7.6	5.1	5.7	22.4	10.2	14.3
Gorhi	185	142	167	88	68	78	11.5	8.1	9.5	30.4	15.7	24.2
Tamnar	176	126	146	62	52	56	7.8	6.4	7.0	15.6	6.8	11.9
Regaon	147	112	132	58	46	52	6.7	5.2	5.7	14.2	7.6	10.2
Devgaon	170	128	143	60	50	54	7.6	6.1	6.9	14.2	7.6	10.4
Jhingolpara	154	115	134	56	48	52	6.8	6.1	6.6	14.4	6.8	10.8
Dolesara	160	138	147	63	42	52	6.6	4.6	5.5	12.5	5.8	10.0

	Location	Ozone			Mercury		
		Max	Min	Avg	Max	Min	Avg
1	Mohloi	45	40	42	<0.1	<0.1	<0.1
2	Parigaon	42	35	39	<0.1	<0.1	<0.1
3	Gorhi	36	34	35	<0.1	<0.1	<0.1
4	Tamnar	30	27	28	<0.1	<0.1	<0.1
5	Regaon	40	36	38	<0.1	<0.1	<0.1
6	Devgaon	42	38	40	<0.1	<0.1	<0.1
7	Jhingolpara	43	40	40	<0.1	<0.1	<0.1
8	Dolesara	32	25	28	<0.1	<0.1	<0.1

Observation on Ambient Air Quality:

The SPM, RSPM, SO_2 and NO_2 values of all the eight locations are well within the national ambient air quality standards of residential area; 200, 100, 80 and 80 µg/m^3 respectively. The SPM and RSPM level of Taraimal and Dongamauha are slightly higher because of concentration of sponge iron plant clusters. CO level at all the location were found to be less than 1 ppm. The concentration of ground level ozone was found to be in normal range of 25 µg/m^3 to 45 µg/m^3 (proposed national standard is 120 µg/m^3). Mercury is found to be below the detectable range of measurement, that is not traceable (<0.1 µg/m^3)

3.5 Ambient Noise Quality

Ambient noise measurements were done at ten locations around the project site. Measurements were noted at an interval of 5 seconds over a period of 10 minutes per hour for 24-hours using integrated sound level meter. The monitored noise level is shown in Table 3.8.

Table 3.8 Ambient Noise Quality of Study Area

	Location	Day Leq dB(A)}	Night Leq dB(A)}
1	Site	49.2	41.2
2	Tamnar	50.1	43.3
3	Gorhi	49.4	40.0
4	Regaon	49.2	40.6
5	Mohloi	51.9	43.2
6	Devgaon	53.5	44.3
7	Taraimal	53.9	44.0
8	Kosampali	49.2	42.9
9	Taraimal – Punjipatra road near Punjipatra	73.6	53.2
10	Punjipatra - Dhaurabhata Road near Tamnar	71.5	51.0

Observations on Ambient Noise Quality

The ambient noise level of the study area is within the prescribed standard of residential area, that is 55 dBA during day time and 45 dBA during night time. The road side noise levels are lower than 75 dBA. .

3.6 Surface and Ground Water Quality

Ten ground water samples and six surface water samples were collected from different locations during study period. The water samples were examined for physico-chemical parameters and bacteriological parameters. The samples were collected and analysed as

per the procedures specified in Standard Methods (APHA). Samples for chemical analyses were collected in polyethylene carboys. Samples for bacteriological analyses were collected in sterilized bottles. Temperature, pH, conductivity and dissolved oxygen were measured at site itself. The water sampling locations are given in Table 3.9. The analysis results of groundwater quality are presented in Table 3.10. The analysis results of surface water quality are presented in Table 3.11.

Table 3.9 Water Quality Sampling Stations

Code	***Location***	***Source***
GW1	Site	Borewell
GW2	Dongamahua	Hand pump
GW3	Mohloi	Hand pump
GW4	Tamnar	Hand pump
GW5	Gorhi	Hand pump
GW6	Devgaon	Hand pump
GW7	Dholesara	Hand pump
GW8	Manjhapara	Hand Pump
GW9	Mudogaon	Hand pump
GW10	Kasdol	Handpump
SW1	Kelo River upstream Near Gare	Surface water
SW2	Kelo River downstream near Kasdol	Surface water
SW3	Pajhar river 500 m upstream	Surface water
SW4	Pajhar river just before confluence with Kelo river	Surface water
SW5	Kurket river 500 m upstream of Dam	Surface water
SW6	Kurket river downstream of Dam	Surface water

Table 3.10 Ground Water Quality of Study Area

	Parameters	**GW1**	**GW2**	**GW3**	**GW4**	**GW 5**
1	pH	8.12	6.25	6.4	6.7	7.06
2	Conductivity, μmhos/cm	394	170	245	400	240
3	Turbidity (NTU)	4	3	4	3	4
4	Dissolved solids	253	107	142	266	146
5	Suspended solids	6	4	5	4	6
6	Total hardness	170	40	140	128	150
7	Chlorides as Cl	21	12	21	71	14
8	Sulphates as SO4	22	6	12	5.8	19
9	Nitrates as NO3	11.2	5.2	5	3.5	4
10	Calcium as Ca	36	12	20	24	20
11	Magnesium as Mg	19	2	5.0	16.5	10
12	Flourides as F	0.95	0.90	1.0	0.9	0.95
13	Iron as Fe	0.14	0.25	0.26	0.25	0.35

14	Lead as Pb	0.04	0.05	0.05	0.05	0.03
15	Copper as Cu	NT	NT	NT	NT	NT
16	Mercury as Hg	NT	NT	NT	NT	NT
17	Nickel as Ni	NT	NT	NT	NT	NT
18	Zinc as Zn	2.2	1.8	1.4	1.4	1.4
19	Chromium (as Cr)	NT	NT	NT	NT	NT
20	Arsenic as As	NT	NT	NT	NT	NT
21	Manganese as Mn	NT	NT	NT	NT	NT
22	Cadmium as Cd	NT	NT	NT	NT	NT
23	Total coliform MPN/100ml	NT	NT	NT	NT	NT

Ground Water Quality of Study Area

	Parameters	**GW6**	**GW7**	**GW8**	**GW9**	**GW 10**
1	pH	8.12	7.65	6.8	7.1	7.70
2	Conductivity, μmhos/cm	441	236	168	223	173
3	Turbidity (NTU)	4	5	3	4	2
4	Dissolved solids	288	146	114	132	117
5	Suspended solids	7	5	5	5	4
6	Total hardness	160	80	40	72	50
7	Chlorides as Cl	72	28	21	14	21
8	Sulphates as SO4	18	20.4	12	12	14
9	Nitrates as NO3	8.6	5.8	6.4	7.0	4.8
10	Calcium as Ca	40	18	12	20	12
11	Magnesium as Mg	14.6	7.8	2.0	4.8	4.8
12	Flourides as F	0.95	1.0	2.6	2.9	0.85
13	Iron as Fe	0.28	0.15	0.25	0.22	0.20
14	Lead as Pb	0.03	0.01	0.03	0.03	0.03
15	Copper as Cu	NT	NT	NT	NT	NT
16	Mercury as Hg	NT	NT	NT	NT	NT
17	Nickel as Ni	NT	NT	NT	NT	NT
18	Zinc as Zn	1.5	1.8	1.5	1.6	1.0
19	Chromium (as Cr)	NT	NT	NT	NT	NT
20	Arsenic as As	NT	NT	NT	NT	NT
21	Manganese as Mn	NT	NT	NT	NT	NT
22	Cadmium as Cd	NT	NT	NT	NT	NT
23	Total coliform MPN/100ml	NT	NT	NT	NT	NT

Table 3.11 Analysis Results of Surface Water Quality

	Parameters	SW 1	SW 2	SW3	SW4	SW5	SW6
1	pH	7.23	7.21	7.51	7.58	7.5	7.41
2	Conductivity, μmhos/cm	126	145	176	178	130	138
3	Turbidity (NTU)	3	3	3	3	4	4
4	Temperature; ^{o}C	24	24	24	24	24	24
5	Dissolved solids	81	92	118	120	79	82
6	Suspended solids	8	10	6	6	10	10
7	Total hardness	32	35	80	81	40	45
8	DO	5.7	5.4	5.0	5.1	6.0	5.8
9	BOD	0.1	0.1	0.1	0.15	0.1	0.2
10	COD	6	6	7	7	8	10
11	Chlorides as Cl	12	14	16	16	12	12
12	Sulphates as SO4	5	6	8	8	5	6
13	Nitrates as NO3	1.1	2	1.6	1.7	1.3	1.5
14	Flourides as F	0.6	0.6	0.65	0.68	0.60	0.65
15	Iron as Total Fe	0.02	0.02	0.048	0.052	0.040	0.045
16	Lead as Pb	NT	NT	NT	NT	NT	NT
17	Copper as Cu	NT	NT	NT	NT	NT	NT
18	Mercury as Hg	NT	NT	NT	NT	NT	NT
19	Nickel as Ni	NT	NT	NT	NT	NT	NT
20	Zinc as Zn	1.1	1.2	1.0	0.8	1.2	1.3
21	Chromium (Total)	NT	NT	NT	NT	NT	NT
22	Arsenic as As	NT	NT	NT	NT	NT	NT
23	Manganese as Mn	NT	NT	NT	NT	NT	NT
24	Cadmium as Cd	NT	NT	NT	NT	NT	NT
25	Oil & Grease	0.1	0.1	NT	NT	NT	NT
	Total coliform MPN/100ml	7	10	6	8	10	11

Observation of Water Quality of Study Area

The surface water quality of Kelo river is good in the upstream near Kasdole and in the downstream near Urdana. The water quality is fit for drinking water purpose after conventional disinfections. The river water quality at upstream point is slightly better than the downstream point. The fluoride content is high in ground water sample of Majhapara and Mudogaon village. In other locations the fluoride contents are within the recommended limit of 1.0 -1.2 mg/l. The solids and hardness content are well within the standard limit. No heavy metals have been detected in the groundwater samples. Overall the groundwater quality is good and did not show any sign of significant metallic or bacterial contamination.

3.7 Aquatic Monitoring

Information from aquatic monitoring helps in classifying the water bodies according to level of ecological degradation and Central Pollution Control Board (CPCB) has derived Biological Water Quality Criteria (BWQC) for assessment of water quality (five classes of water quality. The system is based on the range of saprobic values and diversity of the benthic macro-invertebrate families with respect to water quality

Biological sampling has been undertaken at water depth of less than one meter, with the help of showels, hand net and hand picking by uprooting the water plants growing near the bank. Organisms were collected, with help of forceps, and kept in a tray for identification (with the help of magnifying glass). Taxonomic identifications of the macro-invertebrates were carried out using standard chart prepared by CPCB and all the families and species were listed to obtain the Saprobic Score and Diversity Score. Thereafter, Biological Water Quality Criteria (BWQC) of the stream was derived. Bio-monitoring was done on 18th December at Kelo river u/s near Gare and d/s near Kasdol. Bio-monitoring was done on 19th December at Kurket river u/s of Jindal dam and d/s of Dam. Bio-monitoring was done on 20th December at Pajhar river 2 km u/s of confluence and just before confluence with Kelo river. The observations are given in Table 3.12.

Table 3.12 Biomonitoring of Kelo River

Location	Name of Family/Species found in the stream	Saprobc Score	Diversity Score	BWQC
Kelo river at Gare	Molusca / Physidae, Lymnacidae / Planorbidae Diptera / Chironomidae (larvae) Coloeptera / Hygrobidae, water beetles Odanata / damsel fly nymph	6.2	0.68	B Slight Pollution
Kelo river at Kasdol	Molusca / Physidae, Lymnacidae / Planorbidae Diptera / Chironomidae (larvae) Coloeptera / Hygrobidae, water beetles Odanata / damsel fly nymph	6.3	0.74	B Slight pollution
Kurket river u/s Dam	Molusca/ Physidae, Lymnacidae/ Planorbidae Diptera/ Chironomidae (larvae) Coloeptera/ Hygrobidae, water beetles Odanata/ damsel fly nymph	6.2	0.68	B Slight Pollution

Kurket river d/s Dam	Molusca/ Physidae, Lymnacidae/ Planorbidae Diptera/ Chironomidae (larvae) Coloeptera/ Hygrobidae, water beetles Odanata/ damsel fly nymph	6.3	0.74	B Slight pollution
Pajhar river 1 km before confluence	Molusca/ Physidae, Lymnacidae/ Planorbidae Diptera/ Chironomidae (larvae) Coloeptera/ Hygrobidae, water beetles Odanata/ damsel fly nymph	6.2	0.68	B Slight Pollution
Pajhar river just before confluence	Molusca/ Physidae, Lymnacidae/ Planorbidae Diptera/ Chironomidae (larvae) Coloeptera/ Hygrobidae, water beetles Odanata/ damsel fly nymph	6.3	0.74	B Slight pollution

The rivers, streams, ponds and tanks spread in the regions abound plenty of fishes. There are numerous tanks/ ponds of different sizes in the study area for water coverage and fishery. The major fishes of the area are Rohu (Labeo rohita), Katla (Catla catla) Mrigal (Cirrhina mrigala), Kalbaus (Labeo kalabasu), Silond (Silondio silondia), Attu (Wallago attu) and Singhan (Mystus seenghala). Other common fishes found in the region are Perch, Catfish, Murral, Tilapia, Punti, Magur, Tangra, Sol and similar local variety.

3.8 Soil Quality

Matasi (sandy loam) and bhata (sandy) type soils are prevailing in most part of the study area. Soil is brown to light red in colour, consists of poor detritus of laterite containing numerous little pebbles and does not retain sufficient moisture. It cannot sustain more than one crop a year and requires long resting falloffs. The pal kachhar type (alluvium rich silty loam) soil is rich brown silt found only on the banks of Kelo, Kurket, Mand and Pajhar rivers.

Six soil samples were collected for determining the physico-chemical characters of the soils of study area. At each location, soil samples were collected from three different depths; 1 - 5 cm, 10 - 20 cm and 40 - 50 cm below the surface. The samples were homogenized and the quantity was reduced using the coning and quartering method. The

samples were packed in polyethylene bags and analysed for relevant physico-chemical parameters. The name of locations and test results are shown in Table 3.13.

Table 3.13 Soil Quality of Study Area

	Parameters	Site	Rodapali	Dholesera	Regaon	Gorhi	Gharghoda
1	Bulk Density; g/cm^3	1.4	1.3	1.4	1.3	1.4	1.3
2	Organic matter; %	0.72	0.68	0.61	0.64	0.70	0.72
3	Water Holding Capacity, %	48	42	45	31	48	42
4	pH	6.90	7.12	7.01	6.25	6.90	6.56
5	Texture	SCL	SCL	SCL	SL	SCL	SCL
6	Alkalinity, meq/100g	0.216	0.216	0.216	0.016	0.216	0.14
7	Bicarbonate, %	0.013	0.013	0.013	0.01	0.013	0.008
8	Chlorides, %	0.0106	0.0106	0.0106	0.0071	0.0106	0.0036
9	Conductivity, μmhos/cm	78	70	73	56	75	38
10	Available Potassium,%	0.44	0.42	0.41	0.12	0.44	0.32
11	Available Phosphorus,%	0.021	0.020	0.020	0.015	0.021	0.02
12	Available Nitrogen,%	1.4	1.3	1.3	1.2	1.4	1.4
13	Infiltration rate, cm/hr	2.9	2.5	2.7	5.2	2.9	2.9

SL- Sandy Loam, SCL-Sandy Clay Loam

Observation on Soil Quality

The soil quality of the agriculture fields is sandy loam with very little amount of silt (less than 10%). The organic matter content is moderate. The pH of the soil sample of site, Libra, Regaon and Ghargoda is slightly acidic. Depending on the bulk density and water holding capacity, it can be stated that the soil is prone to water logging during monsoon, when the atmospheric humidity level is high and evaporation rate is less. This makes the soil suitable for paddy cultivation. The soils are less suitable for wheat and mustard cultivation. In the event of non-monsoon for long spell, the soil looses its moisture content and becomes unsuitable for agricultural practices. The available nitrogen content of the soil is moderate to high and the available potassium and phosphorus content is moderate.

3.9 Ecology

3.9.1 Forests

As per the Report of Forest Survey of India, the total forest area of Chhattisgarh State is 59772.4 km^2, 25782.1 km^2 reserved forest, 24036.1 km^2 protected forest and 9954.1 km^2 undemarked protected forest. This accounts for 41.8% of the total geographical area of the State and 8.4% of the total geographical area of the Country. 32% of the total forest area of Chattisgarh is covered under sal forest, 9.42% is teak forest and 50.02% is mixed forest.

The forests of Raigarh district fall under Tropical Dry Deciduous Forest. Sal (*Shorea robusta*) is the major tree species forming top canopy. Other notable wood species are Teak (*Tectona grandis*), Bija (*Pterocarpus marsupium*), Saja (*Terminalia tomentosa*), Dhawra (*Anogeissus latifolia*), Mahua (*Madhuca indica*) and Tendu (*Diospyros melanoxylon*). Amla (*Embilica officinalis)*, Karra (*Cleistanthus collinus*) and Bamboo (*Dendrocalamus strictus*) constitute a significant chunk of middle canopy.

As per the Forest Survey of India Report, the total forest area of Raigarh district is 3243.015 km^2. Reserved forest area is 1597.615 km^2, protected forest area is 580.998 km^2 and un-demarked protected forest area is 1064.402 km^2 (Source: Chattisgarh Forest Department Website). 35.93% of the total geographical area of Raigarh district is covered by forest (FSI Report 2003).

There are two forest divisions in Raigarh district; Dharmjaigarh Forest Division (north side of district) and Raigarh Forest Division (central and south side of district). Dhramjaigarh forest division covers six forest ranges namely Dharmjaigarh, Kapu, Lailunga, Bakaruma, Chhal and Boro. Raigarh forest division covers five ranges namely Raigarh, Kharsia, Sarangarh, Gharghoda and Tamnar. The forests of Raigarh division have been described into three categories; Sal forest (Plain Sal Forest and Hill Sal Forest), Mixed Forest and Bamboo Forest. The map of Raigarh Forest Division, in which the study area falls, is shown in **Figure 3.5.**

Sal Forest: The northern and central portion of Raigarh forest division is covered by sal forest. It is found in all the ranges except Sarangarh. Nearly 60 percent of the forest area is covered under sal forests. The plain sal forest is the most valuable forest type. The plain sal extends practically to the whole of the Chhal, part of Boro, Dharamjaigarh Ghargoda and Lailunga ranges. The hill sal forest occurs on slopes and tops of hills or undulating area with shallow soil. The slops are generally rough and covered by boulders. Hill sal forest is distributed in part of Raigarh, Ghargoda, Tamnar, Boro and Lailunga ranges.

Mixed Forest: The common tree species found in mixed forest are Saja, Dhaura, Tendu, Harra, Char, Bhirra, Mahua, Salia, Karra, Aonla, Ghont, etc. The mixed forest is commonly found in southern part of Raigarh and Kharasia range and whole of the Sarangarh range.

Bamboo Forest: Dendrocalamus strictus is only found in Raigarh forest division. Large and dense clumps of bamboo are found in the forest of Raigarh, Tamnar and Ghargoda forest ranges. Scattered bamboo is found in the Kharsia forest range.

According to the latest Forest Working Plan, the area of Raigarh forest division is 1582.576 km^2; 652.639 km^2 is reserved forest, 221.702 km^2 is protected forest, 430.435 km^2 is un-demarked forest. The name and area of five forest ranges is given below:

	Name of the Forest Range	Protected Forest Area, in km^2	Reserved Forest Area, in km^2	Un-demarked Forest Area, km^2
1	Raigarh	44.851	171.150	98.862
2	Kharsia	19.626	94.102	67.247
3	Sarangarh	69.749	103.617	92.857
4	Gharghoda	47.989	109.706	85.655
5	Tamnar	39.487	174.064	85.814
	Total	221.702	652.639	430.435

Forest Produce: 50-60% of the total area in Raigarh forest division is covered by good variety of sal (MP IV). Plain sal is better than hill sal with regard to density, stocking and

quality of crop. Sal seed is one of the major products of economic value. Dendrocalmus strictus (Bamboo) is the only variety found in the Kharsia and Sarangarh ranges. Tendu leaves derived from Diospyros melanoxylon, used in making 'beedis' is found in huge quantity in the Raigarh forest. The tendu leaves is collected by the local people and sold to state government agency, which in turn is supplied to beedi manufacturers. The total collection of tendu leaves in year 2005 from Raigarh forest division is 57337 manak boras; revenue worth Rs.5.28 crores. The total collection of tendu leaves in year 2005 from Dharmjaigarh forest division is 81115 manak boras; revenue worth Rs.9.04 crores. 261 m^3 of timber and 1162 chatta of fire-wood has been collected from Raigarh forest division in 2005. 818 V.I of bamboos has been collected in 2005 from Raigarh Forest Division. Such forest related activities also generate employment to the tribal population of the district.

Other minor forest products are honey, harra, mahul leaves, mahua, chargum, dhanwari flower, chhind grass, chironji seed, jatropha seed, tulsi seed, kusum lac, chiroy seeds, kanta bahari and behera fruits.

Threat to Forest:: There is minor decline in forest cover of Raigarh Forest Division due to increasing human settlements and cattle population coupled by unplanned industrial activity inside forest-land. Other factors resulting for deforestation are described below:

a) Fuel wood: Collection of fuel-wood by tribal people for own use and sale.
b) Grazing : In absence of adequate productive grazing land, forest have become the major source of grazing and fodder.
c) Forest fire: Uncontrolled forest fire results in significant loss of forest regeneration, burning of biomass and destruction of microorganism.
d) Diversion of forest-land: Diversion of forest land for non-forestry purpose like irrigation projects, roads, industrial development and settlement.
e) Mining Activity - Exploiting the mineral wealth by opening mines and industries led to destruction forests. Also release of wastewater on land and air pollution has affected the natural regeneration of forest cover.

3.9.2 Flora

The list of flora noted from the Working Plan of Raigarh Forest Division is given in **Table 3.14.** The listed as well as observed floral species has been cross-checked with the Red Data Book of Indian Plants (Botanical Survey of India). No extinct, endangered, vulnerable, rare and critical floral species has been found in the Raigarh Forest Division.

Table 3.14 Floral Listing of Raigarh Forest Division

Vernacular Name	Botanical Name	Family
LARGE TREES		
Aam	Mangifera indica	Anacardiacea
Amera	Spoindias pinnata	Anacardiaceae
Anjan	Hardwickia binnata	Leguminioceae
Aonla	Emblica officinalis	Euphorbiaceae
Arjun	Terminalia arjuna	Combretaceae
Babul	Acacia arabica	Leguminioceae
Behara	Terminalia belerica	Combretaceae
Bargad	Ficus benghalensis	Utricaceae
Bhorsal	Hymenodictylon excelsum	Rubiaceae
Bel	Aegle marmelos	Rutaceae
Bijasal	Petrocarpus marsupium	Leguminoceae
Chichwa	Albizzia Odoratissima	Leguminoceae
Dhaman	Grewia tiliaefolia	Tiliaceae
Dhaora	Anogeissus latifolia	Combretaceae
Dhobin	Delbergia Paniculata	Papilionaceae
Domsal	Miliusa velutina	Anonaceae
Garari (Karra)	Cleistanthus collinus	Euphorbiaceae
Gamari	Gmelina arborea	Verbenaceae
Gular	Ficus recemosa	Utricacea
Haldu	Adina cordifolia	Rubicaeae
Harra	Terminalia chebula	Combretaceae
Imli	Tamarindus indica	Leguminoseae
Jamun	Syzygium cumini	Myrtaceae
Kaith	Feronia Limonia	Rutaceae
Kala siris	Albezzia Lebbek	Leguminiosae
Kalla	Dillenia Pentagyna	Dillinaceae
Karanj	Pongamia pinnata	Leguminiosae
Kardhai	Angessus pendula	Combretaceae
Kadam	Anthocephalus cdamba	Rubiaceae
Kasai	Bridlia retusa	Euphorbiaceae
Kekad	Garuga pinnata	Bursersceae
Khair	Aacia catechu	Mimoceae

Kullu	Sterculia urens	Sterculiaceae
Kumbi	Careya aeborea	Myrtaceae
Kusum	Schleeichera oleesa	Sapindaceae
Lasora	Codia dhohoma	Boroginaceae
Lendia	Lagerstroemin parviflora	Lythraceae
Maharukh	Ailanthus excelsa	Simarubaceae
Mahua	Madhuka indica	Sapotaceae
Mokha	Schrebera swietenioides	Oleaceae
Moyen,Gunga	Lannea coromandelica	Anacardiaceae
Mundi	Mitragyna parvifolia	Rubaceae
Neem	Azardicachta indica	Meliaceae
Padar	Stereopermum personatum	Bignoniaceae
Palas	Butea monosperma	Leguminaceae
Pasi	Anogeissus acuminata	Combertaceae
Pipal	Ficus religiosa	Legumenosae
Pulu	Kydia calycina	Malvaceae
Rohan	Soymidia febrifuga	Meliaceae
Sagon	Tectona grandis	Verbenaceae
Saja	Terminalia tomentosa	Combretaceae
Sal	Shorea robusta	Depterocarpaceae
Salai	Boswellia serreta	Burseraceae
Safed siris	Albizzia procera	Legumenoceae
Semal	Slamalia malabaricum	Malvaceae
Senha	Largerstroemia parviflora (Roxb)	Lythraceae
Shisham	Delbergia latifolia	Legumenoceae
Sisso	Delbergia sisso	Legumenoceae
Suria	Xylia dolaeriformis	Legumenoceae
Tendu	Diospyros melanoxylon	Ebenaceae

SMALL TREES

Achar	Buchanania lanzan	Anacardiaceae
Amaltas	Cassia fistula	Leguminoceae
Amti	Bauhinina malabarica	Leguminoceae
Ber	Zizyphus mauratiana	Rhamnaceae
Bhilwa	Semecarpus anacardium	Anacardiaceae
Dikamali	Gardeniaresinifera	Rubaceae
Galagal	Cochlospermum gossypium	Bixaceae
Ghont	Zizyphus xylophyra	Rhamnaceae
Jamrasi	Elaeodendron glaucum	Celastraceae
Kachnar	Bauhinia variagata	Leguminosae
Kakai	Flacourtia ramontchi	Bixaceae
Katul	Randia uliuginosa	Rubiaceae
Karra	Cheistanthus collinus	Euphorbiaceae
Katmoh	Bauhinia variegata	Leguminoceae
Lokhandi	Ixora arborea	Rubiaceae

Maida lakri	Litsae sebifera	Lauraceae
Mainphal	Reandia dumetorum	Rubiaceae
Thuar	Euphorbia tirucalli	Euphorbiaceae
Kharhar	Gardinia turgida	Rubiaceae
Tilwah	Wendlendia exserta	Rubiaceae
Bairi	Casearia tomentosa	Samydaceae

SHURBS & UNDER SHURBS

Apamarg	Achyranthes aspera	Amarenthaceae
Arhar	Cajanus indicus	Leguminoceae
Baibirang	sambelia robusta	Myrsinaceae
Ban rahar	Flemingia semialata	Leguminoceae
Bansuli	Grewia rothii	Tiliaceae
Bantulsi	Eranthamum Pulchellum	Acanthaceae
Barna	Heptaplenrum venulosum	Araliaceae
Chipti	Desmodium pulchellum	Leguminiosae
Chhind	Phoenix acaulis	Palmaceae
Dhawai	Woodfordia floribanda	Lytharaceae
Gursukri	Grewia hirsute	Tiliaceae
Harsingar	Nyctanthus arbortristis	Oleaceae
Kalabansa	Colebrookia opyositifolia	Labiatae
Karonda	Carissa spinarum	Apocynaceae
Kath Jamu	Eugenia heyneana	Myrtaceae
Kela	Musa sapientum	Scitaminaceae
Karantha	Dedonia viscose	Sapindaceae
Koria	Holarrhena antidysentrica	Apocynaceae
Lokhandi	Ixora Parviflora	Rubiaceae
Madukamani	Murraya exotica	Rutaceae
Marorphali	Helicteres isora	Sterculiaceae
Mothi	Veronia roxburghii	Compositeae
Nirgudi	Vitex negundo	Verbenaceae
Tarota	Casia tora	Leguminioseae
Raimunia	Lantana acculeata	Verbenaceae
Safed musli	Chlorophytum tubersum	Liliaceae
Jogilati	Asparagus racemosus	Liliaceae
Tikhur	Curcuma longa	Zingibcraceae

CLIMBERS

Dokarbel	Cissus Repanda	Ampelidaceae
Gauj	(syn -vitis repanda)	
Gurar or gubari	Millerria auriculare	Legumiinosae
Harjuri	Vitis quadrangularis	Vitacae
Mahul	Bauhinia vahlii	Leguminosae
Mallkangni	Celastrus paniculata	Celastraceae
Nagbel	Cryptalepis buchanani	Asclepirdaceae

Pslasbel	Butea superba	Leguminosae
Pivar bel	Combretum decandrum	Combretaceae
Raoni	Acacia pennata	Liliaceae
Kewanch	Mucuna pruriens	Leguminosae
Ramdatoon	Smilas macraphilla	Leguminosae

EPHIPHYTES

Banda	Vanda terres	Orchidaaceae
Banda	Dedrobium	Orchidaaceae
Banda	Dendrobium regium	Orchidaaceae
Banda	Vanda parviflora	Orchidaaceae
Banda	Vonda roxbudrghii	Orchidaaceae

PLANT PARASITES

Amarbel	Cuscuta reflexa	Convolvulaceae
Banda	Loranthus falcate	Loranthaceae
Gurbel	Viscum orientale	Loranthaceae

GRASSES & BAMBOOS

Bans	Dendrocalamus strictus	Gramineac
Bhurbhusi	Eragrostis tenella	Gramineac
Chhir	Imperata cyclindrica	Gramineac
Doob	Cynodon dyctylon	Gramineac
Gunher / Chhirra	Themeda Quadrivaluis	Gramineac
Kantangbans	Bambusa arundinacea	Gramineac
Khus	Vetiveria Zizanioides	Gramineac
Kusal	Heteropogon contours	Gramineac
Madia	Eleusine corcana	Gramineac
Mushan	Iseilema laxum	Gramineac
Tikari (Rusa)	Cymbopogon martini	Gramineac
Sabai (Bagai)	Eulaliopsis binnata	Gramineac

OTHER PLANTS

Eucalyptus	Eucalyptus camaldulensis	Myrtaceae
Eucalyptus	Eucalyptus citriodora	Myrtaceae
Eucalyptus	Eucalyptus hybrid	Myrtaceae

Source: Working Plan of Raigarh Forest Division, Government of Chhattisgarh

3.9.3 Fauna

The census of wild animals found in Raigarh Forest Division is given in Table 3.15.

Table 3.15 Census of Wild Animals found in Raigarh Forest Division

	Name of animal	Number		Name of animal	Number
1	Chital	312	12	Langur	2945
2	Sambhar	23	13	Red Face Monkey	6749
3	Rabbit	728	14	Sloth beer	788
4	Mouse deer	14	15	Fox	660
5	Kotri	1043	16	Peacock	300
6	Chausingha	15	17	Wolf (Bhedia)	170
7	Black deer	5	18	Hyena	242
8	Blue bull	29	19	Python	17
9	Wild boar	3678	20	Wild Elephant	10
10	Bison (Gaur)	13	21	Wild Hen	32
11	Pangolin	32			

The list of fauna noted from the Working Plan of Raigarh Forest Division is given in **Table 3.16**.

Table 3.16 List of Fauna Noted in Raigarh Forest Division

Local name	English name	Scientific name
ANIMALS		
Bhalu	Sloth bear	Melursus urcinus
Bherki	Barking deer	Muntiasus muntjak
Bijjoo	Indian ratel	Millivora capensis
Chital	Spotted deer	Carvus axis
Gaur	Bison	Bos gourus
Jangli billi	Common jangle cat	Felis chaus
Khargosh	Hare	Lepus ruficaudatus
Kutta jungli	Wild dog	Cuon alpinus
Langur	Monkey	Presbytis entellus
Lakkar bagha	Hyena	Hyaena hyaena
Nilgai	Blue bull	Boselaphus tragocamelus
Sahi	Porcupine	Hystrix indica
Sambhar	Sambhar	Cervus unicolor

Shiar (Gidhar)	Jackal	Canis aureus
Suar (Barha)	Indian wild boar	Sus cristatus

BIRDS

Bater	Bush quail	Perdicula asiatica
Cheel	Common parah Kite	Milvus migrans
Chitta fakata	Spotted Dove	Sterptopelia chinensis
Gidh	Benbal vulture	Gyps bengalensis
Harial	Green pigeon	Treron phoenicoptera
Kabutar	Blue rok pigeon	Columba livia
Koel	Koel	Eudyanamys sclopacea
Mor	Fea fowl	Pavo cristatus
Murgi jungli	Red jungl fowl	Gallus gallus
Murgi jungli	Grey jungli fowl	Gallus sonneratii
Nilkanth	Blue jay or Roller	Coracias banghalensis
Gidh	Vulture	Neophron peronopterus
Sarus	Crane Sarus	Grus antigona
Teetar (safed)	Grey patridge	Francolinus pondicerianus
Teetar (kala)	Painted patridge	Francolinus Pictus
Tota (Jungli)	Parrot	Taccocua leschenaur

REPTILES

Ajagar	Indian python	Python molurus
Chhipkali	Monitor lizard	Varanus monitor
Dhaman	Oriental rat snake	Plyas mucosus
Kacchawa	Turtle	Tustudo sp.
Kekra	Crab	Paratelphusa baratelphusa
Nag	Indian cobra	Naja naja

FISHES

Bam	Bam	Mastocembelus armatus
Katla	Catlo	Catle catle
Mahaseer	Mahaser	Tor putitora
Rohu	Rohu	Labeo rohita

Source: Working Plan of Raigarh Forest Division, Government of Chhattisgarh

The listed faunal taxon has been cross-checked with Red Data Book of Indian Animals (Zoological Survey of India) as per the following definitions:

- **Extinct:** A taxon is extinct when there is no reasonable dought that the last individual has died.
- **Critical:** A taxon is critical when it is facing an extremely high probability of extension in the wild in the immediate future.
- **Endangered:** A taxon is endangered when it is not critical but facing a very high probability of extinction in the wild in the near future.
- **Vulnerable:** A taxon is vulnerable when it is not critical or endangered but facing a very high probability of extinction in the wild in the medium term future.
- **Rare:** A taxa with small populations in the world that are not at present endangered or vulnerable but are at risk. These taxa are usually localized within restricted geographical areas or habitats or are thinly scattered over a more extensive range.

There is no endangered or critical or rare faunal species in the Raigarh Forest Division. Some vulnerable faunal species found in Raigarh forest division are described below:

1. English name Bison **Local name – Gaur**
Scientific name- *Bos gaurus* **Order: Artiodactyla**
Family: Bovidae

Habitat- Gaur is essentially a hilly animal and dweller of dense tropical forest, inter-spread with glades or open meadows.

Threat to survival: Destruction of habit due to modified land use, poaching for meat and various types of diseases are the main threats to its survival. Competition with domestic stock for food is another factor for being vulnerable.

2. English name- Mouse deer **Local name – Pisora**
Scientific name- *Tragulus Meminna* **Order: Artiodactyla**
Family: Traguilidae

Habitat- Mouse deer inhabits dense forest, amongst rocks, and grass-covered hillsides up to elevation of 1850 m.

Threat to survival: The population has become very thin due to killing by man for flesh. Destruction of habitat as well as predation by carnivores is also responsible for its being vulnerable.

3. English name- Asian Elephant **Local name – Hathi**
Scientific name- *Elephus maximus* **Order: Proboscidea**
Family: Elephantidae

Habitat- Elephants are forest animals requiring a shady environment but having free access to grasses, an important part of their diet, and water.

Threat to survival: A major cause of threat to elephant population in Raigarh forest division is degradation of forest cover, fragmentation of its habitat and migratory corridors and increasing urbanization. As a result, elephant population has been confined such that no genetic continuity with any other population could be maintained. Hence the elephants of Raigarh forest division are susceptible to genetic degradation and are highly vulnerable.

4. English name- Indian pangolin **Local name- Surajmukhi,**
Scientific name- *Manis crassicaudata* **Order: Pholidota**
Family: Manidae

Habitat- Lives in forest, open or grass land and also near villages. Spends the day curled up in a borrow dug by itself or shelters among rocks and boulders. Climb well on trees in quest of ants.

Threat to survival: The pangolin is under considerable pressure from hunters because of its delicious meet and supposed medicinal value of its scales. Scales are made in to finger rings and buckles. Destruction of habitat and use of insecticides are responsible for the decline of pangolin population in Raigarh forest division.

5. English name- Indian rock python **Local name- Ajagar**
Scientific name- *Python molurus* **Order: Squamata**
Family: Boidae

Habitat- The python is a serpent of marshes, gallery forest and wet rocky areas near streams and pools. It is denizen of burrows, dense clumps of vegetation, large rotten logs, caves, crevices and old ruins. The species is more nocturnal than diurnal. Its dietary habits are largely restricted to reptiles, birds and smaller mammals.

Threat to survival: The population of python has depleted due to commercial exploitation of its skin and their products, which are in high demand in the world market. The habitat destruction is another important threat to the species.

6. English name- Wolf **Local name- Bheria**
Scientific name- *Canis lupus pallipes* **Order: Carnivora**
Family: Canidae

Habitat- The wolf occurs in almost all sorts of habitats where it founds a refuge like crevices in rocks, caves, borrows in sands, etc. It hunts during night and animals such as antelopes, fox, hares, rodents, etc.

Threat to survival: The wolf has become extremely rare as a result of increased human settlement, and killing by man for commercial value of its fur. It is also killed by farmers to protect their poultry, sheep and goats from its predation.

7. English name- Indian Peafowl **Local name- Mor**
Scientific name- *Pavo cristatus* **Order: Galliformes**
Family: Phasianidae

Habitat- They remain in small groups in open areas adjacent to the forest, dense scrub jungles and deciduous forest for foraging.

Threat to survival: The peacock features are in great demand for commercial purpose. This is the main reason for the bird to be vulnerable.

3.10 Demographic Profile and Occupational Pattern (Source : District Statistics Handbook 2007)

The demographic profile of Gharghoda Tehsil, Lailunga tehsil and Raigarh district is shown in Table 3.17. The overall literacy rate of Gharghoda Tehsil is 71.96%, Lailunga is 58.81 and Raigarh district is 70.16%. There are only 14.55% Schedule Caste and 35.38% Scheduled Tribe population in Raigarh district. The male to female ratio is 1006 and 1000 for tehsil Ghargoda and Lailunga respectively.

3.17 Demographic Profile of Study Area (2001)

	District/ Tehsil/ Block	Total Population		Population density Per km^2		Male to Female Ratio	
		1991	2001	1991	2001	1991	2001
1	Raigarh district	1063083	1265529	156	185	1000	994
2	Gharghoda tehsil	131046	148903	253	165	1008	1006
3	Lailunga tehsil	96790	113531	166	125	1001	1000
4	Tamnar block	68991	78882	160	182	1015	998
5	Gharghoda block	52101	61972	93	132	1013	1021

	District/ Tehsil/ Block	Literacy Rate (%)		SC Population		ST Population	
		1991	2001	1991	2001	1991	2001
1	Raigarh district	35.52	70.16	148901	179744	392385	447703
2	Gharghoda tehsil	39.32	71.96	11319	12633	74557	83657
3	Lailunga tehsil	24.18	58.81	7022	8165	62315	72149
4	Tamnar block	33.94	73.77	6947	7423	36945	41596
5	Gharghoda block	29.79	69.00	4372	4236	37612	39480

Population Trends in Study Area

Block/Tehsil. /Distt.	1991		2001	
	Male	Female	Male	Female
Raigarh District	531480	531603	634597	630932
Gharghoda Tahsil	65053	65993	74209	74694
Lailunga Tahsil	48382	48408	56756	56775

The name of villages in study area with demographic profile is given in Table 3.18.

Table 3.18 Demographic Profile of the Study Area (2001 Census)

	Village name	Total	Male	Female	SC Total	SC Male	ST Female	ST Total	ST Male	ST Female
1	Jharan	861	449	412	29	17	12	603	316	287
2	Libra	757	369	388	44	25	19	330	154	176
3	Lamdond	797	395	402	4	2	2	387	194	193
4	Diyagarh	506	245	261	21	12	9	308	149	159
5	Chadero	-	-	-	-	-	-	-	-	-
6	Bhalumar	736	361	375	70	30	40	183	88	95
7	Jhanypali	747	390	357	72	34	38	250	125	125
8	Charbhantha	701	323	378	9	5	4	580	267	313
9	Jhankadarha	317	157	160	32	16	16	137	70	67
10	Bhalumuda	314	158	156	36	17	19	208	106	102
11	Dholnara	408	200	208	17	8	9	281	137	144
12	Bajarmuda	800	407	393	74	38	36	470	238	232
13	Karwahi	557	288	269	2	1	1	269	142	127
14	Khamahariya	531	264	267	62	32	30	198	91	107
15	Milupara	1165	573	592	78	38	40	784	386	398
16	Kondkel	856	423	433	74	38	36	563	278	285
17	Chirramuda	588	293	295	44	24	20	428	211	227
18	Banai	1137	565	572	118	51	67	881	444	437
19	Rengalbahri	502	251	251	73	40	33	402	198	204
20	Barkaspali	635	316	319	164	82	82	162	81	81
21	Uttarregaon	656	318	338	48	25	23	495	239	256
22	Kolam	427	223	204	54	32	22	188	92	96
23	Chitwani	747	363	384	40	23	17	515	249	266
24	Dolesara	1061	513	548	216	118	98	408	187	221
25	Dakshinregaon	334	168	166	0	0	0	126	56	70
26	Rodopali	688	351	337	89	50	39	430	220	210
27	Salihabhantha	764	383	381	58	27	31	395	198	197
28	Ukaripali	484	228	256	36	17	19	406	192	214
29	Deogarha	1945	949	996	242	120	122	1453	710	743
30	Patrapali	425	224	201	39	22	17	310	158	152
31	Barpali	328	153	175	18	7	11	197	96	101
32	Mauhapali	670	326	344	39	22	17	461	226	235
33	Punjipathra	366	241	125	16	9	7	273	159	114
34	Samaruma	392	206	186	8	3	5	18	12	6
35	Padkipahri	352	174	178	0	0	0	220	109	111
36	Kasdol	1326	661	665	71	30	41	488	242	246
37	Salihari	265	141	124	26	14	12	183	93	90
38	Kanta Jharia	176	90	86	9	6	3	95	47	48

39	Gorkamunda	17	10	7	0	0	0	28	15	13
40	Taraimal	620	327	293	24	14	10	301	157	144
41	Ujjalpur	74	36	38	0	0	0	0	0	0
42	Bhainsgarhi	230	121	109	1	1	0	154	81	73
43	Barbahli	111	54	57	0	0	0	43	21	22
44	Amaghat	1018	490	528	45	19	26	878	431	447
45	Kachkoba	1056	519	537	186	99	87	584	284	300
46	Jarekela	1018	503	515	42	26	16	587	296	291
47	Nawapara	293	142	151	39	20	19	215	104	111
48	Basanpali	991	459	532	84	39	45	197	89	108
49	Gorhi	1774	841	933	160	79	81	718	311	407
50	Tamnar	3974	1997	1977	158	80	78	994	501	493
51	Budhiya	960	480	480	27	12	15	488	248	240
52	Bagbadi	379	177	202	0	0	0	233	113	120
53	Kunjemura	1054	539	515	76	37	39	528	269	259
54	Kosampali	279	146	133	16	5	11	143	79	64
55	Gare	741	368	373	44	22	22	438	214	224
56	Pata	1189	595	594	124	60	64	474	228	246
57	Mudagaon	520	245	275	33	15	18	339	163	176
58	Saraitola	520	245	275	33	15	18	339	163	176
59	Saraitola	564	272	292	84	37	47	367	182	185
60	Sarasmal	508	260	248	0	0	0	415	212	203
61	Tapranga	593	301	292	42	22	20	155	75	80
62	Dongamahua	777	590	187	0	0	0	231	117	114
63	Dhaurabhata	1046	535	491	67	37	30	315	172	143
64	Nagaramuda	565	290	275	61	32	29	148	81	67
65	Jhinka Bahal	599	294	305	66	31	35	189	86	103
66	Raipara	466	229	237	21	9	12	246	119	127
67	Samkera	1491	726	765	242	124	118	621	289	332
68	Gaurbahari	1075	531	544	353	167	186	396	199	197
69	Manloi	2292	1166	1126	316	167	149	1385	704	681
70	Deogaon	1079	525	554	134	68	66	441	218	223
71	Amlidhondha	595	297	298	94	52	42	325	159	166
72	Pali	144	79	65	25	14	11	104	57	47
73	Jobaro	775	384	391	46	22	24	337	174	163
74	Khureshlenga	1437	722	715	334	171	163	643	320	323
75	Hamirpura	1252	655	597	75	40	35	418	220	198
Total Population		56377	28289	28088	5084	2571	2513	28502	14111	14401

Occupational Pattern : The occupational status is given in **Table 3.19**

Table 3.19 Trends of Occupational Pattern

	Farmers		Agricultural Workers		Domestic Workers	
	2005	**2007**	**2005**	**2007**	**2005**	**2007**
Raigarh District	246883	194678	233429	128942	14107	11447
Gharghoda Tehsil	34488	29322	31442	16901	2115	1662
Lailunga Tehsil	28466	22939	24249	12454	1489	1268

	Other Workers		Marginal Workers		Total Worker	
	2005	**2007**	**2005**	**2007**	**2005**	**2007**
Raigarh District	107160	95658	170820	170839	772399	601564
Gharghoda Tehsil	7456	6829	21769	21786	97270	75600
Lailunga Tehsil	4928	4438	18000	17975	77132	59074

3.11 Landuse & Cropping Pattern

Table 3.20 Land use Pattern of Study Area in Hectares (DSH-2007)

	District/ Tehsil/ Block	Total Land	Forest Land	Land put to Non Agricult--ural Use	Fallow Land (other than current fallows)	Cultura ble Land	Current Fallow Land	Net Sown Area
1	Raigarh District	503075	58310	64226	64041	7852	31521	309818
2	Gharghoda Tehsil	90342	6507	8432	13732	2049	9871	52431
3	Lailunga Tehsil	60047	5251	10562	9241	580	4182	33432

Classification		Gharghoda Tehsil	Lailunga Tehsil	Raigarh Dist.
1	Area Under Forest	6507	5251	58310
2	Land Put to Non Agriculture	8432	10562	64226
3	Barren Land	13732	9241	64041
4	Culturable WasteLand	2049	580	7852
5	Area Under Crop	59622	34413	308646
	Total	90342	60047	503075

Table 3.21 Trends of Land Use Pattern in Raigarh District. (In Hectare)

Classification		2001	2002	2003	2004	2005	2006	2007
1	Area Under Forest	58565	57733	58315	58314	58265	58325	58310
2	Land Put to Non Agriculture	65075	9989	60549	60743	63549	63834	64226
3	Barren Land	64209	64322	64576	64341	64082	64140	64041
4	Culturable WasteLand	7924	9361	9355	9659	7905	7784	7852
5	Area Under Crop	310963	310502	310280	309327	309274	308992	308646
	Total	506736	451907	503075	502384	503075	503075	503075

Table 3.22 Land use Pattern of the Study Area (in %)

	Category	Ghargoda Tahsil	Lailunga Tahsil	District Raigarh
1	Area Under Forest	7.21	8.74	11.59
2	Land Put to Non Agriculture	9.33	17.59	12.77
3	Barren Land	15.2	15.39	12.73
4	Culturable WasteLand	2.27	0.97	1.56
5	Area Under Crop	65.99	57.31	61.35
	Total	100	100	100

Kharif is the major cropping pattern of the study area. The main kharif crop is paddy, which is cultivated in June and harvested in November. Rabi crop is grown in small area and the main crop is wheat. Other minor crops grown in the study area are maize, jowar, arhar and groundnut. The distribution of irrigated area and irrigation potential in Lailunga tehsil, Gharghoda Tehsil and Raigarh District is shown in Table 3.23.

Table 3.23 Irrigated Area and Irrigation Potential in Study Area

Irrigated area (hect)	Lailunga Tehsil	Gharghoda Tehsil	Raigarh District
Irrigated Area from main sources (Canal)	2918	2038	59599
Irrigated area from other sources (ponds, tube wells)	513	887	6894
Gross Irrigated Area	3237	2217	63219

		Canal irrigated Area (ha)	Tube well Irrigated area (Ha)	Ponds irrigated Area (Ha)	Area irrigated by other sources (ha)	Total irrigated area (ha)
1	Raigarh	22974	26329	5518	6894	59599
2	Gharghoda	315	661	110	887	2038
3	Lailunga	2197	83	160	513	2918

The area-wise distribution pattern of kharif and rabi crops in the study area and area under production is shown in **Table 3.24.** The maximum part of the study area falls under Ghargoda tehsil. The area covered in Gharghoda tehsil during 2004-05 for rice was 40101 ha, wheat was 84 ha, maize was 92 ha, gram was 72 ha, arhar was 305 ha, sugarcane was 64 ha, and oilseeds was 2431 ha,. The production of paddy in Riagarh district during 2004-05 was 227325 tons, wheat was 1931 tons, maize was 897 tons, gram was 266 tons, arhar was 1875 tons, mung was 1020 tons, urad was 3501 tons, sugarcane was 2174 tons, til was 44000 tons and groundnut was 4890 tons.

Table 3.24 Details of Rabi and Kharif crops in Raigarh District (Area hectares)

	2001	2002	2003	2004	2005	2006	2007
Cereal Crops	270441	269283	268853	268389	268153	266421	266273
Other crops	11324	10306	10940	10522	11025	10334	10223
Total Kharif Crop	2817652	279589	279793	278911	279178	276755	276496
Cereal crops	15088	17117	18240	27673	23112	23421	23696
Other crops	3138	4782	5602	11159	8502	9690	9626

Area Covered Under Cereals (in Ha)

	Wheat		Paddy		Jowar		Maize	
	2005	**2007**	**2005**	**2007**	**2005**	**2007**	**2005**	**2007**
Raigarh	1895	1601	241526	240616	35	21	980	1015
Gharghoda	84	92	40101	39313	Nil	Nil	92	94
Lailunga	279	210	22827	22753	4	6	129	134

	Other Cereals		Total Cereals	
	2005	**2007**	**2005**	**2007**
Raigarh	536	382	244972	243635
Gharghoda	98	66	40375	39565
Lailunga	59	51	23298	23154

Area Covered Under Pulses (in Ha)

	Arhar		Gram		Other Pulses		Total pulses	
	2005	**2007**	**2005**	**2007**	**2005**	**2007**	**2005**	**2007**
Raigarh	2146	2386	662	563	34766	33568	37574	36517
Gharghoda	305	329	72	77	9356	8770	9733	9176
Lailunga	693	741	288	226	6174	5976	7155	6943

Area Covered Under Oilseeds and Fibre Crops (in Ha)

	Soyabeen		Til		Groundnut		Others		Total Oilseeds	
	2005	**2007**	**2005**	**2007**	**2005**	**2007**	**2005**	**2007**	**2005**	**2007**
Raigarh	33	13	3755	3169	9115	8555	6081	7663	18984	19400
Gharghoda	Nil	Nil	1557	1470	685	674	189	440	2431	2584
Lailunga	Nil	Nil	107	135	873	761	945	1314	1925	2210

Area Covered Under Other Crops (in Ha)

	Sugarcane		Total vegetables		Total spices	
	2005	**2007**	**2005**	**2007**	**2005**	**2007**
Raigarh	748	678	5760	7214	1467	1925
Gharghoda	64	52	522	893	105	108
Lailunga	72	76	724	873	77	112

Area Covered Under Other Crops (in Ha)

	Sugarcane		Total Fruit & vegetables		Total Silk	
	2005	**2007**	**2005**	**2007**	**2005**	**2007**
Raigarh	748	678	5760	7214	435	444
Gharghoda	64	52	522	893	70	53
Lailunga	72	76	724	873	58	64

Domesticated Animals: Cow, Buffalo, Goat and Hen are the common domesticated animals adopted by the local people of study area, who are pre-dominantly agriculturist. The various types of domesticated animals in Gharghoda Tehsil and Raigarh District is shown below:

Name of Animal	Gharghoda Tehsil			Raigarh District		
	2003	2005	2007	2003	2005	2007
Cow	75356	71412	71751	438712	397308	407218
Buffalo	15609	14753	15574	103718	88936	90333
Sheep	5549	5884	5540	27670	25658	26169
Goat	26310	26209	26323	127249	129440	126909
Pig	539	433	385	15541	17751	16991
Horses	11	11	11	74	61	52
Hen	40389	34465	37443	295577	327639	349446
Duck	409	409	471	13345	11422	13496

3.12 Socio-economic Scenario (Source : District Statistics Handbook 2007)

The growth of industrial sectors and infrastructure development in and around agricultural dominant villages is bound to create its impact on the socio-economic life of the local population. To study the socio-economic aspects of this region, data has been collected from District Statistical Handbook 2005 (Raigarh District).

Commerce and Infrastructure Facilities: Raigarh is the nearest commercial center located 22 km away. The timber trade in Raigarh is prominent. Taraimal, Punjipatra and Tamnar are slowly converting to industrial areas with establishment of several sponge iron plants, rolling mills, coal mines and power plants. Raigarh town has of several educational institutions such as primary, secondary and higher secondary schools, polytechnic college,

degree college, arts and science college, technology institute, public libraries, and reading rooms. Almost all the villages of the study area are accessible by all weather pucca roads, maintained by the PWD.

Educational Facilities: The number of educational institutes and students in Lailunga , Gharghoda Tehsil and Raigarh District is shown below.

Number of Educational Institute in Raigarh District

	Raigarh Dist.	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
1	Primary School	1750	1678	1719	1844	2010	2125	2164
2	Middle School	455	441	452	541	565	625	927
3	High School	96	92	114	63	63	66	150
4	Higher Secondary	62	61	71	57	55	64	154
5	College	06	06	06	05	05	05	05
6	Commercial institute	04	09	09	09	09	11	12
7	Other Institute	02	02	02	02	02	02	02

Number of Educational Institute in study area

	District /Tehsil/ Block	**Primary School**		**Middle School**		**High School**		**Higher Secondary**		**College**		**Commercial institute**	
		2005	**2007**	**2005**	**2007**	**2005**	**2007**	**2005**	**2007**	**2005**	**2007**	**2005**	**2007**
1	**Lailunga**	264	265	63	108	06	15	03	13	Nil	Nil	Nil	Nil
2	**Gharghoda**	321	313	73	131	12	19	09	22	Nil	Nil	01	02
3	**Raigarh**	2010	2164	565	927	63	150	55	154	05	05	09	12

Number of Students in Educational Institute

Types of Educational Institute	**Lailunga Tehsil**				**Gharghoda Tehsil**			
	Boys		**Girls**		**Boys**		**Girls**	
	2005	**2007**	**2005**	**2007**	**2005**	**2007**	**2005**	**2007**
Primary school	7647	7933	6558	6976	9749	9999	7950	8468
Middle school	2617	2868	2010	2142	2859	3091	2288	2615
High school	1131	1417	826	981	1512	1951	1203	1459
Higher secondary	1314	1462	986	1111	2475	2771	1838	2090
College	--	--	--	--	--	--	--	--
Commercial Instt.	--	--	--	--	43	59	13	19
Other Institute	--	--	--	--	--	--	--	--

Types of Educational Institute	Raigarh District			
	Boys		Girls	
	2005	2007	2005	2007
Primary school	74243	76827	66078	69788
Middle school	30488	32503	23131	24297
High school	14586	17954	10135	11596
Higher secondary	15615	16959	11622	12763
College	2708	2625	1815	2190
Commercial Instt.	1616	1712	245	307
Other Institute	506	274	304	184

Medical Facilities:

Raigarh District

Medical Facilities	2001	2002	2003	2004	2005	2006	2007
Primary Health Centre	46	46	40	41	42	40	50
Sub Health Center	253	253	251	251	311	311	311
Aurvedic / Homeopathic	28	28	28	28	28	28	28
Beds in Allopathic Hospital	623	623	688	525	531	690	690
Available Beds in Other Hospitals	30	30	30	30	30	30	30

Medical Facilities	Lailunga tehsil		Gharghoda tehsil		Raigarh district	
	2005	2007	2005	2007	2005	2007
Primary Health Centre	04	04	06	07	42	50
Sub Health Center	41	42	47	46	311	311
Aurvedic / Homeopathic	--	--	03	03	28	28
Beds in Allopathic Hospital	30	30	72	72	531	690
Available Beds in Other Hospitals	--	--	--	--	30	30

Number of Internal and Outdoor Patient

Tehsil / Distt.	Internal Patient		Outdoor Patient		Total Patient	
	Allopathic	Other System	Allopathic	Other System	Allopathic	Other System
Lailunga Tehsil	2172	----	14999	----	17171	-----
Gharghora Tehsil	1653	----	29393	10841	31046	10841
Raigarh Distrct	102560	246	379415	122798	481975	123044

Electrification: In the study area about 90% of the villages is electrified. Overall electrification rate in Raigarh district is 93% covering 1372 villages. The use in industrial and commercial use is not significant when compared to domestic use. The electricity consumption in domestic, commercial and industrial sector is shown below.

Use of electricity in 1000 KW

Year	Domestic Use	Commercial Use	Industrial Use	Water Supply	Agriculture Use	Road Lighting	Total electricity
2006-2007	103000	7710	163990	5710	165650	2860	448920

Transport: Most of the villages in study area are well connected to the roads. According to the district statistics hand book 2006-07 about 1294 villages in Raigarh district are well connected by roads. The length of roads and their condition in district is given following table.

Length of Roads (in km)

	Year 2005	Pukka Roads			Kutchha roads		
		PWD	Local	Total	PWD	Others	Total
1	Raigarh district	1446.95	8.84	1455.79	49.3	644.4	693.7

Most of the villages in the district are connected with by road network. 98% of the villages in the study area have electricity and drinking water facility. All the centrally sponsored rural poverty alleviation and national social assistance programmes are being implemented in the tehsil. Besides, a number of State Government's rural development and social security programmes are also under implementation. A number of agencies are implementing these schemes. National Old Age Pension Scheme is also administered by Tehsil.

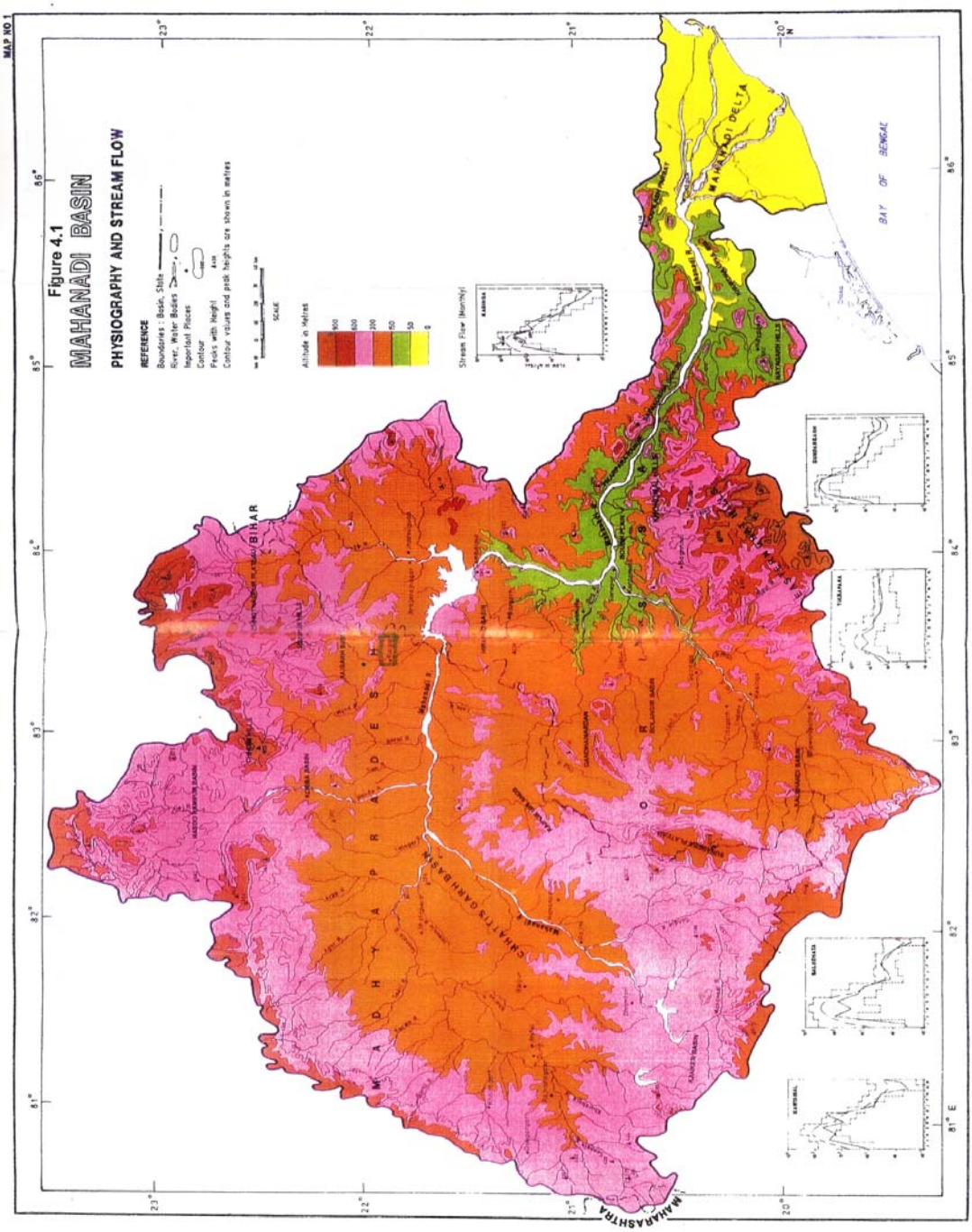
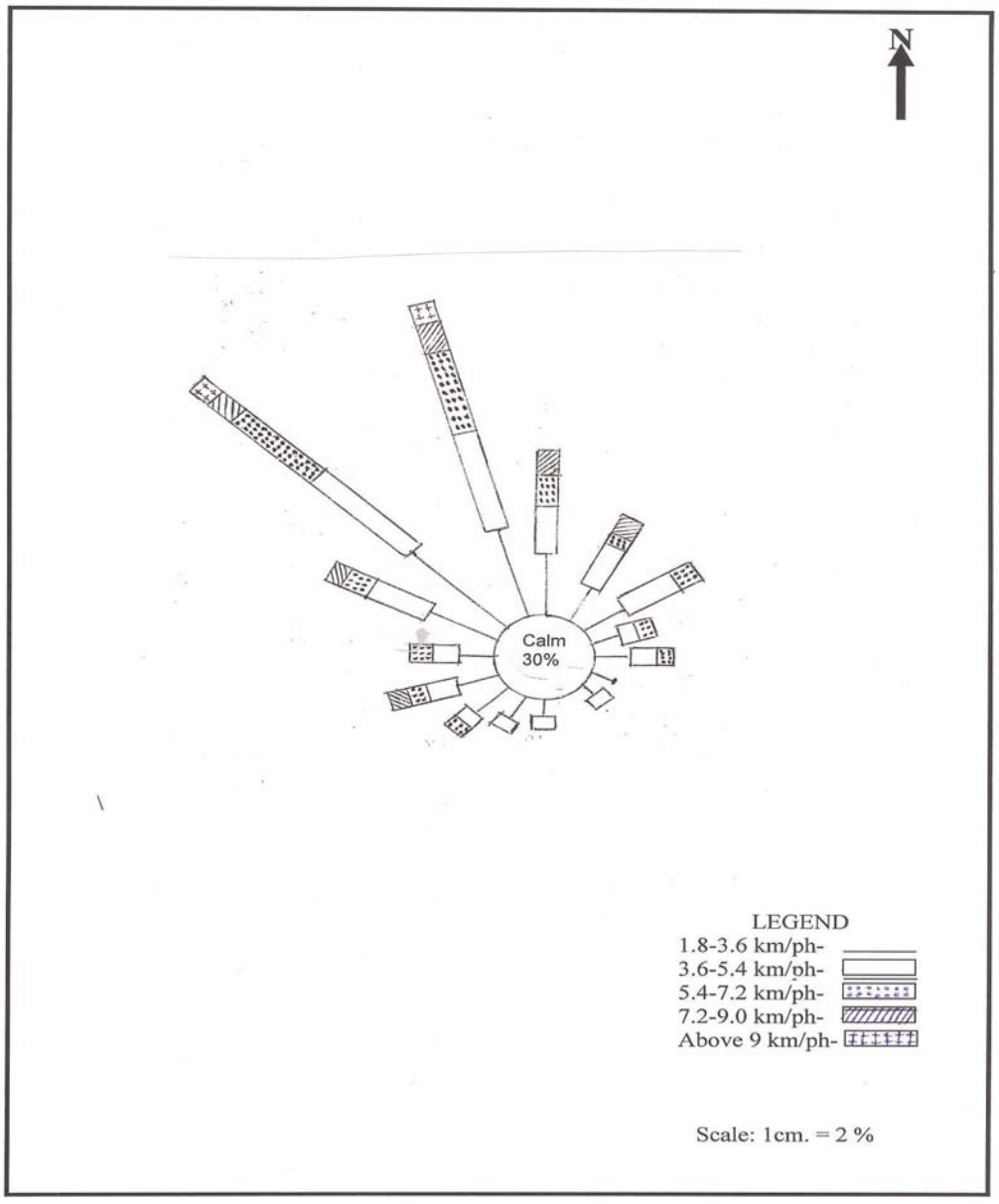
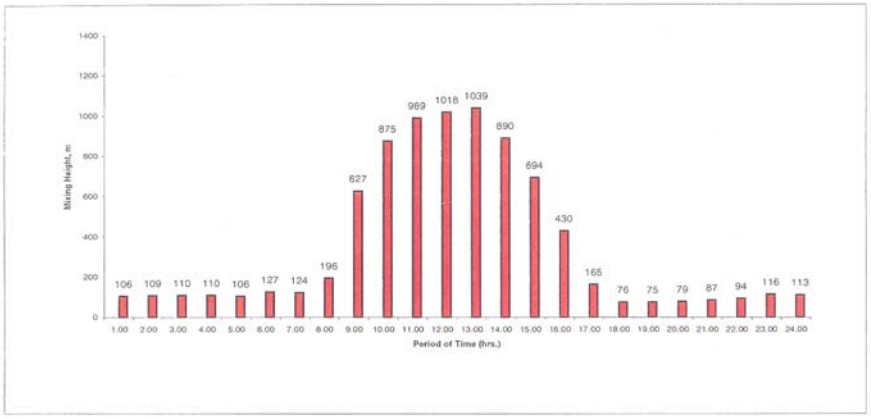


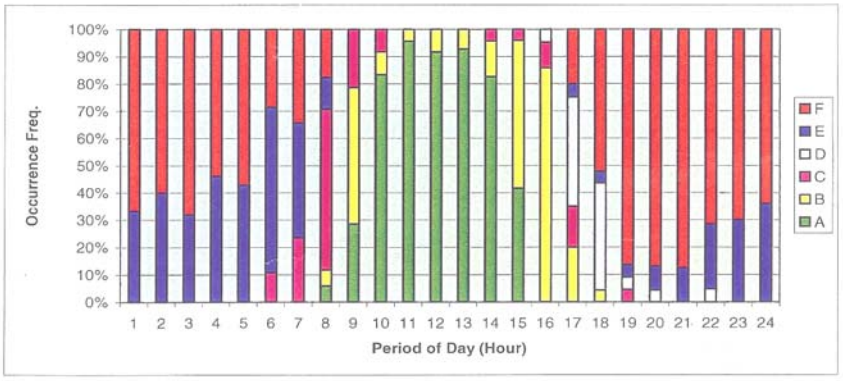
Figure 3.1 Map of Mahanadi River Basin

Figure 3.2 Wind Rose Diagram of Tamnar Site





A PLOT OF AVERAGE MIXING HEIGHT DURING THE PERIOD OF OBSERVATION (3RD DEC 2006 TO 4TH JAN 2007) AT RAIGARH



A PLOT OF AVERAGE ATMOSPHERIC STABILITY CLASSES DURING THE PERIOD OF OBSERVATION (3RD DEC. 2006 TO 4TH JAN 2007) AT RAIGARH

Figure 3.3 Stability class Data generated at Raigarh Area Using SODAR

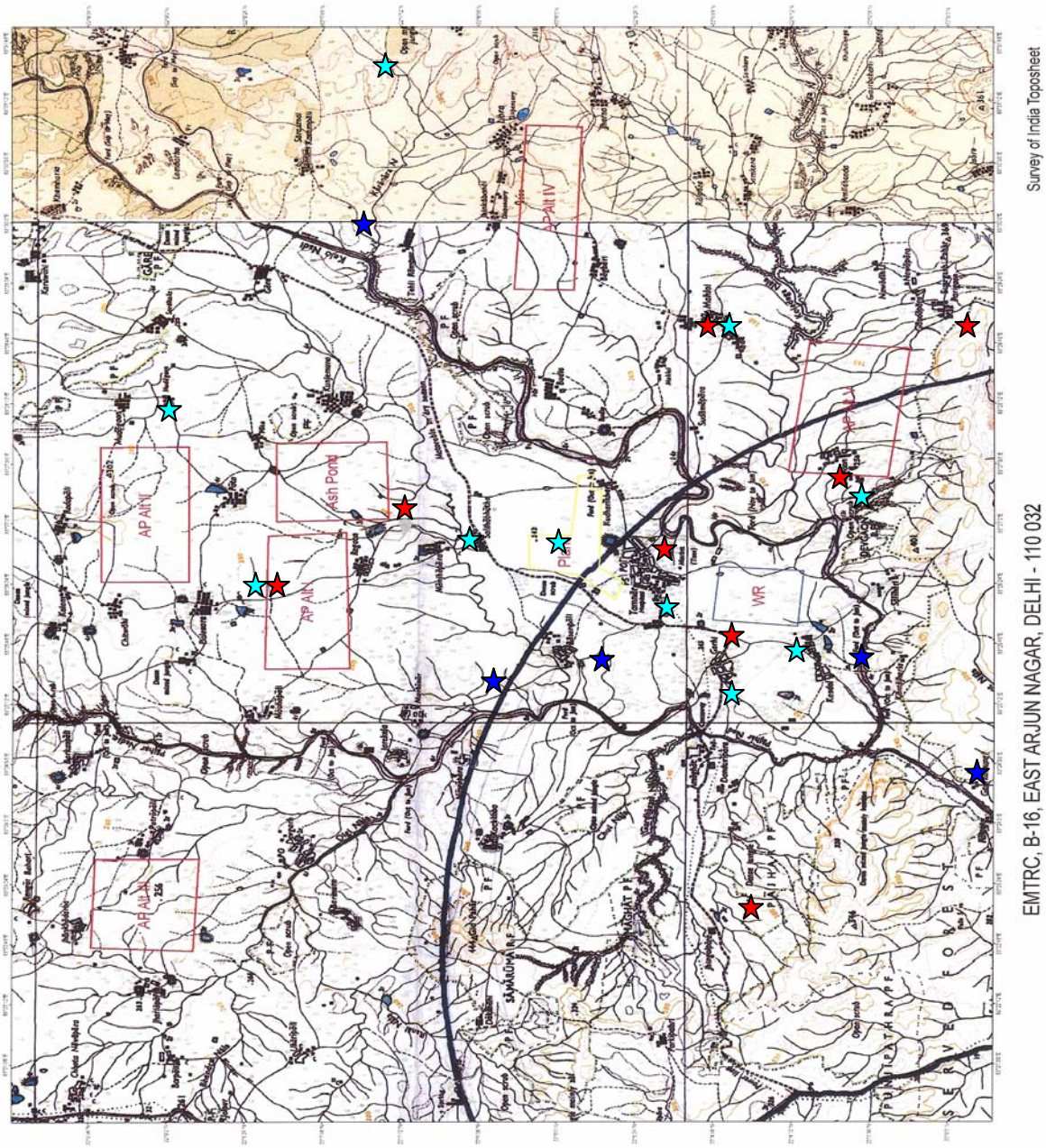


Figure 3.4 Map Showing Monitoring Locations
AAQ Locations ★ Surface Water Sampling locations ★
Ground water Sampling locations ★

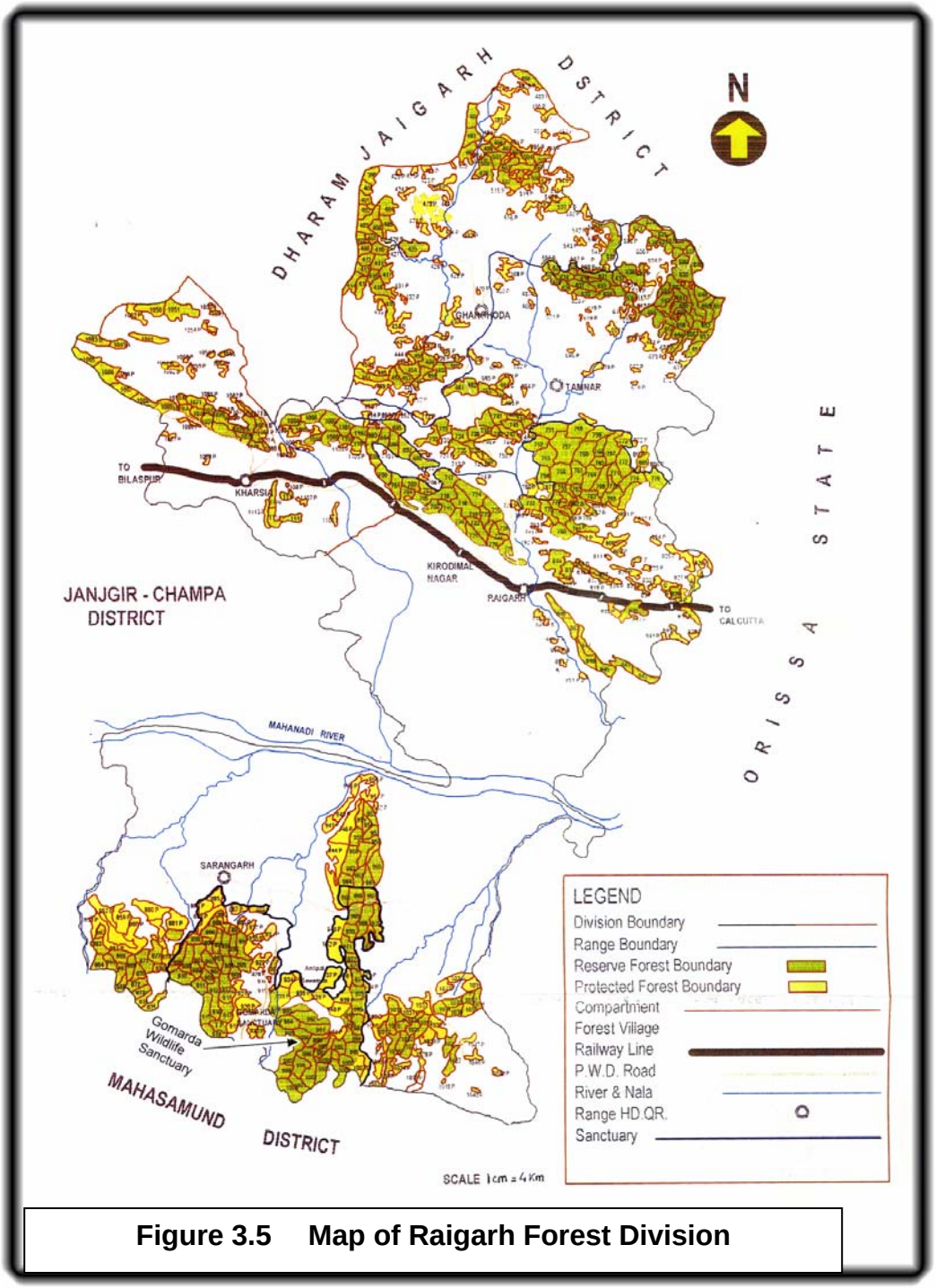


Figure 3.5 Map of Raigarh Forest Division

CHAPTER 4 : ANTICIPATED ENVIRONMENTAL IMPACTS & MITIGATION MEASURES

4.1 Identification of Impact

The construction and operation phase of the proposed project comprises various activities each of which have been considered to assess the impact on one or another environmental components.

Impact assessments are based on conceptual notions on how the universe acts that is intuitive and / or explicit assumptions concerning the nature of environmental processes. In most cases the predictions consists of indicating merely whether there will be degradation, no change, or enhancement of environmental quality. In other cases, quantitative ranking scales are used. The impacts of the project on the environment have been considered based on the information provided by the proponents and data collected at the site. Significant environmental impacts have been categorized as long term or short term and reversible or irreversible impacts.

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4.2 Construction Stage Impact

The construction of the plant will take 44 to 48 months. Construction workers will be taken from nearby villages. Adequate drinking water, sanitation and canteen facility will be provided to the workers.

4.2.1 Impact on Landform (Topography and Geology)

The land is generally flat and requires practically no leveling. No earth will be brought from outside or disposed outside the premises. The excavated earth during civil foundations will be stored at earmarked place with proper slopes and utilized for leveling and landscaping purpose within the plant premises. Excavation work will be carried out during dry season and avoided during rainfall events to prevent soil erosion and washout of excavated materials.

The subsurface of the site has 14 -35 cm varying thickness soil followed by rocks. Drainage system on either side of the road will be developed, which will be connected to the natural drainage system of the area so that the runoff generated does not cause any flooding or siltation problems. The impact on the topography will be localized and reversible in nature. The visual aesthetics of the working and worked out area will start improving after the start of construction activity.

4.2.2 Impact on Natural Resources

During the construction stage there will be impact on the surrounding vegetation due to dust pollution. To prevent the generation of re-suspended road dust due to vehicular movement, internal roads will be developed. The permanent roads will be of WBM. Temporary roads will be stabilized properly (free of loose soil materials) and regular water sprinkling will be done to prevent the dust nuisance. The Central Ground Water Authority has categorized the area as Safe for groundwater extraction. Runoff water stored in the water reservoir will be also used during the construction (where potable quality water is not required). Construction workers will be provided canteen facility so that they do not cut trees for use as fuel. The impact on the natural resources of the surrounding area during the construction stage will be insignificant in nature.

4.2.3 Impact on Ambient Air

Dust will be the main pollutant affecting the ambient air quality of the area during the construction phase. Dust will be generated during excavation, back filling and hauling operations and vehicular movement of trucks, dumpers and construction machinery. Providing suitable surface treatment to ease the traffic flow and regular sprinkling of water will reduce the uncontrolled dust generation.

Aggregates and sand will be stockpiled at suitable places (after stabilizing the surface), near the boundary wall so that the wall acts as windshield. The stockpiles will be aligned along the predominant wind direction, with slopes stablised and maximum height will be maintained close to the boundary wall height. In case the height of stockpiles exceeds that of boundary wall then additional windshields of adequate height (preferably with tin sheets)

will be provided. To prevent dust nuisance from the stockpiles it will be covered with plastic sheet, wherever required. Necessary water sprinkling arrangement will be provided around the stockpiles and used whenever necessary to make them moist. Cement and steel will be stocked inside covered sheds.

Necessary pollution control measures as per the requirement under local laws and regulations will be provided for the RMC plant, stone crushers, asphalt plant and flyash block and brick making plant. Necessary dust suppression measures like water sprinkling using road tankers will be deployed to mitigate the dust nuisance Construction equipment having 'Pollution Under Control Certificate' will be deployed during the activity to restrict the exhaust emissions. Short term, localised and reversible impact is expected due to dust emissions generated during the construction stage.

4.2.4 Impact on Ambient Noise

There will be noise generation from earth moving equipment and material handling traffic. Construction equipment are likely to produce maximum noise levels, between 70-80 dB(A) at 1 m away from source. The construction activity will be carried out mostly during daytime. The construction equipment will undergo preventive maintenance test at routine intervals. Any machinery or equipment generating excessive noise levels (above 80 dBA) will be taken for maintenance. The noise generation will be confined within the surrounding areas of construction site. Short term, localised and reversible impact is expected due to noise emissions generated during the construction stage.

4.2.5 Impact on Water Bodies

Storm water drains will be made immediately after starting construction activity. The drains will be properly aligned in conformity with the site drainage pattern so that the alteration is kept to the minimum and flooding or soil erosion does not occur. Sedimentation pits will be provided at appropriate location to trap the silt laden runoff water and prevent excessive silt from going outside. Construction of water reservoir and land grading / leveling will start along with the construction of boundary wall. The storm water drains will be suitably

diverted to the water reservoir to collect the runoff. This stored water will be utilized for construction purpose.

Rainwater harvesting / recharge structures will be made at suitable points to collect the excessive runoff generated from the paved areas of the plant site and divert them for recharging the groundwater table. Guidelines developed by Central Ground Water Board will be followed for making the recharge structures. Considering the site features shaft type recharge structures are recommended.

Domestic sewage generated will be taken to Sewage Treatment Plant. Sewer lines will be developed to connect the generation points to the STP. The treated water will be reused for gardening purpose within the plant and township premises.

No wastewater will go out of the plant premises during the construction stage and contaminate the surrounding water bodies in any manner. Short term, localised and reversible impact is expected on the surrounding water bodies during the construction stage.

4.2.6 Impact on Soil

Dust, treated wastewater disposal on land and solid waste disposal are the activities that could have impact on the soil quality of surrounding areas. The mitigation measures suggested for controlling / reducing dust nuisance and solid wastes disposal has been described above. The treated domestic wastewater will meet the standards specified for discharge on land for irrigation purpose. Short term, localised and reversible impact is expected on the surrounding soil quality during the construction stage.

4.2.7 Impact on Ecology

The impact due to construction activities on the ecology of the area will be confined to the construction site itself. There will be negligible impact on the ecology (flora and fauna) during the construction phase. Trees present in the site will be retained to the maximum extent feasible. Re-plantation of healthy trees will be done wherever feasible. Few species

of birds are sighted in and around the site. Plantations will improve the habitat of avifauna. No wild life sanctuary or national park is located around the project site. No wild animals have been sighted around the project site. Short term, localised and reversible impact is expected on the surrounding ecology during the construction stage.

4.2.8 Impact on Workers Health, Sanitation and Safety

Most of the construction workers will be taken from surrounding villages. The health of workers will be checked for general illness; first time upon employment and thereafter at periodic intervals, as per the local laws and regulations. The workers will be diagnosed for respiratory functions at periodic intervals and during specific complaints for lung function test, sputum test, X-ray test, auditory tests, etc. Health centre and ambulance facility will be provided to the worker. Workers exposed to dust and noise will be given personnel protective equipment like nose masks, face shields and ear plugs. Job rotation schemes will be practiced for over-exposed persons. Insignificant impact is expected on the workers health and safety during the construction stage.

4.2.9 Solid Waste Disposal

Careful design, planning and good site management would minimize waste of materials such as concrete, mortars and cement grouts. Construction wastes will be segregated as much as possible at site itself to increase the feasibility of recycling concrete and masonry as filling material and steel pieces as saleable scrap. Litter disposal and collection points will be established around the work sites. Empty packaging materials, drums, glass, tin, paper, plastic, pet bottles, wood, thermocol and other packaging materials, solder butts, etc will be disposed through recyclers (locally called kabadis). The construction spoils will be temporarily stored at designated dumpsite located inside the plant premises. Later on these wastes will be used for landfilling / leveling work within the plant premises.

4.2.10 Social Impact

The social impact during the construction stage will be of beneficial nature. About 1000 people of daily average basis will get employment during the construction stage. The construction stage will extend for 48 months.

Involuntary resettlement issues, R&R issues related to minority group are not involved with this project. Child and bonded labour is prohibited under the local laws and regulations; JPL will abide by it. No cultural heritage site (temple, mass bathing site during religious festivals, etc) is located close to the project site that could be affected during the construction stage.

4.3 Operation Stage Impact

4.3.1 Impact on Ambient Air

The impact during the project operation on the ambient air quality of the study area has been predicted using mathematical modeling by following the guidelines developed by CPCB. Upon discharge to atmosphere, the air emissions from stationary sources are subjected to following physical and chemical processes:

1. An initial vertical rise, called plume rise, due to initial buoyancy and momentum of discharge,
2. Transport by wind in its direction,
3. Diffusion by turbulence, and
4. Gravitational settling, chemical transformations, deposition, washout and other complex reactions.

Modeling was carried out using the USEPA's ISCST3 package. The software meets the requirement of CPCB and World Bank Guidelines and calculates worst-case 24-hour average values (Short Term). The modeling procedure is described below:

Emission Inventory

Emission inventory has been prepared based on the engineering details available with JPL. Release rate of pollutants has been calculated after considering the pollution control

measures. Emission inventory of PM, SO_2 and NOx has been prepared for modeling because they are considered criteria pollutants covered under the local regulations (ambient air and emission standards).

The flue gas composition is as follows: CO_2 - 20%, N_2 - 68.2%, O_2 - 4.7%, Moisture - 7%. The dust size distribution at ESP outlet is as follows: <3μ – 97.16%, 3μ - 5μ – 1.18% and <10μ – 0.78% (Source: BHEL).

For PM 50 mg/Nm^3 and for NOx 1000 mg/Nm^3 emission has been considered. SO_2 has been calculated using 375 TPH coal with 0.5% sulphur for each unit. The name of unit, stack diameter, exit velocity, gas temperature and pollution load (inventory) is given in Table 4.1.

Meteorological Data

Surface meteorological data for wind speed, wind direction and ambient temperature has been generated at the project site. Stability class and mxing height data were obtained from SODAR data.

Stack Locations

The stack locations were assigned with reference to one absolute reference point (ARP).

Receptor Locations

Flat terrain was considered for modeling. Cartesian Grid of dimensions 10 km x 10 km area around ARP.

Table 4.1 Stack Emission Inventory

	Name of Unit	Stack height (m)	Stack top dia, m	Stack temp, (K)	Stack velocity (m/s)	Stack Emission Rate (g/s)		
						SPM	SO_2	NOx
1	Stack1 Flue 1, 00	275	4.75	413	25	16	1050	320
2	Stack1 Flue 2, 00	275	4.75	413	25	16	1050	320
3	Stack2 Flue 3, 00 -300m	275	4.75	413	25	16	1050	320
4	Stack2 Flue 4, 00. -300m	275	4.75	413	25	16	1050	320

Default Values

The ISCST model by default does the extrapolation of wind speed (Irwins exponents) to the effective height of release and calculates final plume rise as per Briggs equation. Since 50% of land inside a circle of 3 km radius around the site does not have considerable build-up area, rural dispersion coefficient is considered for modeling. Dry depletion and wet depletion of pollutants, exponential decay of pollutants during the travel time from source to receptor was not modeled, hence the modeled results depicts worst case scenario. The model used regulatory default options for stack tip downwash, buoyancy induced dispersion, uses calm processing routines, default wind processing exponents, vertical potential temperature gradients.

Modeling Results

The model was set up for calculation of 24-hour average values. The ground level concentration (glc) were plotted as isopleths. The plots are shown in Figures 4.1 to 4.3.

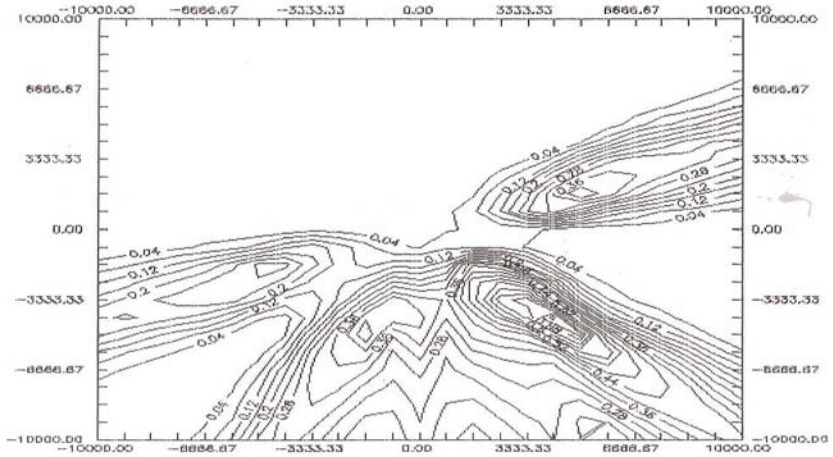
Discussion

The worst incremental glc value of PM, SO_2 and NOx from the project at full operating load will be 1.0 $\mu g/m^3$, 42 $\mu g/m^3$ and 20 $\mu g/m^3$ respectively in the downwind southeast direction (at 2.0 to 2.5 km distance). The maximum incremental glc is superimposed over the maximum baseline ambient air level and the resultant values are shown in Table 4.2 (24 - hour average in $\mu g/m^3$): The 275 m tall stack heights with high momentum and buoyancy takes the plume above the highest mixing height. 99.98% PM emissions are controlled using ESP. The particle size of PM is within 10 microns. This results in lowest ground level concentration of air pollutants in the study area.

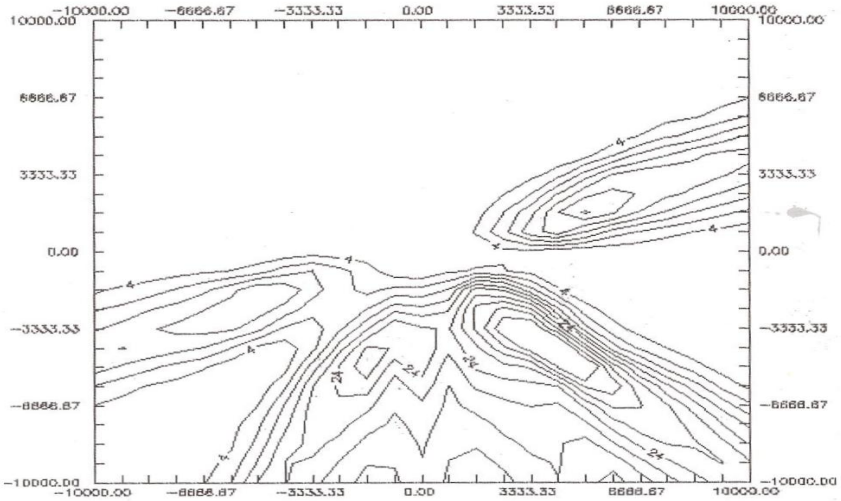
Table 4.2 Impact of Air Emissions on Baseline Environment ($\mu g/m^3$)

Parameter	Incremental glc (max)	Background Level (max in d/w side)	Superimposed value	Indian Standard	World Bank Standard	WHO Standard
SO_2	42	8.2	50.2	80	125	125*
NO_X	20	24.6	44.6	80	150	
SPM	1	180	181	200	--	
RSPM	1	87	88	100	110	150*

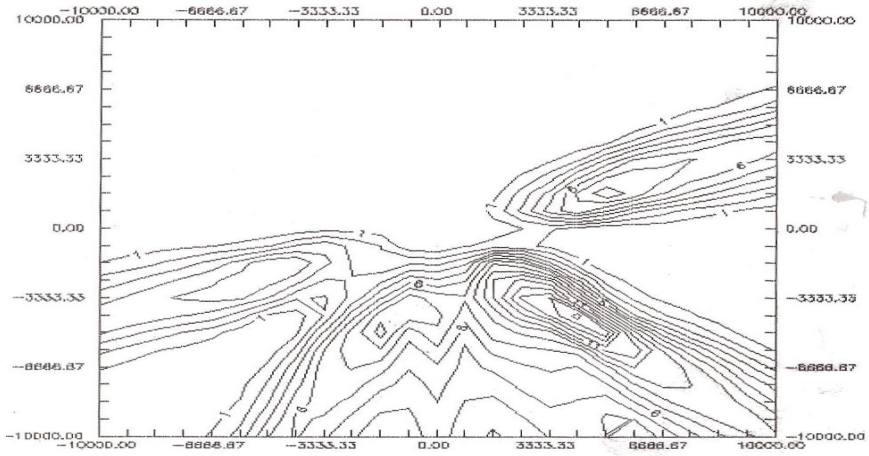
F.4.1 GLC OF SPM:JPL TAMNAR



F.4.2 GLC OF SO2:JPL TAMNAR



F.4.3 GLC OF NOX:JPL TAMNAR



4.3.2 Impact on Ambient Noise

During the operation phase noise will be generated from all sources. With increasing distance from the source the noise level decreases due to wave divergence. Additional decrease also occurs due to atmospheric effects and interaction with objects in the transmission paths. For hemispherical sound wave propagation through homogeneous medium, one can estimate the noise levels at various locations due to different sources using a model based on the following principle:

$L_{p2} = L_{p1} - 20 \text{ Log } (r_2/r_1)$, where L_{p1} and L_{p2} are the sound levels at points located at distance r1 and r2 from the source. Combined effect of all the sources (A, B, C,… etc) can be determined at various locations by the following equation:

$L_{ptotal} = 10 \text{ Log } (10^{lpa/10} + 10^{lpb/10} + 10^{lpc/10} \ldots)$, where Lpa, Lpb and Lpc are noise pressure levels at a point due to different sources.

Based on the above principle a Noise Model “Dhawani” has been developed by National Environmental Engineering Research Institute (India). This model is recommended by the Ministry of Environment & Forests, Government of India in the EIA Manual. The details of the model are as follows:

a. Maximum number of sources that can be modeled is 25.
b. Noise levels can be predicted at any distance from the sources.
c. Model is designed for flat terrain
d. Coordinates of the sources with respect to locations can be fixed
e. Isopleths can be drawn
f. Attenuation factors are not incorporated hence the modeled results are overestimate

.

94.5 dBA noise level has been considered for modeling (max noise generated by the turbines). Modeling study proved that the noise level at plant boundary would not exceed 70 bB(A). At nearest human settlement (Tamnar village) maximum the incremental noise level will be 2.5 dB(A).

Noise attenuation effects due to turbine enclosure, turbine building shed, barriers like the tall boundary wall, dense 25-30 m greenbelt (shrubs, bushes and trees) absorption by air, wind, temperature and humidity, greenbelt were not considered for modeling, hence the values depict worst case scenario. The noise impact contours are shown in Figure 4.4.

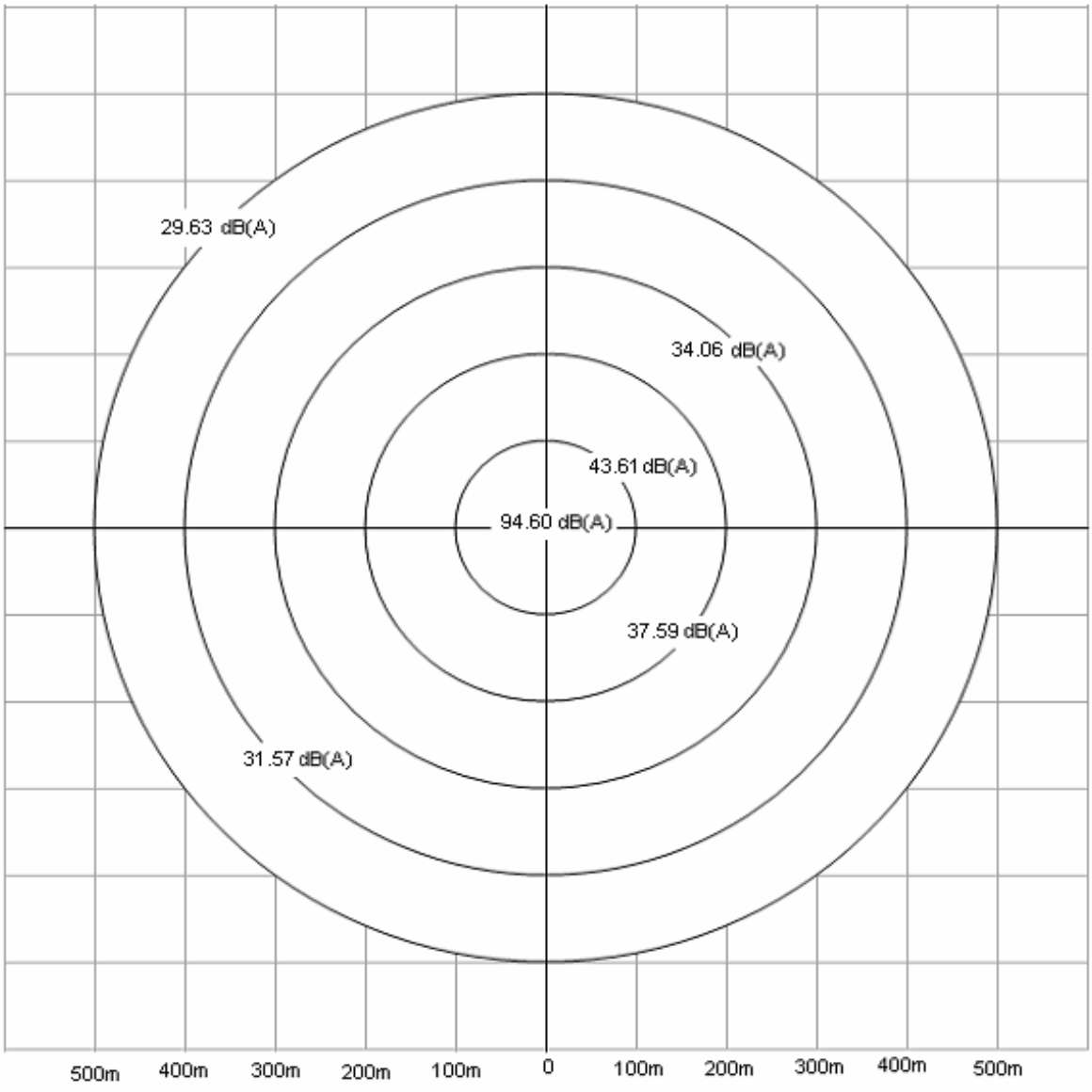


Figure 4.4 Noise Impact Contours

4.3.3 Impact on Water Bodies

The wastewater management schemes have been designed with recycling and reuse systems. No wastewater will be discharged outside the plant premises.

The network of storm water drains and wastewater drains will be made separate. The storm water drain will have sedimentation pits and oil – water interceptors located at suitable points. During monsoon, the storm water will be discharged into the Kelo river / nearby streams.

In order to prevent groundwater contamination from defective sewers, preventive measures will be taken while designing and laying the sewers meant for conveying wastewater from the generation point to the CMB and STP. To safeguard the sewer network from collapsing brick foundation will be used. Sulphate resistant lining and cement lining will prevent corrosion of the sewers. All joints of sewers will be properly sealed and supported with bed concrete.

Material storage surface will be stabilized. Ash pond and dump yard will be adequately lined with clay / other impervious materials to prevent leaching of materials. Spent oil and lubricants (approximately 1 m^3/year) will be collected in drums. The drums will be stored in earmarked area with adequate safety facility like fencing, concrete surface, shed, etc. When sufficient amount of spent oil and lubricants are collected it will be auctioned to authorized re-processors. No oil or lubricant will be discharged into any drains. Therefore the impact of the project operation on the water bodies of study area will be insignificant in nature.

4.3.4 Solid Waste Disposal

Flyash will be utilized for cement making, brick making, low / waste land reclamation, making embankments, filler for making flyovers and roads, etc. Any unutilized portion will be disposed in ash pond. The ash pond will be suitably lined, as per CPCB guidelines, to prevent leaching of cations and anions into groundwater. Particular attention will be paid to the presence of fluoride in coal, boiler emissions and coal ash, and if found its leaching of fluoride into groundwater will be prevented. Any waste cotton / cloth wastes (generated during cleaning of machines and equipment) will be collected in bins and burnt in the

boilers. Electronic wastes and used batteries will be collected and given to authorized recyclers. Garbage will be collected in containers; biodegradable, inerts and non-biodegradable materials in segregated manner. The biodegradable material will be composed and used as manure inside the premises. Recyclable materials like packaging materials, empty drums, bottles, glass, metals, paper, plastic, etc will be given to recyclers. Non-recyclable materials will be disposed in sanitary landfill sites as per the local laws and regulations. The impact of solid wastes during project operation will be significant, long term and irreversible in nature.

4.3.5 Soil and Agriculture

During the operation stage the project will generate fugitive dust and gas emissions. The soils will undergo perceptible qualitative changes due to the deposition of dust particles. The dust particles depending upon the size and weight settles down at varying distances on vegetation in the prevailing wind direction. Foliar deposition of dust interrupts gaseous exchange through stomatal clogging, thereby affecting plant growth. The growth reduction and unfavourable alterations in different plant parameters under the stress of dust pollution can be described in the following manner.

- Quantitative and qualitative changes in solar radiation impinging on the leaf surface and alterations in the energy exchange process of leaf due to dust deposition.
- Decrease in chlorophyll level and injury of chloroplast.
- Interruption in gaseous exchange due to shading of cuticle and clogging of stomata by dust.
- Dust induced alterations in pH and other physico-chemical properties of soil supporting plant growth.

SO_2 and NOx is not considered to be of major concern as phyto-toxicicants, because several studies indicates that concentration that injure vegetation is far above known or monitored ambient levels. Therefore the impact of the project operation on the soil and agriculture of study area will be significant, long term and irreversible in nature.

4.3.6 Ecology (Flora and Fauna)

The impact on the surrounding ecology during the operation of the project will mainly occur from the deposition of air pollutants. Air pollution affects the biotic and abiotic components of the ecosystem individually and synergistically with other pollutants. Chronic and acute effects on plants and animals may be induced when the concentration of air pollutants exceeds threshold limits.

The incremental emission of air pollutants is not likely to induce any significant changes in the ecology because the national ambient air quality standards will remain within the limits. However deposition of small amount of pollutants may also affect the surrounding ecosystem. The project is therefore planned with most efficient air pollution control systems for achieving 50 mg/Nm^3 dust emission level from all the stacks, compared to EP Act norm of 150 mg/Nm^3 so that the impact on nearby ecosystem are minimized. Most of the fugitive dust emission generation points are also fitted with efficient air pollution control systems (Plant dedusting systems). Water sprinkling / dry fog type system will be used at material handling points to suppress the generation of fugitive dust. These measures are adequate to minimize the adverse impact on nearby forest.

USEPA air quality criteria for SO_2 stipulates 0.2 ppm (524 $\mu g/m^3$) level when visible injury to sensitive vegetation in humid regions after 3 hours exposure is observed. In another case, level 0.5 ppm SO_2 level (1310 $\mu g/m^3$) for 1 hour exposure results in visible injury to sensitive vegetation in humid regions. At higher SO_2 concentration of 10 ppm (26214 $\mu g/m^3$), visible injury to vegetation in arid regions is observed. Such high ambient air concentration of sulphur dioxide, is not likely to occur in the area.

USEPA air quality criteria for NO_2 stipulates 2 ppm (3760 $\mu g/m^3$) level when foliar injury to vegetation at 4 hours exposure is observed. At a lower NO_2 concentration of 0.25 ppm (470 $\mu g/m^3$) during the growing period, decrease of growth and yield of tomatoes and oranges are observed. Such high ambient air concentration of nitrogen dioxide is unlikely in the study area.

4.3.7 Impact on Occupational Health

Exposure problems to noise, dust, heat are the major occupational hazards. Noise induced hearing loss is the notified occupational hazard. The employees will be subjected to regular health check-up. The workers will be diagnosed for respiratory functions at periodic intervals and during specific complaints for lung function test, sputum test, X-ray test, etc. Fully equipped Hospital with doctors, occupational health specialist, paramedical staff, medicines, ambulance and other medical equipment is available.

Workers involved in raw material handling activity, ash handling and those working close to the boilers and RMH yard are exposed to high dust levels. Over a long period of time such exposure is likely to result in respiratory problems. Measures will be implemented to reduce the dust generation at the originating point by installing appropriate control devices. Plant personnel working in dust prone areas will wear personnel protective equipment like air filters over their nose. Job rotation schemes will be practiced for over-exposed persons (Those exposed to heat stress and high dust levels)

It will be ensured that workers are not exposed above the threshold noise limits prescribed by OSHA and Factories Act through suitable administrative controls. Personal Protective Equipment like earplugs and muffs will be provided and administrative pressure applied for using them. Auditory examination by qualified doctors upon the first employment and thereafter periodic examination will be conducted which include determination of auditory threshold for pure tones.

4.3.8 Impact on Public Health and Safety

The impact of air emissions during the project operation will occur within 5 km radius of the site. People living in these villages will be exposed to air pollution generated from the plant, sometimes or the other, as per the prevailing wind direction. People living in villages located on the southeast side of the plant site within 3 km distance will be affected more.

The national ambient air quality standards prescribe level of air pollutants that will protect public health and other adverse affect on environment. Exposure to PM, SO_2 and NO_2 is likely to affect public health if the ambient concentrations are above the stipulated criteria. Air quality dispersion modeling predicted that the ambient air quality would remain within

the national standards. The factual position is validated by referring to the prescribed ambient air quality criteria (AAQC) developed by USEPA. AAQC are cause-effect relationships, observed experimentally, epidemiological, or in the field, of exposure to various ambient levels of specific pollutants as shown below.

Level in ppm	Level in $\mu g/m^3$	Exposure Time	Observed human symptoms
For Particulate Matter (Dust)			
-	2000	2 hour	Discomfort
-	1000	10 min	Direct respiratory mechanical changes
-	110	24 hour	Increased respiratory disease risk
For SO_2			
15	4000	1 hour	Decreased mucociliary activity
10	26200	10 min	Bronchospasm
5	13100	10 min	Increased airway resistance in healthy adults at rest
1	2620	10 min	Increased airway resistance in asthmatics at rest and in healthy adults at exercise
0.5	1310	1 hour	Visible injury to sensitive vegetation in humid regions
0.19	500	24 hours	Aggravation of chronic respiratory disease in adults
0.07	180	365 days	Aggravation of chronic respiratory disease in children
For NO_2			
5	9420	15 min	Impairment of normal transport of gases between blood and lungs in healthy adults
2.5	4710	2 hour	Increased airway resistance in healthy adults
2	3770	4 hour	Foliar injury to vegetation
1.0	1890	15 min	Increased airway resistance in bronchitis

The wastewater from the project will not be discharged outside into any streams. The noise will be confined within the plant boundary. No toxic chemicals will be stored inside the plant premises. Solid waste are not hazardous, they will be utilized and managed effectively. Liquid fuel will be stored inside the plant and layout and design of the storage tanks will conform to OISD specifications and necessary fire risk mitigation measures will be provided. Approval to locate this storage tanks will be obtained from the Chief Controller of Explosives. On-site and Off-site disaster management plan will be prepared in consultation with the district administration and implemented during the operation stage of the project. Therefore the impact of the project operation on the health and safety of surrounding public will be insignificant in nature.

4.3.9 Impact on Traffic Movement

The expansion project will increase the vehicular population by almost 1100 dumper trucks (35 tons capacity) per day to carry the coal. About 100 LMV and 500 two and 3wheelers are expected to join the traffic. The extent of impacts due to increase in traffic, at any given time, will depend upon the rate of vehicular emission within a given stretch of road and the prevailing wind speed, wind direction and stability class. The impacts will have strong temporal dependence as both these factors vary with time.

The modeling has been done for traffic of 1200 dumper trucks, 600 passenger vehicles and 1200 scooters. CALINE4 model developed by California Department of Transportation has been used. The model is based on Gaussian dispersion equation and uses a mixing zone concept to characterize pollutant dispersion over the roadway. Given the source strength, meteorology, site geometry, the model predicts pollutant concentration for receptors located within 150 m of the roadway. This is important region for estimating the impacts due to low level emissions. The averaging time of the model is 60 minutes to account for hourly variation. 60 minutes averaging time is selected because the wind speed and direction do not remain steady for more than an hour and the receptor targets are maximum 300 m.

Due to averaging time of 60 minutes, the impacts on the ambient air quality will be mostly for CO where hourly standard is available (NAAQS-1994). The plying of 1200 trucks has been distributed over 12 hours of the day, that is 100 trucks per hour. The plying of 600 passenger cars and scooters has been distributed over 12 hours of the day that is 50 cars per hour and 100 scooters per hour. This is also the peak traffic considered. The carriageway of 6 m, including shoulders of 1.5 m on either side, has been considered for modeling.

Emission standard: The emission standard for Indian vehicles has been used to provide the emission factors. The emission factor for CO is 11.2 g/km/vehicle for dumpers/trucks, 8.68 g/km/vehicle for passenger cars and 6.75 g/km/vehicle for scooters/ three wheelers [EPA Notification GSR 609 E, 15-9-1993].

Meteorology: Air quality predictions were developed for all stability class using the representative wind speed. For Stability Class A, B, C, D, E and F the wind speed considered are 1.0 m/s, 2.0 m/s, 3.0 m/s, 4.0 m/s, 2.0 m/s and 2.0 m/s respectively.

Conclusion: The hourly peak simulation results for CO in $\mu g/m^3$ are shown below. Results of Traffic CO Modeling (all 1-hr-avg values in $\mu g/m^3$)

Distance from road center	Stability Class A	Stability Class B	Stability Class C	Stability Class D	Stability Class E	Stability Class F
50m	35.2	22.3	18.2	12.4	29.5	30.2
100m	15.5	13.1	10.8	0.8	20.4	24.1
150m	11.2	0.90	0.80	0.6	15.2	18.2
300 m	0.70	0.50	0.40	0.3	10.6	13.5

The ambient air quality 50 m away from the road will have insignificant impact due to vehicular exhaust. The national standard of hourly CO level in ambient air is 4000 $\mu g/m^3$ compared to the incremental value of 35.2 $\mu g/m^3$ maximum. The existing baseline level is less than 1 ppm (less than 1100 $\mu g/m^3$). Positive impact will be there on account of increasing traffic because of extra job opportunity as drivers, attendants, technicians, workshop, etc of the vehicles (dumpers and trucks). This will negate the adverse impact on account of vehicular pollution. Implementing the pollution emission rules prescribed under Motor Vehicles Act by the transport authorities will minimize the negative impact.

4.3.10 Social Impact

Keeping its tradition of social consciousness and responsibility, JPL proposes to undertake several activities under corporate social responsibility in the project-affected areas. Keeping in view the commitment of the organization towards social responsibility as well as to honour the sentiments and developmental needs of the affected population, JPL had carried out situation analysis of the 25 nearby villages to make a need assessment of the affected families.

Types of Houses: In all the villages, majority of the families live in kutcha houses. These kutcha houses were made of mud and tiles.

Sources of Drinking Water: The main source of drinking water is handpump. Many handpumps are not functioning properly. Some handpumps required repair while others needed to be shifted to other places with fresh and deep boring. There are large numbers of wells and ponds in the villages. However, due to no repair, maintenance and cleaning of these wells and ponds, water is not used for potable purposes. People also use pond water for bathing purpose. Fluoride level in groundwater samples of some villages has been found to exceed the prescribed limit, causing concern of fluoride related disorders

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Toilet Facility: Many houses in the villages do not have toilet facility and people go out in the open to defecate. There was no provision of public toilets in the villages, results in lot of inconvenience to the female members. This results in health related diseases.

Sports & Games Facility: No facility exists for organizing sports and games in the villages. Children play various games like football, cricket, volleyball, etc in the open land. No teacher / guide are available to help them to improve their sporting skills. Discussions with the young people of the village brought to the fore their desire for facilities and equipments for sports in the villages.

Major Crops Produced: Paddy is the single crop grown in the area, mostly during monsoon. Vegetables were also grown in small quantities in these villages.

Sources of Irrigation: The farmers in the villages mostly depend on monsoon and canal water for agriculture.

Availability of Livestock: Livestock in the villages included cows, bulls, goats, and poultry. However, milk production from the cow is bery less. Poultry in the village were also not used for commercial purposes. People of the area showed keen interest in dairy farming. They expressed their desire to be trained and supported in running dairy farms with high milk yielding breeds of cow. Similarly, many people expressed interest in running poultry farms on commercial lines but were skeptical due to lack of expertise and experience.

Occupation: Despite all limitations like small landholdings, traditional methods of agricultural practices, average quality of seeds, single season farming, the primary occupation of the villagers continues to be agriculture.

In order to meet the needs of the family, the adults in the family go out of the village in search of work as daily labourers for non-agricultural works like brick kilns, stone crushers, helpers, masons, casual labourers in rice mills, and industries and coal mines in Korba district.. Some people in the village have also developed skills, which help them earn regularly in areas like, masonry, vehicle driver, etc.

Major Sources of Income: Major source of income continues to be agriculture. Although most of the income is in the form of agricultural produce which is consumed in the family.

Availability of Potential Earning Opportunities in the Vicinity: There were several earning opportunities available for the people of the villages which could substantially enhance their earnings and consequently their economic condition. These opportunities need to be explored, developed and utilized.

There was lot of scope for improvement in the agricultural practices being followed in these villages. Supply of improved quality seeds, training on modern agricultural practices is some of the areas which required attention.

Schools : All villages have primary schools. Some villages also have secondary school while few even have a high school. However, the schools needed all the support to become good learning centers for the children. Some of the school buildings have inadequate space for seating, desks and benches for the students, high teacher pupil ratio, irregular and poor remuneration to teachers, etc. There is lack of basic teaching learning materials in the schools, which is essential for creating interests among the students and to create conducive environment for joyful learning for the students.

Availability of Health Facilities: Raigarh town has several medical facilities, including Government Hospital. The staff from the department of health visits the villages for routine

immunization of children and for other basic health services to the pregnant and lactating women.

Availability of Electricity**:** In almost all the villages, electricity connection was available.

Availability of Pucca Road**:** Almost all the villages is connected by pucca road

Availability of Grazing Land (Common Property Resource): There is sufficient land in and around the villages where the villagers take their animals for grazing. Due to poverty and search for daily earning they did not tether their animals and left them to graze in the open.

The social impact during the operation stage of the project will be of beneficial nature. About 1000 people will get direct employment during the operation stage. The plant is expected continue to operate for more than 100 years. Generation after generation people will get employment in this project. Local people will be preferred for employment and depending upon their skill and experience they will be allotted suitable jobs. Engineering College and Vocational Training Institute has been opened by Jindal Group where the local people could be trained and then absorbed in the company.

Demographic profile of the area will undergo significant changes after this project. More and more people will come from other places in search for business and employment. There will be significant positive impact on the overall socio-economic pattern of the area. More and more amenities like educational facility, health centres, recreation centres, etc. will come up in the area along with several other infrastructure facilities. Large beneficial impacts in terms of gross economic yield will accrue on account of the project. The gross economic yield will increase through increase in high economic group and subsequent market multiplier effect. The benefits accrued will be obviously tremendous in local as well as in regional context. The project operation will have significant social impact, which will be long term and irreversible in nature.

4.4 Evaluation of Impact

There will be some negative impact on account of air pollution and ash generation. The socio-economic environment will have positive impact because of direct and indirect employment opportunity. The impact details are presented below:

Description	***PIU***	***Baseline (A)***	***Without EMP (B)***	***With EMP (C)***	***Change (C-B)***	***Change (C-A)***
Environmental Pollution	550	390	275	377	102	-13
Biological Environment	150	75	50	70	20	-5
Aesthetic Environment	100	75	50	82	32	7
Human Interest	200	150	150	163	13	13
Total	**1000**	**690**	**525**	**692**	**167**	**+2**

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CHAPTER 5 : ENVIRONMENTAL MANAGEMENT PLAN

5.1 Environment Management During Construction Phase

Environment management plan for this phase will address the measures that need to be taken during construction period in order to mitigate adverse impacts on the surrounding environment, by effective use of available resources and technologies. The major construction activities that have potential environmental impacts involve pre-construction site preparation and installation of temporary and permanent facilities to meet the future requirements for success of the project. The necessary measures that would be followed in respect of construction activities are outlined in the following sub sections.

5.1.1 Site Preparation

Topography of the proposed site is almost flat and no major filling / cutting works are anticipated except for the purpose of foundation. Dust generated due to earthwork including excavation and transportation activities, especially during dry weather conditions, will be controlled by water sprinkling. The earth generated during excavation will be used in refilling, leveling and landscaping the area. There are very few trees on the site, which will be retained or replanted. The above measures outlined will prevent wastages through suspension or runoff in the dry/ wet condition.

5.1.2 Infrastructure Services

The infrastructure created for the 1000 MW power project will be effectively utilized, wherever possible. A temporary base camp will be set up for the out station personnel. Apart from this, necessary arrangements will be made to meet the basic requirements, such as water supply, sanitation facilities, fuel, electrification, etc., of the personnel involved in construction work as per the existing regulations. Any domestic waste

generated due to human activities will be properly disposed off by making use of the existing and/ newly constructed sewage, drainage and solid waste disposal facilities. Canteen facility will be extended to the construction workers, so that they do not cut any fuel wood. The existing rest rooms for drivers will be extended and used for the purpose of expansion project. Construction activity will be done mostly during day time and movement on village roads and interiors will be totally prohibited by JPL.

5.1.3 Construction Equipment

Construction equipments and transport vehicles will be properly maintained so that noise generation, smoke emissions and spillage are minimized. Regular maintenance schedule will be adopted. Workshop for servicing of equipments and exhaust emission testing facility will be provided. Waste oil will be collected and given to authorized recyclers.

5.1.4 Safety Measures

Constructional personnel will be made aware of possible hazardous and safety measures that need to be taken during construction activities through proper training. Adequate personal protective equipments such as dust masks, goggles, earplugs/ earmuffs, safety gloves, safety belts, shoe with toe protection, gumboots will be made available at construction site and the construction company will observe applicable safety norms.

5.2 Environment Management during Operation Phase

This section delineates the measures that would be taken for proper management of resources and wastes generated during the operation of the thermal power plant as well as the proposed mitigation measures for pollution control during this phase.

5.2.1 Air Pollution Management

In thermal power plants, the sources of air pollution would be stack and fugitive emissions. The mitigation measures and equipments proposed for control of these emissions are given in Chapter 2. The following management measures are envisaged during operation phase.

- 275 m tall twin flue stacks (2 Nos.) shall be constructed in order to reduce the ground level concentration of gaseous pollutants, as per the regulatory requirements.

- Particulate emission level of 50 mg/ Nm^3, which is much below the prescribed EPA limit of 150 mg/Nm^3, will be achieved by the use of electrostatic precipitators having efficiency not less than 99.95%.

- Use of low sulphur containing coal (<0.5%) will be maintained to reduce SO_2 emission. Besides, adequate space will be provided for installation of Flue Gas Desulphurisation plant (FGD), if required in future.

- As Dry Low NOx burners (DLNB) will be installed to control NOx emission from the combustion process, routine checking of the DLNB performance will be done during the boiler maintenance period.

- Continuous online monitoring system for SPM, CO, SO2 and NOx with computer display and recording facility will be installed to facilitate regular check up of air emissions and ensure compliance with the prescribed standards. Any faults in the system will be reflected in the computer of control room. Display will be also provided at plant gate and EMD.

- ID fan will be interlocked with the ESP tripping so that the operating boiler can be stopped / adjusted till the defect is rectified.

- Coal dust will be suppressed by water spraying arrangements at suitable locations such as unloading yard, transfer points, etc. Transfer towers and crusher houses will be provided with dust extraction systems. In addition, water sprinklers will be provided in the coal storage area to suppress the coal dust generated during stacking and re-claiming of coal.

- All major roads with in the plant boundary will be paved and periodically cleaned by mechanical sweeping machines to avoid any re-suspension of air borne dust particles.

- Ash handling including conveying system will be monitored for timely intervention and control in case of leakages detected in the line.

- Ash pond will have a freeboard of 1 m. Ash disposal method (location and duration) in the pond will be controlled so that there is no unwarranted build-up of ash at one location. A minimum water depth of 1 feet will be maintained in the ash pond to prevent ash from blowing with surface wind.

5.2.2 Waste Water Management

The proposed water balance of the project is shown in Figure 5.1. It can be seen from the diagram that the entire wastewater will be treated and reused within the plant premises.

- Effluents from the DM plant resin regeneration circuits, generally acidic from the cation units and alkaline from the anion units, will be neutralized in a neutralizing pit. The neutralized effluent shall have less than 5 ppm suspended solids and a pH value of about 7.5 to 8.0 in line with CPCB standards. The neutralized effluents will be led into the central monitoring basin and ultimately to the ash water pond for ash sluicing purpose.

- The run-off from the coal handling area will be collected in the drains suitably provided at various places in the coal yard. The run-off collected in this manner will be led to a common sump from where it will be reused for coal dust suppression.

- Boiler blow down and cooling tower blow down water will be collected in ash water pond and shall be used for ash handling purpose. Clarifier sludge and filter back wash shall be pumped to ash slurry sump and from there it will be disposed to ash dyke along-with ash slurry.

- Sewage from the various buildings in the power plant and staff colony will be conveyed to a sewage treatment plant. The treated water from sewage treatment plant will be reused for green belt development and other horticulture purpose.

5.2.3 Noise Management

Proper encasement of noise generating sources will be done to control noise level below 70 dB(A) at the plant boundary all the time. Suitable vibration control measures will also be provided for major equipment. Turbines will be provided with acoustic enclosure to the maker's standards. Noise damping accessories such as silencers and mufflers will be used wherever necessary. Besides, ear muffs / plugs will be provided to the personnel in the close vicinity of noise sources. Noise proof cabin will be given to operators working in noisy conditions. Due care will be taken to reduce noise by all means from anticipated sources.

5.2.4 Solid Waste Management

Disposal of fly ash and bottom ash generated from coal-fired power plants is one of the major environmental concerns, as it creates nuisance in the vicinity of the disposal area. Ash handling management plan and ash utilization plan has been prepared in line with MOEF Notification.

5.2.4.1 Ash Utilization

As a partial solution to the ash disposal problem, fly ash and bottom ash can be utilized as a raw material / blending material along with other primary raw materials in the manufacture of various construction products. Apart from this fly ash also finds its use as aggregate in many construction activities. Following are some of the possible areas of utilization of fly ash.

- As a pozzolanic material in the manufacture of Portland Pozzolana Cement
- For manufacturing fly ash based bricks and blocks
- As partial replacement of cement in concrete & mortar
- For manufacturing of cellular light weight concrete building blocks and slabs
- For preparation of base and sub-base course for roads, highways and runways for airports etc.
- As a fill material in mine stowing
- For manufacture of lightweight aggregates, ceramic products, etc.
- As a filler for refractory bricks
- For recovery of cenospheres and rare metals
- As soil improvement and conditioning agent for agricultural purposes
- As replacement of cement in roller compacted concrete in large & small dams

5.2.4.2 Ash Utilization

The ash utilization plan will be implemented as per statutory guidelines of Ministry of Environment & Forests. The Ministry of Environment & Forests has issued a Gazette Notification on 14th September 1999 for effective and time-frame utilization of flyash and bottom ash generated from coal based thermal power plants with the following objectives:

- To protect the environment, conserve top soil and prevent ash dumping

- To restrict the excavation of top soil for manufacturing of bricks, promote the utilisation of flyash in the manufacture of building materials and construction activity within 100 km radius of the power plant.

The Notification stipulates that no person shall within a radius of 100 km from coal based power plant shall manufacture clay bricks or tiles or blocks for use in construction activities, without mixing at least 25% of ash (pond ash, fly ash or bottom ash) with soil on w/w basis. State Pollution Control Board is authorized to issue consent and monitor the compliance status and in case on non-compliance, is authorized to move the district administration for cancellation of mining lease of the brick unit.

Ash is made available without any payment or other consideration, for the purpose of manufacturing ash-based products such as cement, bricks, concrete blocks, panels or any other material or for construction of roads, embankments, dams, dykes or for any other construction activity.

Keeping in view the above emerging scenario the following plan has been proposed for utilization of fly ash and bottom ash. Concrete Plan for ash utilization will be prepared at the time of plant commissioning based on the prevailing market demand scenario at that time.

- Fly ash will be made available for the purpose of manufacturing of ash based products viz. cement (PPC), concrete blocks, bricks, pavement tiles, panels or any other construction material or for construction of roads, embankments, dams, dykes or for any other construction activity. This will ensure 10% utilization from day 1 and 20% by the end of the year.

- Supply of ash (fly, bottom or pond ash) for the manufacture of clay bricks / tiles / blocks. Utilization of fly ash in agriculture applications. Such plan will ensure 10% progressive utilization till the end of 9th year.

- Utilization of ash in back filling abandoned mines. This action depends upon the permission accorded by Ministry of Mines and the outcome of CPCB's Task Force and its proposed guidelines under CREP. In case it is allowed / permitted then JPL will achieve 100% ash utilization from 3rd year onwards.

- Utilization of ash in making embankments on river banks and reclaiming the banks for beneficial purposes. Kelo river has huge banks that are broken and rugged on both sides. The banks could provide more than 5000 hectares of developed land area along the Raigarh town stretch that could be used for several commercial purposes. The banks are under the control of Irrigation Authorities. In case the Authority gives permission to JPL to develop some portion of the river bank, on mutually agreed terms and conditions, 100% ash could be utilized from 3rd year onwards till the end of 20th year. (Developing the river banks of Sabarmati at Ahmedabad is a classic case that could be replicated / emulated in Raigarh)

Provision for Ash Disposal: Notwithstanding the above, an ash dyke will be constructed for disposal of entire bottom and fly ash for a period of about nine years. The ash dyke area requirement is estimated as below.

Coal consumption	=	11.7 MTPA (1500 TPH)
Ash content	=	40%
Total ash generation	=	4.563 MTPA
Fly ash (75% of total ash)	=	3.65 MTPA
Bottom ash (25% of total ash)	=	0.913 MTPA

Considering 6 m dyke height and 4.6 MTPA of total ash (relative density: 1.2) generated, the dyke area requirement would be hectares for 9 years as per the following calculation.

$$\frac{4.6 \times 10^6 \times 9}{1.2 \times 6 \times 10^4} = 575 \text{ ha}$$

Ash pond dyke safety : The accidental breach of ash dyke can result into release of huge quantity of ash, contaminate the water bodies & land, fill-up drains and nallahs. In order to prevent such incident, following safety precautions and routine inspection will be adopted for design and construction of ash dykes.

- Internal drainage arrangement like vertical sand chimney, horizontal sand blanket, rock toe, etc. is made for guiding the seepage water flow to the downstream side without any material erosion.

- A minimum free board of 1.5 m is kept to prevent any chances of over-toppling of the dyke, even during rainy season.

- The internal and external slopes of the dykes with stone rip rap, turfing, etc. is adequately protected to take care of erosion due to wave action, rain cuts.

- Provision of cut-off trench filled with impervious soils below the dyke section is made. This increases the length of seepage water flow in the foundation, thereby controlling the exit gradient, which safeguards erosion problem.

- The foundation is prepared by removal of weak and organic materials, compaction by rolling, filling the voids and controlling the moisture on land surface. The dykes are constructed in layers compacted with rollers appropriate to the type of soil used to achieve a dry density of above 95%.

- Regular inspection of the dykes will be carried out with reference to the following aspects:

    - Water level in ponds
    - Presence of cracks, rat holes, etc.
    - Any sign of foundation heaving, sink holes, etc.
    - Developments of any wet area or seepage flow on the embankment slope or on the foundation surface near the toe of the dyke.

5.2.5 House Keeping

- Regular cleaning of plant roads to avoid accumulation of dust.
- Developing a positive outlook among employees for keeping their workplace clean.
- Placing containers for collection of solid wastes and garbage at each office, plant units and residence.
- Maintaining proper storage of wastes materials.
- Maintaining hygienic conditions in canteens, drinking water source and toilets.

5.2.6 Safety and Occupational Health

Plant safety and industrial hygiene measures will be given utmost attention as per provisions stipulated in the Factories Act. No hazardous chemicals as per thresholds prescribed in the Manufacture, Storage and Import of Hazardous Chemicals Rules, 2000 will be stored in the plant. Fire protection with ring system and fire hydrant points at every 30 m intervals will be provided around the coal storage yard. Adequate number of hand held fire extinguishers and wall-mounted CO_2 fire extinguishers would be kept at other locations to be used in the case of fire.

Workers exposed to mechanical accident-prone areas will be provided with personal protective equipment (PPE). The non-respiratory PPE includes tight rubber goggles, safety helmets, welders hand shields and welding helmets, plastic face shields, ear plugs, ear muffs, rubber aprons, rubber gloves, shoes with non-skid soles, gum boots, safety shoe with toe protection which will be provided to workers. All safety and health codes prescribed by the BIS will be strictly implemented in the plant.

The work environment will be monitored for occupational accidents, diseases and dangerous occurrences. A proper record of the same will be maintained. The following will be adopted to ensure good health condition of employees.

- Pre- employment checkup
- Awareness programme
- Routine checkup
- Periodic vaccination programme etc.

A well-equipped hospital with adequate number of qualified medical staff is available for the existing plant. First aid facilities, medicines and ambulance are available to meet any emergency situation.

5.3 Greenbelt Development Plan

About 20% of total land area will be developed as green belt, lawns and other forms of greenery (three tier concept on 210 ha land). Trees will be planted on 20% land area, lawns and gardens on 20% land and shrubs and herbs on 20% land. 1500 trees will be planted per hectare land area. The plantation width will vary from 25 - 100 m, depending upon the space available. After the site is prepared for starting the construction activity and boundary wall is completed, the land portion earmarked for green will be fenced. Plantation will start soon after. Landscaping and development of lawns, horticulture and gardens will start when the construction activity is complete.

The main objective of greenbelt is to provide a barrier between the sources of pollution and the surrounding habitation. The greenbelt will help to capture the fugitive dust and attenuate the noise apart from improving the aesthetics. Greenbelt and greenery development also prevent soil erosion and washing away of top soil besides helping in stabilizing the functional ecosystem, make the climate more conducive and restore water balance.

Plant species for greenbelt has been selected based on following criteria:

1. Availability of saplings (from Forest Department)
2. Tolerance to local climatic conditions
3. Fast growth
4. Capacity to endure water stress and extreme climates
5. Large biomass

The following trees are specifically recommended in wood land and road side plantations:

1. Alstonia scholaris
2. Azadiructus indica
3. Butea frondosa
4. Casia fistula
5. Dalbergia sisoo
6. Diospyros Montana
7. Ficus glumerota
8. Pongamia glabra
9. Ptrospurmum acerifolium
10. Terminalia arjuna

The following trees are recommended in Parks and Gardens:

1. Acacia auriculiformus
2. Bahunia v
3. Casia fistula
4. Cretavea religiosa
5. Delonix regia
6. Erythina indica
7. Jacaranda mimosifolia
8. Largerstroemia flosregini
9. Mimusops elengil
10. Peltaphorum ferreugenum
11. Plumeria albavar
12. Petrospirnum acerifolium
13. Saraca indica
14. Tecoma argentia
15. Schelichera figuga

Plantation will start from the beginning of construction activity (after the site is made clear and demarcating the green portion). The plant species will be planted using pitting technique. The pit size should be 45 cm x 45 cm x 45 cm size. Soil proposed to be filled in the pit after plantation will be mixed with compost (1:1). Plantation will be done after first rainfall. Adequate protection will be ensured for achieving high survival rate of the planted saplings. Water and nutrients / manure will be given at appropriate intervals.

Stabilization of ash dump with plants: Attempts will also be made to stabilize the ash dump for development of agro-forestry cum recreational parks. Case studies on ash dump stabilization in the country have revealed that within 2-3 years, the plants get chlorotic, bronzed or copper colored and eventually did not survive beyond 3 years. In one reasonably successful operation, where a variety of trees grew normally for 5-6 years, two drawbacks were observed; the tall trees (4-5m) started lodging and ash between the tree bases blew away. Hence the emphasis will be made on planned landscaping of ash dump, plantation of grasses, herbs, shrubs and trees, taking adequate care for survival and prioritizing stabilization effort to convert the area into recreational park.

Flyash is deficient in plant nutrients like nitrogen and phosphorus and also contains some heavy metals. Amendments of ash with nutrients will, therefore, be essential for covering it with plants. Some inexpensive soil additives and commonly used nutrients based organic manure will be tried. Mixing of farmyard manure in 1:4 proportion with flyash (top portion upto 15 cm) will be suitable for growing variety of grasses. Growing grasses with spreading habit will stabilize the ash surface effectively. Cultivation of herbaceous legumes in the ash dump will enrich the sub-stratum with nitrogen. The stabilized ash will then form suitable ground for other planned utilities. Table below gives the list of plants that will be considered for growing on ash dumps. The plants listed are grasses, legumes and multi-purpose trees forming a comprehensive agroforestry system.

The list of plants species has been considered from the angle of species combination, in conformity with local horticultural/ forestry conditions. While for tree saplings, pits of suitable dimensions (60 x 60-x 60 cm or 90 x 90 x 90 cm) will be made and filled with mixture containing flyash, soil additives and organic manure. Watering regimes will depend upon the climatic conditions, though in initial stages regular watering – daily for grass and 2-3 times a week for trees will be considered. Possibilities for development of further amenities in the stabilized ash dump are numerous, including parks. Continuous monitoring of plant growth, immediate replacement of casualties, supplementation of nutrients, rescheduling of watering regimes will be given top priority.

Soil Additives and their Properties

Material	pH	Durability	C:N	Applicability to Soil per ha		
				While seeding	For erosion control	Established sites
Hay	5.5	1 season	25:1	2	3	4
Manure	6.6	12 months	25:1	15	30	40
Sawdust	5.0 to 7.0	5 years	200:1	1	5	10
Leaves (composted)	6.5	1 season	40:1	3	4	5
Municipal Refuse	7.5	1 season	45:1	20	--	--

Nutrient Contents of Some Organic Manure

Manure Type	Nutrient contents %			Organic matter %
	N	P	K	
Farm yard manure	0.02	0.13	0.49	24
Pig slurry	0.21	0.10	0.18	5
Poultry manure	2.30	0.90	0.65	65
Sewage sludge	1.62	0.43	0.46	39
Mushroom compost	2.80	0.20	0.80	65
Domestic refuse	0.50	0.20	0.30	65
Straw	0.48	1.62	0.85	95

List of Grasses, Legumes and Trees for Plantation on Ash Dump

Grasses	**Herbaceous Legumes**	**Trees**	***Trees (for Degraded habitat)***
Bothriochloa intermedia Bothriochloa pertus Brachiaria mutica Cenchrus setigerus Chloris gayana Chryosopogon fulvus Cynodon dactylon Echinochloa colona Eragrastis cynosuroides Heteropogon contortus Paspalidium germinatum Sacharum bengalense Sehima nervosum Sporobolus airodes	Cajanus cajan Crotalaria juncea Crotalaria burhia Desmodium triflorum Medicago sativa Phaseolus mungo Stylosanthes hamata	Acacia albida Acacia auriculiformis Acacia catechu Acacia holosericea Acacia nilotica Acacia senegal Albizia amara Albizia lebbeck Erythrina variegata Gliricidia sepium Grewia tenax Hardwickia binata Leucaena latisiliqua Pithecellobium \	*Acacia catechu* Acacia nilotica *Acacia tortillis* *Acacia laebbeck* *Albizia procera* *Casurina equisetifolia* *Dichrostachys cineria* *Gmelina arborea* *Holoptelia integrifolia* *Melia azaderach* *Phyllanhus emblica* *Pongamia pinnata* *Prosopis cineraria* *Sesbania aegyptiaca* *Shorea robusta* *Syzygium cumini* *Terminalia arjuna* *Zizyphus mauritiana*

5.4 Rain Water Harvesting Plan

The groundwater depth at the site is about 5 m during monsoon. Due to presence of abundant forest cover the natural recharge rate is very high. The project site has sandy lateritic type soil. As per CGWB guidelines shaft recharge type rainwater harvesting structures is suitable. The recharge shaft will be perforated and the depth of the shaft will be about 4 m. The annual average rainfall of the region is about 1400 mm. Under such condition it is desirable to collect the rooftop rainwater (from Administrative Building, TG Building, Township, etc) and direct them to the recharge pits. The dimensions of the pits will be made as per CGWB guidelines (the rainfall collection volume from a defined area multiplied by runoff coefficient of the particular area type). The pits will be partially filled by sand and boulders. Depending upon the available area several numbers of such pits will be constructed for rainwater harvesting. Detailed design and location of recharge pits will be finalized during the final engineering design. Runoff water from the surrounding catchment areas will be drained to the proposed water reservoir and reused in plant.

5.5 Rehabilitation and Resettlement Plan

The land that JPL proposes to acquire for the expansion units does not have any human habitation; hence no population will be displaced. As such no resettlement plan is required. However JPL will acquire agriculture land, for which financial compensation will be paid as per the CG policy. Rehabilitation plan is necessary for these land losers so as to sustain their livelihood. The rehabilitation plan is given below.

1. JPL will provide employment to one member of each family who gave their land to this project. The type of employment will depend upon the qualification and skill of the person. The number of landowners is 448 in the plant area, 262 in ash dyke area and 59 in township area. Therefore 769 persons will be employed at different positions according to their qualification and skill. JPL will also provide them adequate training before the employment.

2. In case of agriculture land losers, they will be provided compensation as per Policy of State and Central Government.

3. Jindal Power Limited has taken up several initiatives to improve living conditions of the underprivileged and make positive difference in their lives. JPL has started its community development and social welfare activities in 2005 with only 6 backward villages in Tamnar block, which gradually increased to 32 villages having adopted, covering a population of almost 50000. Till date Rs.22.37 crores have been spent for different CSR activities, which include infrastructure development, education, health care, sanitation, drinking water facility, capability building activity, promotion of social and cultural activity and watershed development activity.

4. JPL will continue to provide scholarships to bright students from nearby villages. JPL also proposes to provide free education in its OP Jindal Institute of Management and Technology (located at Punjipatra, about 10.5 km away) and later absorb them in the power plant as well its power plant near Taraimal and Raigarh.

5. Heath camp will be organized every month to provide free medical consultation and medicines to the villagers. JPL will arrange medical facilities from its own hospital for the affected families.

6. Job oriented skill training courses will be organized through Industrial / Technical Training Institutions for educated youth (both for male and female), like O&M of electrical, home appliances, tailoring, plumbing, automobile repairs, welding and fabrication and any other project related specific trades.

7. Entrepreneurship Development Programme (EDP) will be undertaken for both male and female, irrespective of their educational qualification in the areas like cattle, goat and sheep rearing, poultry farm, dairy farm, weaving, envelop making, soap making etc. based on the local facilities.

8. Through such measures the land losers will be trained and motivated to sustain their livelihood. These measures are apart from financial compensation (more than prevailing market rate) that will be offered to the land losers.

The following schemes are further recommended under the CSR plan of JPL.

1. Continue to coordinate and tie-up with the nearby Industrial Training Institutes (ITI) for training the local youths as electricians, plumbers, carpenters, masons, workshop technicians, fitters, welders, drivers, tailors, etc. The company will provide scholarships.

2. Continue to coordinate with Block Development Office and village Panchayats to identify and provide assistance for conservation and development of grazing land and growing fodder crops (like Jai) in vacant space.

3. Coordinate with Agriculture University and State Agriculture Department to organize Annual Fair in the area. Local farmers will be provided knowledge for better yield of paddy, pulses, oilseeds and other vegetable crops.

4. Continue to coordinate organize training programs and demonstration projects for converting household organic wastes into compost by using vermiculture process, and its use as soil conditioner for better crop yield.

5. Organize training programs and demonstration projects with State Ground Water Board and Engineering College at Patrapali for developing rainwater harvesting structures. .

6. The company will promote traditional handicrafts like embroidery, paintings, batik and block prints, silver work, etc. The company will encourage brotherhood, fraternity and religious feelings among villagers and will continue to contribute for organizing religious functions and construction / repair of religious places.

7. The company will develop a mobile dispensary, which will be taken to surrounding villages in consultation with the BDO and Gram Panchayat. Free consultation and medicines will be provided to needy people. The company will organize cataract operation camps, dental health check-up camps, AIDS awareness campaign at regular intervals.

8. The company will coordinate with the State Transport Department and Local Administration, cooperate for developing plans and provide all assistance for the maintenance and upkeep of existing roads and highways.

The Personal Relations Department of JPL will coordinate with the BDO, Gram Panchayat, ADM and DM of the area for encouraging the local people to form self-help groups to obtain benefits under the CSR program of the company. JPL has already entered an MOU with District Collector and provided Rs.1.87 crores for CSR activities in these 20 villages.

5.6 CDM Intent

The proposed expansion project as such does not quality for CDM benefits because of the use of subcritical boilers and pulverized fuel firing technology. However several green building concept will be used in the project, as described in following paragraph.

Energy efficiency and greenhouse gas emissions are linked together. Consumption of more energy or energy guzzling manufacturing process generates more greenhouse gases that in turn contribute to adverse climate change. Implementing energy efficiency programs in steel and power sector not only makes the steel production cost-effective but also reduces greenhouse gas emissions. The recommendations for reducing green house gas emission are given below:

1. The township should be designed with 'Green Buildings' concept. Guidelines issued by the Bureau of Energy Efficiency and Energy Conservation Bureau Code 2007 should be followed. Compact Fluorescent Lamps (lighting system), energy efficient refrigerators and air-conditioners, water-cooled screw type HVAC system, CFC and

HCFC free refrigerants and chillers, solar water heaters on major buildings are some recommended energy saving devices that should be considered in this project.

2. Energy efficient building materials should be considered for construction of structures. For external walls and boundary wall flyash bricks and blocks should be considered. Flyash, which is a waste of power plant should be mixed with cement to make concrete. Rat trap cavity brickwork using flyash bricks / blocks should be considered. Thermally insulated building roof through traditional methods of brick batcoba technique / other recommended technique should be considered. Natural ventilation system comprising screen walls, low emissive double glazed glass with U value of less than 2.8 W/m^2K, shading coefficient of 0.5 should be considered for the buildings. Fenestration with UPVC framing that reduces solar heat gain should be considered. Landscaping with deciduous tree canopy should be considered for reducing heat gain into the structures (by blocking sun rays in summer and permitting penetration during winter).

3. Energy efficient process and building structures should achieve 20% reductions in energy consumption. It is recommended that the project authorities should undertake yearly energy audit for their entire manufacturing process and ancillary facilities. PIL should also avail the benefits under CDM or carbon credit, as per applicable rules framed by the International Panel on Climate Change.

5.7 Budget for EMP

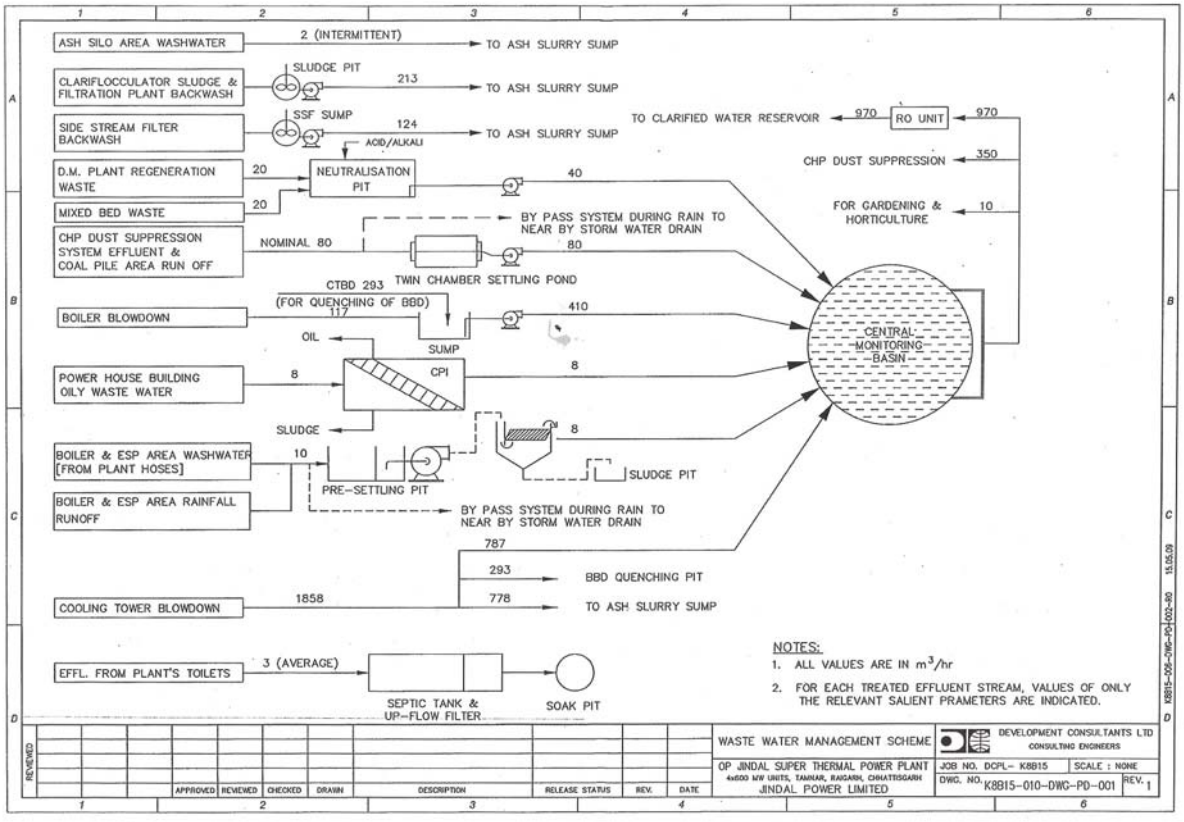
The capital cost for environmental management of the proposed power plant is estimated to be Rs.407 crores. Budget allocation of Rs.34.0 crores will be made every year to meet the recurring expenditure for implementing the environmental control and improvement measures. The details are given below.

Investment on Environmental Protection Measures (Rs. in Crores)

SN	Particulars	Capital Cost	Annual Recurring Cost
1	Air Pollution Control System - ESP, Bag Filters, Ventilation System, Tall Stacks, Water	235.00	14.0

	Sprinklers, Closed Conveyors, etc.		
2	Wastewater Management and Effluent Treatment Plant	25.00	2.0
3	Environmental Management Department	5.00	2.0
4	Environmental Monitoring Instruments and Laboratory	6.00	1.0
5	Noise Reduction Systems	4.00	0.25
6	Occupational Health Management	2.00	0.25
7	Green Belt and Greenery Development	15.00	1.0
8	Solid Waste Management including Flyash Handling and Utilization	25.00	2.5
9	Plant Safety	88.00	9.0
10	Community Development Plan	2.0	2.0
Total		**407**	**34**

Fig 5.1 Wastewater Management Scheme



CHAPTER 6 : RISK ASSESSMENT (ADDITIONAL STUDIES)

6.1 Consequence Analysis

Thorough examination of the preliminary TEFR of facilities and P&I, together with consultation with JSL, all accident or spill scenarios has been identified that could result in environmental consequences. Following scenarios feel under Maximum Credible Accident Scenario

- Fire due to spill of 4000 KL LDO storage tank
- Fire in coal yard and gallery
- Leakage in acid / alkali storage tank near DM Plant
- Injury to body and body parts (mechanical)

a) **Fire in Fuel Tanks:** Light Diesel Oil is viscous mixture of aromatic hydrocarbons with flash point and auto ignition point higher than naphtha, petrol and kerosene. It is flammable and needs source of ignition to catch fire. Its vapour pressure is also higher than its other counterparts. Hence, fire risk due to storage and handling of LDO is less compared to naphtha or petrol. LDO has boiling point above the ambient temperature and therefore stored in tanks under normal atmospheric pressure and temperature. Continuous release of such non-boiling liquids from vessels due to leaks will form a contained pool inside the dyke area of the Tank. Upon ignition the liquid pool will result in pool fire. In case of ignition of the hydrocarbon vapour-air mixture present near rim seals and rim vents of storage tanks, tank fire will result in tank fire. Pool fire and Tank fire falls under MCA scenario. The heat radiation effect distances for the largest tank combination are described below.

1st degree burn - 4.0 KW/m^2
1% fatality - 12.7 KW/m^2 for 20 seconds exposure [EIA manual of MOEF prescribes thermal limit of 12.7 for 20 seconds exposure]
50% fatality - 25.0 KW/m^2
99%fatality - 37.5 KW/m^2

The following assumptions have been considered during modeling:

1. Steady state burning has been assumed.
2. A surface radiation flux of 120 KW/m^2

3. The flame is cylindrical in shape with the diameter based on the hydraulic diameter of the spillage area.
4. The flames maintain a constant and uniform surface heat flux. No account is made for the pulsation effects.
5. The effect of wind speed on the flame length is considered insignificant.

Computer Aided Management of Emergency Operations (CAMEO software) and USEPA guidelines (Central Federal Register - CFR 40, Part 68, 1998 titled "Chemical Accident Prevention Provision") have been followed for end-point distance calculation. Wind speed affects the flame parameters in two ways, namely flame length and flame tilt. At a low wind speed, the flame length is more, which reduces with increase in wind speed, whereas the tilting of the flame in the direction of wind increases with higher wind speed. Hence a largely tilted flame intensifies radiation at any point in the direction of wind and on the contrary large flame length poses greater threat at any point from radiation point of view. For similar fire sizes the effect distances under 3 m/s wind speed is significantly larger than those distances under 1.5 m/s wind speed. This is due to tilting of flame under higher wind speeds (21 to 47 degrees tilt). For 1.5 m/s stable atmosphere (F class stability), 5 degree tilt has been considered in the cases of pool fire.

Consequence of Fire: The summary of the consequence modeling results for Pool fire is shown below: Endpoint distance [1% fatality - 12.7 KW/m^2 for 20 seconds exposure]

In case of pool fire pertaining to total 4000 KL fuel, the thermal damage for 1% fatality under 3 m/s wind speed, B class stability is 42.2 m.
In case of pool fire pertaining to 4000 KL fuel, the thermal damage for 1% fatality under 1.5 m/s wind speed, E class stability is 38.6 m.

Maximum Consequence Tank Fire: The fire consequence of tank fire is less than that of pool fire, hence endpoint distances are not of any significant because risk management measures for pool fire consequence will be adequate for this scenario.

The risk contour is shown in **Figure 6.1**.

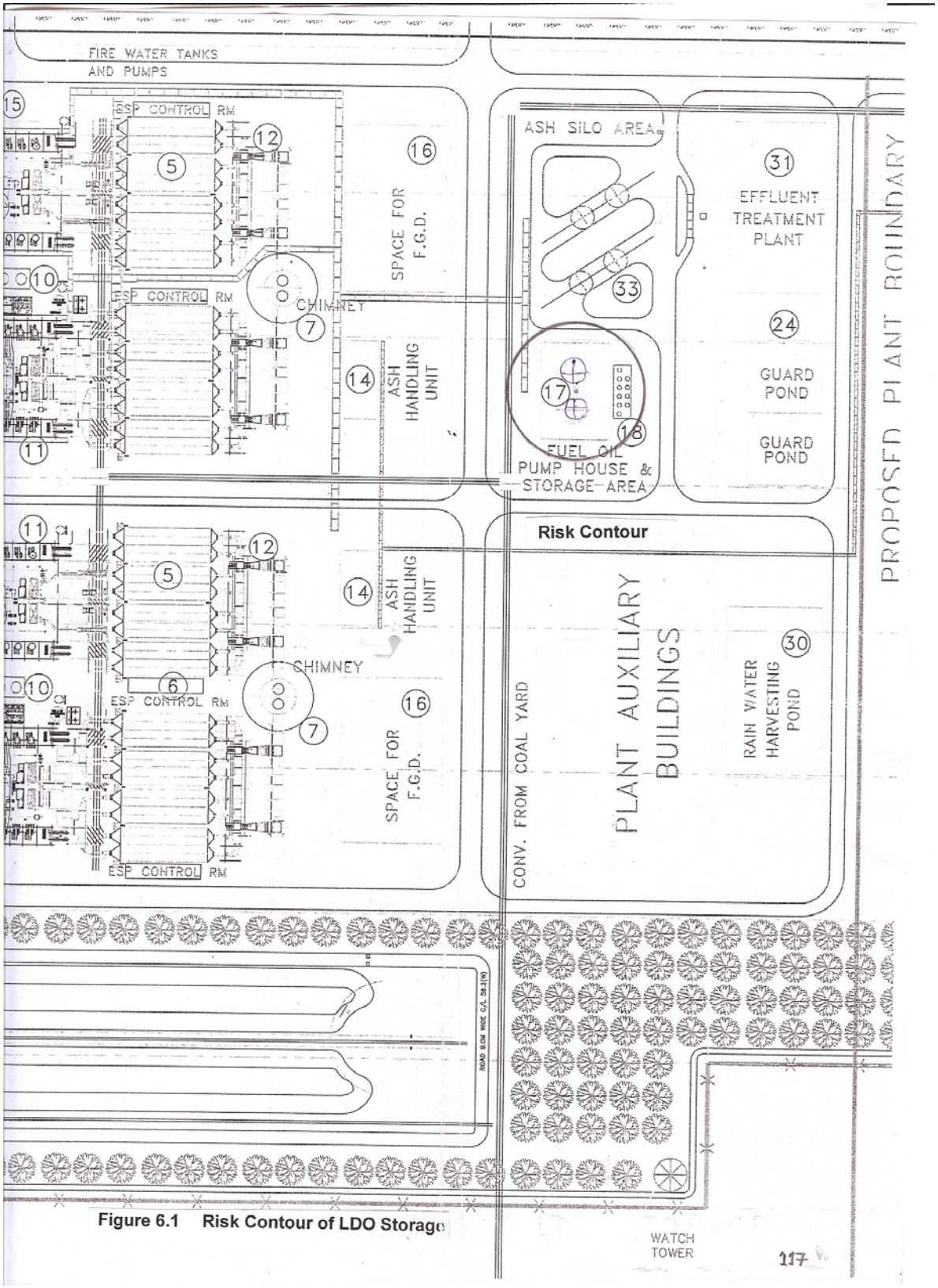


Figure 6.1 Risk Contour of LDO Storage

The probability of ignition of flammable vapours is given below:

Probability of Ignition of Flammable Vapours (Source DNV)

Continuous release rate (kg/s)	Instantaneous release rate (kg)	Ignition probability Immediate	Ignition probability Delayed	Ignition probability No Ignition
< 10	< 1000	0.2	0.05	0.75
10 to 100	1000 to 10000	0.5	0.1	0.4
> 100	> 10000	0.7	0.2	0.1

Fire in coal yard: This is the most common accident known to occur in any plant storing and handling coal. Since such incident takes sufficient time to get widespread, enough response time is available for plant personnel to get away to safer distance. An elaborate fire hydrant network and fire fighting system comprising of trained crew and facilities will mitigate the risk of such incidents. In case of bunkers / tunnel, alarm system and smoke detectors should be installed.

Leakage and spill of chemicals: Chemicals like sodium hydroxide and hydrochloric acid will be stored for use in the DM plant. Handling of these chemicals is risky for plant personnel. Other water treatment chemicals like flocculent, polyelectrolyte, lime, etc do not posses any risk. Caustic and acid are corrosive and contact due to their sJSLl will cause burn injury to plant personnel. Personnel involved in handling of these chemicals will be properly trained and made aware of the safety data and related first-aid measures. Water tap/jet will be installed near the DM plant so that the affected personnel can thoroughly wash in case of acid / base contact incident. Therefore accidental risk due to sJSLl of chemicals can be minimised.

Mechanical injury to body parts: In a power plant there are several palaces where workers are likely to be involved with accidents resulting in injury to body parts. The places are workshop, during mechanical repair work in different units, during construction work, road accidents due to vehicular movement, etc, etc.

Workers exposed to mechanical accident-prone areas will be given personal protective equipment. The non-respiratory PPE includes tight rubber goggles, safety helmets, welders hand shields and welding helmets, plastic face shields, ear plugs, ear muffs, rubber aprons, rubber gloves, shoes with non-skid soles, gum boots, safety shoe with toe protection.

All safety and health codes prescribed by the BIS will be implemented. Safety data sheets of the hazardous chemicals will be displayed at specific locations. Fire hydrants will be located at all convenient and strategic points along the major drains and checked for water availability on regular basis. Fire extinguishing equipment, sand buckets, water sprinklers and water hoses will be provided at all convenient point. Fire, heat, smoke and hydrocarbon detection alarms will be installed.

On-site disaster management plan will be prepared after the construction is over and considering the actual inventory of stored hazardous materials. The plan will contain the name and contact number of plant personnel, district officials, police station, fire station, and hospitals.

The likelihood of accidents and hazards has been assessed. In the absence of documented failure frequency data for this type of plant, a qualitative relative likelihood band of ‘high’, ‘medium’ or ‘low’ was assigned. The assessment of the potential likelihood of each scenario concluded that three of the scenarios pose a likelihood of ‘low’, and the MCA scenarios pose a likelihood of ‘medium’. This was primarily as a result of following considerations:

- The chemical or material released not reaching an off-site receptor, due to the nature of the chemical or some form of on-site containment;
- The chemical not being sufficiently toxic, or present at a particular environmental receptor for a sufficient period of time, or at a sufficient level, to have an adverse effect on that receptor; and

6.2 Emergency Response Plan

The quantum of risk posed by an industry depends not only on the hazardous chemicals being used, stored, handled or manufactured, but also on the industry management, level of safety awareness among employees and the safe practices and preventive measures followed while handling these chemicals. The main areas considered for management capability are as follows:

Compliance with existing Rules and Regulations: The following statutory provisions to be complied by JPL:

The MSIHC Rules, 1989/2000 notified under the Environment Protection Act, 1986.
Rules on Emergency planning, Preparedness and Response for Chemical Accidents, 1996.
Hazardous Wastes (Management and Handling Rules) 2000
Factories Act, 1987 (Amended)
Public Liability Insurance Act, 1991
Air Act, 1981 and Water Act, 1974

Engineering Aspects: This includes the factory layout and following general features of the facility.

1. Demarcation with proper boundary wall
2. Green belt and buffer zone
3. Segregation of process and utility blocks
4. Access for emergency vehicle movement
5. Adequacy of exit and entry points
6. Ventilation of process area
7. Dyking of hazardous material storage tanks
8. Source of process knowhow and documentation
9. Use of codes and standards
10. Third party inspection

Process Aspects**:** This include the process safety angle like reaction characterization (is the reaction well characterized in terms of runaway potential, exotherms, heat of reaction, etc.), existence of high temperature pressure alarms, back up indicators, annunciate panel, etc. and existence of process control through PLC, single loop controls, interlocks, etc.

Emergency response: It includes the emergency preparedness of the installation like

1. Working on-site emergency plan
2. Fire protection system in terms of fire water storage, hydrant, sprinkler, foam, fire alarms, smoke detectors and gas detectors

3. Emergency power
4. First aid, emergency vehicle and medical provisions
5. Back-up communication
6. Training and mock drill
7. Personnel Protective Equipment and Self contained breathing apparatus

Management System**:** It includes the management commitment within the organisation.

Existence of professionals in key factory positions
Safety, health and environment function
ISO 14000 and ISO 9000 certification, safety and environment policy
System for recording near miss and accident investigation
Workers awareness of hazards involved

Operation and Maintenance System: This includes

Existence of SOP for all critical operations
Inerting systems used for reactors, tanks, pipelines, etc.
Earthing system
Preventive maintenance system
System for implementing plant modifications

The aim of hazard control and disaster management is concerned with preventing accidents through standard design and efficient operation, preventive maintenance, inspection and proper usage of safety measures by which it is possible to reduce the risk of an accident. Proponent should coordinate with the District Administration and adopt all measures to minimize the effect of disaster. The objective should be to localize the emergency and, if possible, eliminate it and minimize the effects of the disaster on workforce and surrounding community. This EMP formulates a procedure for controlling disaster with minimum damage to men, material and machines, evacuating the victims to safer places, rescuing the victims and providing them medical treatment, rehabilitating the affected areas, delegating specific tasks to staff (avoid overlapping of activities within various groups) and preserving relevant records as evidence in any subsequent inquiry.

1. Elimination of hazards will require prompt action by operators and emergency staff and mobilizing fire-fighting equipment, emergency shut-off valves and water sprays. To minimize the effects of a disaster, prompt operation for providing rescue, first aid, evacuation, rehabilitation and right information to people living in nearby areas is necessary.

2. Emergency team leader is called site main controller (SMC) who should be the plant manager. He should lead the emergency response team. In his absence the senior most person available at plant should act as emergency team leader. Besides the top officials described above, rest of the employees should be divided into three action teams namely A, B, C. Action team A consists of staff of section in which accident has occurred. Action team B consists of staff of non-affected section and maintenance department. Action team C consists of supporting staff i.e. security supervisor, shift supervisor and ancillary people comprising of contractor, labour, etc.

3. Team A should initiate action in case of an emergency. Team B should help team A by remaining in their respective sections and preparing to comply with specific instructions of SMC. Team C consisting of supporting staff should help Team A as and when required and receive direction from Team B to act. Team C should help in evacuating the affected personal to safer place, under the supervision of Team B. A multi-channel communication network should connect Site Emergency Control Room (SECR) to control rooms of various other departments and the nearest fire station, medical centre and district hospital.

4. The onsite emergency will in all probability commence with fire or burns and the victims will be the members of operational staff on duty. In case a staff member on duty spots the emergency, he (as per site emergency procedure of which he is adequately briefed) should go to nearest emergency (fire) alarm location. He should try his best to inform the exact location and nature of emergency to the fire fighting station. In accordance with work emergency procedure, the following key activities should immediately take place to control the emergency.

5. On site crew should arrive at the site of incident with fire extinguishers and necessary equipment.

6. Emergency security controller should commence his role from main gate office.

7. Incident controller should arrive at SECR with members of his advisory and communication team and assume absolute control of the site. He should receive

information continuously from incident controller and give decisions and directions to the following:

a) Incident controller
b) Plant control rooms
c) Emergency security officer
d) Site or shift medical officer

8. After all the key emergency personnel have taken up their respective positions, the incident controller should use communication system to convey and receive the messages. At the site of incident the incident controller should directly handle the emergency with the help of specific support group such as Team C and fire fighting personnel. At the main gate, the Emergency Security Controller and Personnel Manager will contact external agencies. At the site medical center / first aid center, the Medical Officer will take control of medical support services. Site Main Controller should direct and decide all issues and direct the following aspects:

a. Whether the incident controller requires reinforcement of manpower and facilities.
b. Whether the plant operation should be shut down or kept in running condition.
c. Whether the staff in other locations should be kept indoors or evacuated and assembled at predefined safe areas.
d. Whether the missing staff members should be searched or rescued.
e. Whether off-site emergency plan should be activated and message to that effect should be sent to the District Headquarter / Administration.
f. Whether and when outside emergency services should be called.
g. Respond to any large size complaints from outside public and to assess an off-site impact arising out of the on-site emergency.

9. On receiving the message of Disaster from site main controller (SMC), fire control room attendant should sound siren ‘wailing type’ for 5 minutes. Incident controller should arrange to broadcast disaster message through public address system. On receiving the message of ‘Emergency Over’ from incident controller the fire control room attendant should sound alarm ‘All Clear Signal’ straight for two minutes. The features of alarm system will be explained to one and all to avoid panic or misunderstanding during disaster.

10. On receiving the signal following actions will be taken:

a. All the members of advisory committee, personnel manager, security controller, etc. shall reach the SECR.
b. The process unit persons will remain ready in their respective units for crash shutdown on the instruction from SECR.
c. The persons from other sections will report to their respective officer.
d. The concerned section will take immediate action to remove contractor's personnel outside the plant gate.

11. When the incident has eventually been brought under control as declared by the incident controller, the SMC will send two members of his advisory team as incident site for the following purpose:

a. To conduct an on-the-spot assessment of total damage and prevalent condition with particular attention to possibility of recurrence of the emergency situation, which may be temporarily under control.
b. To inspect other parts of site, which might have been affected by impact of incident.
c. To inspect the personnel collection centers and roll call centers, to check if all persons on duty have been accounted for.
d. To inspect all the control rooms of the plant in order to assess and record the status of respective plants and to supervise any residual action that is deemed necessary.

12. Once the emergency situation comes under control, the advisory team should return to SECR with their observations, report and submit the findings in writing to SMC. Based on the reports, SMC should communicate further directives to all emergency management sub-centers and finally declare and communicate termination of emergency and authorize step by step restoration of normal operation of the affected plant. Emergency security controller and personnel manager should deal with all the members of public and other local bodies from the main gate office. During the entire period of emergency, the site should remain out of bounds to external visitors except for the following officials:

a. District fire personnel

b. District hospital ambulance staff
c. Civil/ Defence personnel
d. District administration
e. Factory Inspectorate Officers and Labour Commissioner
f. Officers of State Pollution Control Board
g. Insurance authorities.

13. Effective working of rescue team is essential during the disaster. In order to make the services of rescue team more effective following equipment will be provided to the team.

a. Self rescue type gas filters (with oxygen cylinder or compressed air)
b. Mechanical filters
c. Fire proximity suits, asbestos aprons or aluminized asbestos suits)
d. Safety helmets
e. Face shields (Asbestos or PVC)
f. Petromax lamp/Torches
g. Axes/hand saw
h. Fire entry suits
i. Fire blankets
j. Gloves (PVC, asbestos, special rubber make)
k. Ropes
l. Ladders
m. Rubber glove (tested upto 25000 volt.)
n. Blanket
o. Rubber sole shoes and gum boots
p. Safety shoes with toe protection
q. Shoes with non-skid soles
r. Safety belt with life line (leather, hard rubber or neoprene)

14. In view of vulnerability to fire, effective measures have been considered to minimize fire hazard. Fire protection is envisaged through hydrant and sprinkler system, designed as per the recommendation of Tariff Advisory Committee of Insurance Association of India / Loss Prevention Association of India.

15. For detection and protection of the plant against fire hazard, any one or a combination of the following systems will protect susceptible areas:

a. Hydrant system
b. Medium velocity spray system
c. Portable fire extinguishers
d. Fire alarm system

16. Fire hydrant points should be provided at all necessary places. Medium velocity spray system should be provided for protection of transformers, cable galleries and coal storage areas. Water for hydrant, spray and sprinkler systems should be supplied from the fire-water pumps located in water pump house. The hydrant system should be designed as an ordinary hazard class. Adequate number of portable and mobile chemical fire extinguishers (Carbon dioxide, dry chemical powder, foam types) should be provided at strategic locations throughout the plant. Fire detection, heat detection, hydrocarbon detection and alarm system should be provided to detect fire/heat/smoke/hydrocarbons in vulnerable areas of the plant.

6.3 Risk Mitigation Measures

1. Appropriate storage facilities should be provided for special requirements such as for substances that are flammable, and incompatible by-product and waste types should be kept separate.

2. After constructing the plant and based on actual inventorization of hazardous chemicals that are stored inside the premises, their exact location and appointment of O&M staff, JSL project management team should carry out a detailed risk analysis. Based on the results of consequence analysis and end-point distances, On-site and Off-site Disaster Management Plan should be prepared as per the guidelines of Factories Act. The Plan should be prepared in consultation with the district administration and got approved by the Hazard Control Cell of the district. Name and contact numbers of plant personal, concerned government officials, police station, fire station, ambulance, district hospital staff should be mentioned in the plan.

3. Passive mitigation measures that should be considered are dyke walls around the liquid fuel storage tanks, enclosures, drains, sumps, fire walls, etc, wherever necessary. Adequate capacity dyke wall around the tank to contain the entire volume of tank in case of spill should be made.

4. It is recommended to locate the fuel tanks at least 80 m away from the plant boundary so that societal risk is avoided.

5. Active mitigation measures that should be considered are water sprinkler system, water curtain, flares, scrubbers, emergency shut down system, etc.

6. In case of spill or leaks in storage tanks leading to containment of flammable liquid, vaporisation should be avoided by placing fume suppression chemicals over the surface of liquid [they provide a curtain over relevant sections]. Water spray systems or foaming systems should be used over storage tanks, and storage vessels.

7. Emergency isolation valves at critical locations on equipments / pipings should be placed to isolate high inventory of hydrocarbons.

8. Nitrogen / steam purging facilities should be provided on critical equipment / system for driving out hydrocarbons.

9. In case of fire, the cooling of adjoining tanks should be started immediately. It is also necessary to cool the tank on fire.

10. Non-essential plant personnel (office staff, administration and accounts staff) should be located away from the storage area outside the zone of 4 KW/m^2 radiation intensity.

11. All hazardous storage systems should be designed with safety features as appropriate and recommended to enhance the safety against design failure.

12. Pumps of reliable quality should be installed. Arrangements should be made around the pumps so that leaks from glands, valves or joints can be contained locally.

13. Earthing of road tankers carrying flammable chemicals should be made before unloading to eliminate possibility of static sparks.

14. All lighting and electrical equipment in the unloading area and flammable chemicals storage area should be suitable to the area classification approved by Competent Authority.

15. Safety showers and eyewash fountains should be provided in section where caustic soda, acid and other corrosive or reactive chemicals are handled.

16. Pressure detectors should be installed for oil & gas pipelines, the indication of which should be seen in the control room. This would enable the control room to detect any leakage in the pipelines forwarding fuels / products.

17. Hydrocarbon detectors should be provided at strategic locations.

18. Minor leaks could occur in routine operations, like pump seal failure, flange leak, sample point valve left open or drain valve left open. These should be checked regularly by a preventive maintenance program and rectified immediately.

19. Corrosion protection methods for pipelines should be done. All locations where the above ground pipelines are close to traffic movement, protection like crash guards should be provided.

CHAPTER 7 - ENVIRONMENTAL MONITORING PLAN

7.1 Monitoring Plan

Monitoring plan has been prepared to ensure compliance with the applicable environmental laws and conditions stipulated in the environmental permits. The monitoring plan also ensures compliance with the recommended safeguards for pollution prevention and abatement and sustainable development of the project. The objectives of the monitoring plan are as follows:

- To verify the results of the impact assessment study.
- To study the trend of concentration values of the parameters, which have been identified as critical and planning the mitigative measures.
- To check and assess the efficacy of pollution control equipment.
- To ensure that any additional parameters, other than those identified in the impact, do not become critical after the commissioning of proposed plant.

The effectiveness of monitoring program depends mainly how best the objective of the monitoring is addressed through its core elements, for example.

a. Manpower and Instruments
b. Monitoring network
c. Frequency of monitoring
d. Parameters to be monitored
e. Method and duration of sampling
f. Method of analysis

The manpower requirement for monitoring is shown in Table 7.1.

Table 7.1 Manpower for Environmental Management Department

	Designation	Qualification	No. of Staff	Experience
1	Head-EMD	M.Tech – Engg or Ph.D – Science	1	10-15 years in environmental management of metallurgical industry or in regulatory authority.
2	Environmental Scientist	Ph.D – Science	1	5 years in environmental laboratory of metallurgical industry or in the laboratory
3	Environmental Engineer	M.Tech – Engg	1	5 years in manufacture or operation and maintenance of pollution control systems
4	Chemist	M.Sc – Chemistry	1	5 years experience in environmental laboratory and pollution monitoring systems
5	Field Assistants	B.Sc – Science	2	5 years experience in laboratory, greenery development, environmental sampling, pollution monitoring, etc.

The instruments required for routine environmental monitoring is given in Table 7.2

Table 7.2 Instruments for Environmental Monitoring

	Name of Instruments	Number	Purpose
1	Respirable Dust Sampler	4	Ambient Air Quality Monitoring
2	Fluoride Analyser	2	Fluoride testing in air and water
3	Spectrophotometer	2	Analysis of air and water samples
4	Mercury Analyser	2	Analysis of air and water samples
5	pH, Conductivity, Dissolved Oxygen, Temp. Monitor	2	Water Quality testing
6	DO Meter	2	DO measurement
7	BOD Incubator	2	BOD measurement
8	COD Digestion Kit	2	COD measurement
9	Atomic Absorption Spectrophotometer	1	Analysis of Metals in Wastewater
10	CO Monitor	2	Monitoring of CO
11	Refrigerator	2	Storing samples
12	Deep freezer	1	Storing samples
13	Electronic Balance	3	Weighing
14	Oven	3	Drying
15	Desiccator	3	Desiccation
16	CO & HC Monitors	2	CO HC measurements
17	Stack Monitoring Kit	2	Stack Monitoring
16	Continuous Ambient Air Quality Monitoring Station	1	On-line continuous station at EMD, to monitor RSPM, SO2, NOx and CO.
17	Continuous stack monitors	4 flues	Direct reading on-line PM, SO_2 and NOx monitors

7.1.1 Stack Emission Monitoring

Air emissions from the project should be monitored using Stack Monitoring Kit as per Method prescribed by CPCB. The details of grab sampling are given below:

Component	Location	Parameter	Monitoring & Analysis Method	Monitoring Frequency
Stack Emission Monitoring	All Flues Port holes should be made on the stack (6 cm diameter, 4 Nos. at 90^{o} to each other), provided with flange. Location of the port hole should be at 6 times the stack diameter. Platforms with railings should be provided below the port holes.	SPM SO_2 NOx CO_2 CO F Hg	SPM & SO_2 – CPCB Method NO_X – USEPA Method 7 CO – NDIR method CO_2 – Orsat Analysis F – Fluoride anayser Hg – Mercury analyser Duration of sampling – Isokinetic method using stack monitoring kit Sample volume – 500 l of flue gas	Weekly
Fugitive Emission Monitoring	Material Handling Ash Pond Stock House Crushers Mills	SPM	CPCB Method High Volume Sampling 25 m upwind and 25 m downwind direction of the point simultaneously for 1 hour. @1100 l/minute sampling rate	Daily

7.1.2 Ambient Air Monitoring

Ambient air of the premises and surrounding area should be monitored using High Volume Samplers with attachment for sampling particles less than 10 microns size (respirable particles) as per Method prescribed by CPCB. Monitoring should be done at three corners of the plant premises by establishing permanent monitoring stations (120 deg to base SE direction). Monitoring should also be done at 6 locations outside the plant premises.

The monitoring height should not be less than 3 m from ground. The station should not have any obstacles around 500 m area, Station should be 500 m away from road.

Monitoring should be done during the construction stage as well as during the operation stage. The sampling details are given below.

	Location	**Parameter**	**Monitoring & Analysis Method**	**Monitoring Frequency**
Ambient Air Quality	At 3 locations within 1-2 km of plant (120 degree to each other; at human settlements) At 3 locations of plant boundary (except one at EMD where continuous instrument is recommended)	SPM RSPM SO_2 NO_2 Fluoride Mercury	SPM, RSPM, SO_2, NO_2, F and Hg – CPCB Method Duration of sampling – 24 hours Sample volume – Not less than 1100 l per minute	Twice a week

Continuous online ambient air monitoring station should be installed at one location (EMD Building), which should be connected to data logger and real time display unit. Parameters recommended for continuous monitoring are PM10, SO2, NOx and CO.

7.1.3 Meteorological Monitoring

Meteorological monitoring using continuous online instrument is necessary to know the upwind and downwind directions, assess and evaluate the stack emissions results and ambient air quality results and check the effectiveness of air pollution prevention measures. The details of the meteorological monitoring are given below.

Component	**Location**	**Parameter**	**Monitoring & Analysis Method**	**Monitoring Frequency**
Meteorology	At EMD Building	Wind Speed, Wind Direction, Temperature Humidity, Rainfall and Solar insolation	As per BIS 8829 Method	Hourly, Continuous

7.1.4 Equipment and Ambient Noise

Noise monitoring is recommended for all work areas inside the plant, plant boundary and surrounding villages. The details of noise monitoring are given below:

Component	Location	Parameter	Monitoring & Analysis Method	Monitoring Frequency
Plant Noise Levels	Plant Boundary (4 sides), Equipment and Work Place (all units)	Average Leq values and Maximum value of Sound Pressure Level in dB(A)	CPCB method using equipment as per IS-9989 & IS:9779	Monthly
Ambient Noise Levels	All villages outside the plant	Leq values in dB(A)	CPCB method using equipment as per IS-9989 & IS :9779	Monthly (separately for day & night time)

7.1.5 Water and Wastewater Monitoring

The details of water and wastewater monitoring are given below:

Component	Location	Parameter	Monitoring & Analysis Method	Monitoring Frequency
Wastewater Quality	From the outlet of CMB, Inlet and Outlet of STP	Flow pH TDS TSS O&G BOD COD Heavy metals Fluoride Mercury Coliform count for STP outlet water	APHA Method	Daily
Groundwater Quality	Observation wells inside plant and ash pond (4 Nos. of Piezometers)	Ground water Level pH TDS TSS Total hardness	Standard Methods of APHA	Once during pre-monsoon and once during post

	Groundwater of all villages around the plant (Hand pumps / borewells / dug wells)	Fluoride O&G Mercury Heavy metals		monsoon
Surface water Quality	Nearby streams, disposal point of storm water (upstream and downstream) and village ponds of surrounding area	Ground water Level pH TDS TSS Total hardness Fluoride Mercury O&G Heavy metals BOD COD Coliform Count	Standard Methods of APHA	Once during pre-monsoon and once during post monsoon

7.1.6 Solid & Hazardous Wastes Monitoring

Coal ash is categorized as Non-Hazardous Wastes; they are not mentioned in the Schedule of Hazardous Wastes Notification. Spent oil and lubricants generated from various process equipment, machines, vehicles, instruments, oil storage tanks, are categorized as Hazardous Wastes under the Notification. Used Batteries are also categories as hazardous wastes. Soiled cotton waste is generally fired in Boilers along with gas. Electronic wastes should be given to authorized re-processors.

Component	**Location**	**Parameter**	**Monitoring & Analysis Method**	**Monitoring Frequency**
Flyash and bottom ash	From all units of the plant (dust, slag, sludges, scales)	SiO2, Al2O3, Fe2O3, CaO, MgO, MnO, FeO, S, F organic matter and toxic metals (including Hg) and compounds mentioned in the Hazardous Wastes Notification	CPCB Method If any of the parameters exceed the threshold limit given in the Rules, then the solid waste is categorized as hazardous wastes and treated according to the Rules.	Yearly

Spent Oil and Lubricants	From all units of the plant	It is categorized as hazardous wastes	The quantity should be recorded. It should be stored in drums, properly sealed and stored in earmarked place for auction to Authorized re-processors Records of sale should be kept and annual returns should be submitted to SPCB	Half Yearly
Used Batteries	Vehicles and computers	It is categorized as hazardous wastes	The quantity should be recorded. It should be stored in earmarked place for auction to Authorized re-processors Records of sale should be kept and annual returns should be submitted to SPCB	Half Yearly

7.1.7 Flora and Fauna Monitoring

The details of flora and fauna monitoring plan is given below:

Component	**Location**	**Parameter**	**Monitoring & Analysis Method**	**Monitoring Frequency**
Flora and Fauna	Surrounding forests	Health of Flora and Fauna	Visual checks by the Ecologists of EMD Frequent interaction with the forest officials News Reports	Once in 5 years

7.1.8 Workers Health and Safety Monitoring

The details of workers health and safety monitoring plan is given below:

Component	Location	Parameter	Monitoring & Analysis Method	Monitoring Frequency
Work Environment	At all places where there is presence of workers all the time	Respirable Dust & Inhaled Dust (dust analysis for free silica,F, Fe, Ca, Pb, Zn, Hg, Cr, Mg & graphite)	Respirable Dust Sampler – CPCB method Personal Sampler - OSHA Method	Monthly
Occupational Health	Workers	Respirable disorders, heart diseases, diabetes, reproductive and child health, ENT problems, etc	By engaging Occupational Health Specialist in the Health Centre	Yearly

7.1.9 Community Health Monitoring

The details of community health monitoring plan are given below:

Component	Location	Parameter	Monitoring & Analysis Method	Monitoring Frequency
Health of Community	Surrounding villagers	Respirable disorders Heart diseases Fluorosis Diabetes Reproductive Health Child Health ENT problems	Organizing health camps in surrounding villages with qualified doctors and supporting staff. Inviting surrounding people for health check-up. CPCB Protocol to be followed during the health camps.	Yearly

7.1.10 Monitoring of DMP

During accident the Onsite and Offsite Disaster Management Plan should be initiated. In order to monitor the effectiveness of the plans, mock drills at regular intervals should be

carried out. The fire fighting systems should be checked at regular intervals. Fire extinguishers should be refilled and certified. Awareness programs should be initiated to make the employees aware of their role and responsibility during any accident. The surrounding community should be made aware through awareness camps about the probable disasters and the emergency response plans.

7.1.11 Monitoring of CSR Activities

The CSR work proposed by the company will be monitored by JSL through its dedicated staff engaged in CSR / PR Department. Regular progress report of the activities of the work undertaken by the company will be prepared and presented to the top management of the company for review. Apart from this, the company will get monitoring and evaluation of the work proposed to be undertaken by appointing reputed external agency. This will ensure a neutral and an outsider's view on the progress of work undertaken by the company.

7.2 Action during Abnormal Operating Conditions

During abnormal operating conditions like process upsets or failure of pollution control devices, the emission concentration would exceed the prescribed limit. Air emissions from major stacks are measured using online instruments with real time display facility. In case of abnormal emissions the Head of EMD will directly contact the CEO and HOD of the unit and assess the situation. The emission load should be brought down to barest minimum level by reducing the production. In case it is observed that the failure / upset condition is likely to exceed reasonable time (say 8 hours or more) then the unit should be shut down till the defect is corrected.

7.3 Budget for Monitoring

The estimated capital cost for implementing the environmental monitoring plan is Rs 11 crores. Rs. 3 crores would be required as annual recurring expenses for salary, purchasing spares and chemicals, training, etc.

7.4 Reporting

The monitoring results need to be reported every six-months to the SPCB, CPCB and MOEF as well as the Financial Institutions. Effective reporting mechanism should be developed as part of Environment Management System (ISO 140001 certification). Individual monitoring results should be compiled at one central location in a computer. The results should be statistically analyzed with graphical representation for understanding of technical and administrative personnel. Standard reporting formats for all environmental components should be developed while implanting the EMS. The results should be communicated to the HOD of all units and CEO of the project during the weekly review meetings. In case any problems with the pollution control measures or environmental management plan has been found during the routine monitoring, it should be immediately communicated to all concerned and time-targeted action plan should be prepared to rectify the defect. The environmental performance of the project should be published in the form of a document / brochure. The document should contain targets and action plan for demonstrable improvement in the environmental performance of the project.

CHAPTER 8 : PROJECT BENEFITS

With the aim to achieve power for all by the year 2012 and considering the growth rate of economy, the Government of India has envisaged capacity addition of 1,00,000 MW in next 6 years. This translates to almost doubling the existing capacity. Considering the fact that there is around 13% overall deficit of power availability with the present installed capacity, there is an immediate need to install power projects to achieve the economic growth which has been planned to meet the supply and demand equilibrium. This expansion project will add 2400 MW to the power generating capacity of the Nation and assist in reducing the demand supply gap of power in the country.

The major benefit envisaged is that the project will give a boost to the socio-economic status of the Chhattisgarh by way of royalty, direct and indirect taxes, resource utilization, employment and infrastructure development.

The recommendations given by CPCB in the form of Corporate Responsibility for Environmental Protection for power plants will be 100% complied. This will result in lowest possible emissions, water conservation and reuse of treated wastewater, solid waste utilization and resultant low cost of production.

JPL will also contribute 1% of the profit as part of Corporate Social Responsibility. JPL acknowledges that better education and health care facilities, road infrastructure and drinking water facilities are basic social amenities for better living standard of any human being. The above activities will be initiated either by providing or by improving the facilities in the area, which will help in uplifting the living standards of local communities.

The project will provide direct employment to 1000 persons during the construction period of about 48 months. The construction workers will be taken from the project affected families of surrounding villages. This will help the Government implement its commitment under the NREGS. .

About 1000 persons will get direct employment in the project during the operation stage. Preference will be given to project affected people depending upon their skill and qualification. The company also proposes to provide training to local youths, so that their skill can be gainfully used in project activities.

The project will create opportunities for direct employment to 250 persons who will be employed for the greenery development work, housekeeping and other related logistic activities.

The project will create opportunities for indirect employment to more than 2000 persons (as drivers, conductors and attendants of new trucks, passenger carrying vehicles, technicians in workshops and garages besides the plumbers, electricians and masons). The project will create opportunities for indirect employment due to increase in trade opportunities like stockiest / retailers of building materials, groceries, provision shops, medical stores, garment shops, furniture shops, etc.

CHAPTER 9 – SUMMARY AND CONCLUSION

Due to rapid industrialization and urbanization, there is substantial increase in demand for electricity in India. In order to reduce the huge deficit in demand and supply of electricity new power plants are urgently required in India. Jindal Power Limited (JPL) proposes to set up additional 2400 MW (4 X 600 MW) coal based power plant, with pulverized coal technology, adjacent to existing 1000 MW Power Plant, at Tamnar, District Raigarh in Chhattisgarh. The north and northeast side of Tamnar has abundant coal reserves; which are yet to be opened and developed. Utilization of the coal for power generation in the state would fulfill the Vision of Chhattisgarh for recognition as a Power Hub of India.

1041 hectares land is required for the project; 350 ha for main plant, 491 ha for ash pond at two locations, 100 ha for water reservoir and 100 ha for staff colony. The land is flat. Land is directly purchased from land owners as per mutually agreed rate. The land does not have any habitation; hence no resettlement is required. Water requirement is 8000 kl/hour, which will be taken from river Mahanadi and transported by pipeline following road route. Permission to draw water from river Mahanadi has been obtained from Water Resources Department. Coal requirement is 11.7 million tons per annum, which will be brought to the site by rail or road or conveyor depending upon the location of coal mines. In case the captive coal block of JPL at Gare Palma (Block IV/2 & IV/3) is used, then coal will be transported using conveyor belt.

The project activity falls under category A and 1 (d) of EIA notification 2006. The Ministry of Environment & Forests, Government of India has approved the Terms of Reference for EIA Study vide letter J.13012/ 117/ 2008-IA.II (T) dated 31st March 2009. The draft EIA report has been prepared as per the TOR and submitted to Chhattisgarh Environment Conservation Board for Public Hearing.

Baseline environmental data generation of study area was carried out during the period December 2008 to February 2009. Data was generated by following the standards / approved procedures of the Ministry of Environment & Forests and the Central Pollution Control Board. Micrometeorological data has been generated inside plant premises.

Historic meteorological data was collected from India Meteorological Department at Raigarh. The predominant wind direction is from northeast to northwest sector. The average wind speed ranges from 2.9 to 4.1 kmph. Daily mean temperature varied from 13.2^{o}C to 31.6^{o}C.The relative humidity varied from 30 - 62%. The annual rainfall is 1602 mm.

The project site is situated more than 25 km north of Raigarh. The site is well connected by road. No national park, wildlife sanctuary, biosphere reserve, wetland and archaeological monuments are present in the study area. Kurket river, Kelo river, Pajhar nadi and Digi nala and their minor tributaries are the watercourses present in the study area. Dam on Kurket river, Rabo Dam, some small check dams / irrigation weirs and village ponds are the water bodies present in the study area. The north and east side of the area is dominated by forests. Sponge iron plants, ferroalloy plants, rolling mills and induction furnaces and coal mines are the type of industries present in the study area.

The SPM, RSPM, SO_2 and NO_2 levels were monitored at eight locations in the study area. The baseline air quality levels are within the National Standards prescribed for residential area. Ambient noise levels were monitored at eight locations in the study area. The baseline noise levels are within the National Standards. Eight surface water samples and eight groundwater samples were collected from the study area. The water quality of streams is satisfactory. The groundwater quality of study area is fit for potable use, except two villages where fluoride content has been found to exceed the limit. No metallic or bacterial contamination was found in the water samples. Eight soil samples were collected from the study area. The texture of soil is sandy. The organic matter, nitrogen, potassium and phosphorus content of the soils are moderate. No endangered species of plants and animals are found in the study area.

Water will be required for steam generation and condenser cooling purpose. The hot water will be taken to cooling towers and after cooling it is recycled back for condenser cooling. The cooling tower blowdown will be taken to common monitoring basin (CMB). DM plant regeneration wastewater will be taken to neutralization pit and then to CMB. Boiler blowdown will be taken to CMB. The quality of outlet water from CMB will be checked and then it will be used for dust suppression and ash handling No wastewater will be

discharged outside the plant premises. Sewage Treatment Plant will be provided to treat the sewage water generated from plant and colony. The treated sewage water will be used for gardening. The storm water drain will be provided with sedimentation pits and oil-water interceptors. The storm water will be discharged into nearby nalla. Spent oil and lubricants will be collected in drums and given to authorized recyclers. Rainwater harvesting pits will be constructed and rooftop rainwater will be diverted towards these pits for recharging the groundwater. Such measures will be adequate to protect the adverse environmental impact.

The dust emissions during coal unloading and coal stock yard will be suppressed using water sprinkling. The boiler emissions will be taken to Electrostatic precipitators for dust trapping. The SPM emission at stack outlet will be kept below 50 mg/Nm^3. 275 m tall stack will be provided. Water spraying will be done to suppress the dust generated during construction activity. All internal roads will be made pucca. All roads and shop floors will be cleaned regularly. Appropriate ventilation system will be provided in all work areas including coal bunkers. Ozone friendly refrigerants will be used inside the plant. All process parameters will be optimized for energy conservation. Greenery development will be dome at 33% of the land area and all available open spaces will be made green. Mathematical modeling studies proved that the ambient air quality will remain within the National Ambient Air Quality Standards.

Movement of trucks and dumpers will be properly scheduled to minimize construction noise. The compressors, rotating machines, turbines, etc will be the major sources of noise. All activities will be carried out inside sheds and buildings. Turbine will be provided with acoustic enclosure. Sound absorbing materials will be provided in the room where both the source and receiver are present. In noisy work areas soundproof duty rooms will be provided. Workers working in noisy areas will be given ear plugs. Mathematical modeling studies proved that the ambient noise quality will remain within the National Noise Quality Standards.

Flyash will be collected in dry form in silos. It will be utilized as per rules, in cement making, making embankments, low land filling, making roads and flyovers, aggregates, bricks, blocks, etc. Bottom ash will be used in road making. Surplus ash will be stored in

ash pond. Garbage will be segregated and recyclable materials will be given to kabadis. Biodegradable garbage will be composted. Inert material will be given for landfilling. No plastic materials will be handled inside the plant. Used batteries will be given back to dealer, while purchasing the new batteries. Such measures will be adequate to protect the adverse environmental impact.

The soil quality of the site and surroundings is sandy loam. The infiltration rate of the soil is moderate. Air pollution control devices will be installed at all points to trap the dust. Solid wastes generated from the air pollution control devices will be reused. No solid wastes will be dumped on land, hence there will be negligible impact on the soil quality.

Dust emission from the plant will be controlled using Scrubber and Bag Filters. Flue Gas will be dispersed using tall stacks. All air emissions will be kept within the prescribed standards. The incremental air pollution will be accommodated within the air quality standards. Wastewater and solid waste will be reused. Greenery development will be intensified, all available open spaces will be made green. Such measures will be adequate to protect the surrounding ecology.

Exposure to dust, noise, heat, mechanical injury, fire in coal yard, etc are some of the hazards identified. Workers will be given mask, ear plugs, goggles, gloves, boots, etc. The existing hospital is equipped with doctors, medicine, ambulance and other medical equipment to take care of emergency and first aid cases. The workers will be checked for any clinical complaints and abnormal symptoms by the in-house medical department. Workers will be provided clean drinking water and toilets. Regular training and awareness programs will be conducted.

Impact Assessment study has been carried out to identify the potential impacts of the project on the environment. Based on the study various measures have been proposed to mitigate adverse impacts on the environment during construction and operation phases of the project. These include the following.

- 275 m high twin flue stacks to reduce ground level concentration of air pollutants

- Installation of high efficiency electrostatic precipitators for control of particulate matter emission. The SPM emission will be kept below 50 mg/Nm^3.
- Use of low sulphur content coal and installation of dry low NOx burners (DLNB) for control of SO_2 and NOx emissions.
- Water sprinkling practices for control of fugitive emissions.
- Adoption of closed cooling system for condenser cooling purposes; using cooling towers to mitigate thermal pollution
- Proper treatment of effluents from plant and domestic sewage from plant and colony and recycling the treated water for various purposes such as gardening, ash handling, dust suppression etc.
- Ash utilization plan provided for 4.563 million tons per annum as per MoEF notification.
- Disposal of unutilized ash in suitably lined ash pond in a proper and scientific manner.
- Regular monitoring practices for all components of environment and immediate intervention in case of any discrepancy.
- Development of an extensive greenbelt around the power plant to mitigate air and noise pollution

Environmental Management Plan, Environment Monitoring Program and Disaster Management Plan have been prepared for improving the environmental quality and plant safety.

Environmental Management Department (EMD), under the direct control of Chief Executive with full-fledged environmental laboratory and qualified scientists and engineers exists. EMD is responsible for the following functions:

I. Regular monitoring of :

1. Stack emissions, fugitive emissions, work environment and report any abnormalities for immediate corrective measures.

2. Ambient air quality at upwind and downwind direction of plant and at three locations at plant boundary (120 degree to each other).

3. Re-circulating water quality and testing the inlet and outlet water quality of CMB.

4. Ground water quality inside plant, and surrounding villages.

5. Water quality of rivers at upstream and downstream points. .

6. Noise testing of equipment, noise monitoring at the plant boundary, work areas and nearest habitation.

8. Quantity & quality of flyash and bottom ash and their reuse in various purposes.

II. Development and maintenance of greenbelt and greenery within the plant boundary and in surrounding villages and barren land.

Light Diesel Oil will be stored in Tanks for use as supporting fuel during start-up, during shut down and low load conditions. LDO will be stored in 2 x 2000 KL Tanks. The oil tanks will be designed and located as per standards of Oil Industry Safety Directorate, secured with bunds, pipelines, isolation valves and other safety devices. Onsite emergency response plan will be modified in consultation with the District Administration. Approval of Chief Controller of Explosives will be taken for the layout and design of oil storage tanks.

Elaborate fire fighting system with fire extinguishers, hydrant system, sprinkler system, pumps and pipeline network will be provided as per the recommendation of Loss Prevention Association and Tarrif Advisory Committee. Water for fire fighting will be taken from the water reservoir.

The optimal utilization of coal reserves of Chhattisgarh state for power generation within the state will boost the economic development of the state. The project will create additional employment generation for 1000 people. During the construction phase, 1000 people on an average will be employed for construction related activity for 48 months. JPL will employ local people for plant construction and operation, depending upon availability of skilled and unskilled persons.

Several other indirect employment opportunities will be created in the surrounding area. Transport business, vehicle drivers and attendants, workshops, grocery and retail, medical, school, coaching centers, technical institutes, restaurants, self employed persons like tailors, carpenters, plumbers, electricians, etc will get indirect job opportunity.

The company will earmark 1% of the annual profit for Corporate Social Responsibility. The following schemes are recommended under CSR program.

9. Coordinate and tie-up with the nearby Industrial Training Institutes (ITI) for training the local youths as electricians, plumbers, carpenters, masons, workshop technicians, fitters, welders, drivers, tailors, etc. The company will provide scholarships.

10. Coordinate with Block Development Office and village Panchayats to identify and provide assistance for conservation and development of grazing land and growing fodder crops (like Jai) in vacant space.

11. Coordinate with Agriculture University and State Agriculture Department to organize Annual Fair in the area. Local farmers will be provided knowledge for better yield of paddy, pulses, oilseeds and other vegetable crops.

12. Organize training programs and demonstration projects for converting household organic wastes into compost by using vermiculture process, and its use as soil conditioner for better crop yield.

13. Organize training programs and demonstration projects with State Ground Water Board and Engineering College at Patrapali for developing rainwater harvesting structures. .

14. The company will promote traditional handicrafts like embroidery, paintings, batik and block prints, silver work, etc. The company will encourage brotherhood, fraternity and religious feelings among villagers and will contribute for organizing religious functions and construction / repair of religious places.

15. Organize and sponsor sports tournaments by involving the local villagers, schools and colleges of Tamnar and other villages.

16. Contact the surrounding schools to obtain list of economically weak students and provide them with scholarships and study materials.

17. Contact the nearby school administration to assess the requirement of computers, books, study materials, furniture, building materials, safe drinking water and toilet

facility. The company will provide the materials through the BDO and Gram Panchayat.

18. Financial assistance will be provided to economically weak but exceptionally bright students to take admission in Technical and Management Institutes.

19. The company will develop a mobile dispensary, which will be taken to surrounding villages in consultation with the BDO and Gram Panchayat. Free consultation and medicines will be provided to needy people. The company will organize cataract operation camps, dental health check-up camps, AIDS awareness campaign at regular intervals.

20. The company will coordinate with the local administration and develop park, gardens and road side plantation in the area.

21. The company will coordinate with the State Transport Department and Local Administration, cooperate for developing plans and provide all assistance for the maintenance and upkeep of existing roads and highways.

The CSR Department and Liaison Department of JPL will coordinate with the BDO, Gram Panchayat, ADM and DM of the area for encouraging the local people to form self-help groups to obtain benefits under the CSR program of the company.

Environmental Management Plan (EMP) for effective management of environmental impacts and protection of the environment through appropriate management procedures has been developed. In order to implement the recommended mitigation measures and institutionalise the EMP, budgetary provision of Rs.407 crores for capital expenditure has been made. Recurring annual expenditure will be about Rs. 34 crores.

EMD will ensure that all air pollution control devices, effluent treatment plant and water re-circulating systems function effectively. Schemes for resource conservation (raw materials, water, etc), rainwater harvesting and social forestry development will be taken up by EMD. Environmental awareness programs for the employees will be conducted. .

Workers will be given personal protective equipment and their health check-up done every year. EMD will also ensure cleanliness and industrial hygiene in the plant. EMD in association with the safety department will undertake full review of the potential hazard scenarios during plant commissioning. The review will ensure enforcement of the proposed

safeguards for pollution abatement, resource conservation, accident prevention and waste minimization. The implementation of EMP would ensure that all elements of project comply with relevant environmental legislation throughout its life cycle.

The Central Electricity Authority (CEA) emphasizes urgent need for introduction of large scale thermal power plants in an environmentally friendly manner. In order to achieve the twin objective of quick capacity addition and better efficiency, unit size of 600 MW plant is ideally suited for this purpose. The proposed project is considered techno-economically viable and attractive.

The proposed power project will direct and indirect generate employment opportunities for skilled, semiskilled and unskilled labourers, which will prove to be beneficial for the development of the area. The project will be useful in enhancing economic growth by promoting industrial development in the area as well as alleviating power supply in the region and in the adjoining areas.

CHAPTER 10 : DISCLOSURE OF CONSULTANT FOR EIA STUDY

M/s Jindal Power Limited appointed M/s EMTRC Consultants Private Limited having its office at B-16, Plot 10-A, East Arjun Nagar, Delhi -110032 to carry out the EIA Study as per the guidelines of Ministry of Environment & Forests. EMTRC Consultants Private Limited has its own central laboratory at Delhi and working laboratory at its camp office in Raipur for sampling and testing of air, water, noise and soil samples. The laboratory is recognized by the Ministry of Environment & Forests, Government of India under the relevant provision of Environment (Protection) Act 1986. Copy of the Gazette Notification by Government of India is attached. EMTRC generated the baseline environmental data for the EIA Study during the winter season from 1st December 2008 to 28th February 2009. The following officials of EMTRC participated in the EIA study.

	Name & Designation	**Qualification**	**Experience**
1	Dr. J. K. Moitra, Govt. Analyst (EIA Co-ordinator)	M.Sc (Chemistry), Ph.D	22 years
2	Mr. R. Kotiyal, Govt. Analyst	M.Sc (Ecology)	8 years
3	Mr. S.K.Pandey	BE (Engineering)	8 years
4	Mr. Mukesh Kumar Verma	M.Sc (Environmental Science)	2 years
5	B. Bisht (Technical Assistant)	Class XII (Lab Assistant)	8 years
6	H.S.Adhikari (Lab Attendant)	Class XII (Lab Assistant)	4 years
7	Mr. Pradeep Rana	Class X (Field Assistant)	2 years
8	Mr. Sanjay Kumar	Class X (Field Assistantt)	2 years
9	Mr. Sunil Kumar	Class XII (Field Assistant)	2 years

The detailed profile of EMTRC is available in website www.emtrc.com.

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असाधारण

EXTRAORDINARY

भाग II—खण्ड 3—उप-खण्ड (ii)

PART II—Section 3—Sub-section (ii)

प्राधिकार से प्रकाशित

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पर्यावरण एवं वन मंत्रालय

अधिसूचना

नई दिल्ली, 15 अक्तूबर, 2004

का.आ. 1139(अ).—केन्द्रीय सरकार पर्यावरण (संरक्षण) अधिनियम, 1986 के नियम 10 के साथ पठित पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 12 की उपधारा (1) के खंड (ख) और धारा 13 द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए नीचे सारणी के स्तंभ (2) में विनिर्दिष्ट प्रयोगशालाओं को उक्त अधिनियम और उसके अधीन बनाए गए नियमों के अधीन पर्यावरणीय प्रयोगशालाओं को सौंपे गए कर्त्तव्यों का पालन करने के लिए पर्यावरणीय प्रयोगशालाओं के रूप में और उक्त सारणी के स्तंभ (3) में विनिर्दिष्ट व्यक्तियों को उक्त अधिनियम की धारा 11 के अधीन केन्द्रीय सरकार या सशक्त अधिकारी द्वारा विश्लेषण के लिए भेजे गए वायु, जल, मृदा या अन्य पदार्थों के नमूनों के विश्लेषण के प्रयोजनों के लिए सरकारी विश्लेषकों के रूप में मान्यता देती है और उस प्रयोजन के लिए भारत सरकार के पर्यावरण एवं वन मंत्रालय, की अधिसूचना सं. का.आ. 728(अ) दिनांक 21 जुलाई, 1987 में निम्नलिखित और संशोधन करती है; अर्थात् :—

उक्त अधिसूचना से संलग्न सारणी में—

(1) क्रम संख्या 116 और उससे संबंधित प्रविष्टियों के पश्चात् निम्नलिखित क्रम संख्या और प्रविष्टियां जोड़ी जाएंगी, अर्थात् :—

"क्र. सं.	प्रयोगशाला का नाम	विश्लेषक का नाम
(1)	(2)	(3)
117.	मैसर्स मिटकॉन कन्सलटेंसी सर्विसिज लि., बी.ए.आई.एफ. कैम्पस, राष्ट्रीय राजमार्ग-4, समीप बारजे, पुणे-411052	1. श्री जगादले सुन्दरराव चन्द्रराव 2. सुश्री स्मिता पी. महाजन 3. श्री अमरदीप राजू
118.	मैसर्स इदमा लेबोरेट्रीज लि., 391, इंडिस्ट्रीयल एरिया-I, पंचकूला (हरियाणा)-134109	1. डा. पवन कुमार अग्रवाल 2. डा. रणदीप सिंह सैनी 3. श्री निरंजन देव बहल
119.	मैसर्स कोणार्क रिसर्च फांउडेशन, प्लॉट सं. 338/1, कचगाम, दमन-396210	1. डा. (श्रीमती) लैला रजवानी 2. श्री सतीश यादव 3. श्री कमलेश पटेल
120.	ई.एम.टी.आर.सी. कन्सलटेंट्स प्रा. लि., बी-16, प्लॉट 10-क, ईस्ट अर्जुन नगर, नवरचना अपार्टमेंट के सामने, दिल्ली-32	1. श्री अजेन्द्र कुमार वर्मा 2. श्री रतनेश कोटियाल 3. डा. जयन्त कुमार भोइत्रा

APPENDIX 1

POINTWISE COMPLIANCE TO TOR CONDITIONS

S.No	TOR Condition	Compliance status
1	Status of compliances of the conditions stipulated in the earlier EC.	The compliance to earlier EC conditions is shown in Annexure 1
2	Comparison of alternate sites considered and reason for selecting the proposed site. Conformity of the site with the prescribed guidelines in terms of distance of 500 m from HFL of the river, highways, and railway lines may also be shown.	Alternate site analysis provided in chapter 1 Table 1.1, page 4 and 5 of EIA report. The plant layout is shown in Figure 2.1, which shows distance from HFL of the river and other features.
3	All the coordinates of the plant site as well as ash pond with top sheet.	Provided in chapter 1 page 2, 3 and 4 of EIA report.
4	Study area should cover an area of 10 km radius around the proposed site.	Provided in chapter 3, page 29.
5	Land use of study area as well as the projected area shall be given.	Provided in chapter 2 17 and page chapter 3 page 60 for landuse of plant site and study area, respectively.
6	Location of any National park, Sanctuary, Elephant / Tiger reserve (existing as well as proposed), migratory routes, if any, within the 15 km of the project site shall be specified and marked on the map duly authenticated by the Chief Wild Life Warden.	No national park or wildlife sanctuary is present within 15 km of the plant site. There is no elephant corridor in the project site and 15 km around the project site Certificate is this regard is attached as Annexure 2.
7	Land requirement of the project to be optimized. Item wise breakup of land requirement and its availability to be furnished. The norms prescribed by CAE should be kept in view. It should also include land to be acquired, if any, for coal transportation system as well as for lying of pipeline including ROW. It may clearly be confirmed that the land including ROW is free of all encumbrances. The relating to land acquisition and R&R should be clearly discussed in the EIA Report.	Provided in Chapter 2 page 17 of EIA report. Provided in Chapter 2 page 17 of EIA report. Water pipeline will follow the road route, hence the ROW is free of all encumbrances. Coal conveyor from existing coal mines of JPL exists. This conveyor corridor will be used to lay new conveyor or strengthen the existing one. This is free of all encumbrances. R&R plan discussed in chapter 5 page 101 and 102 of EIA report.
8	Topography of the area should be given clearly indicating whether the site require any filling. If so details of filling, quantity of filling material required, its source, transportation etc, should be given.	Provided in chapter 2 page 18 and 19 of EIA report.

9	Impact on drainage of the area and the surroundings.	Provided in chapter 4 page 73 to 75 of EIA report
10	Information regarding surface hydrology and water regime and impact of the same, if any due to the project.	Provided in chapter 3 page 30 to 32 of EIA report
11	One season site specific micro meteorological data shall be provided.	Provided in chapter 3 page 34 to 35 of EIA report
12	One complete season Ambient air quality data (Except Monsoon) to be given along with dates of monitoring. Parameters to be covered shall include SPM, RSPM, SO2, NO2, Hg and Ozone (ground level). The location of monitoring station should be decided so as to take into consideration the pre –dominant down wind direction, population zone and sensitive receptors including reserve forests. There should be at least one monitoring station in the up wind direction. There should be at least one monitoring station in the predominant downwind direction at allocation where maximum ground level concentration is likely to occur.	Provided in chapter 3 page 36 to 38 of EIA report. Date wise AAQ data provided in Annexure 3
13	Impact of the project on the AAQ of the study area. Details of the model used and the input data used for modeling should also be provided. The air quality contours may be plotted on a location map showing the location of project site, habitation nearby, sensitive receptor, if any. The wind rose should also shown on this map.	Provided in chapter 4 page 78 to 80 of EIA report. Air quality contours are provided in page 81 of EIA report and Annexure 3.
14	Fuel analysis to be provided (sulphur, ash content, heavy metals including Pb, Cr, As. Hg). Details of auxillary fuel, if any including its quality, quantity, storage etc. should be provided.	Provided in chapter 2 page 18 of EIA report.
15	Quantity of fuel required its source and transportation. A confirmed fuel linkage should be provided.	Provided in chapter 2 page 18 of EIA report
16	Source of water and its availability. Commitment regarding the availability of requisite quantity of water from the competent authority.	Provided in chapter 2 page 19 and 20 of EIA report. Water drawl permission is attached as Annexure 4.

17	Details of rainwater harvesting and how it will be used in the plant.	Provided in chapter 5, page 109 of EIA report
18	Examine the feasibility of zero discharge. In case of any proposed discharge, its quantity, quality and point of discharge, users down stream etc. should be provided.	Provided in chapter 5, page 98 and 113 of EIA report
19	Optimization of COC for water conservation. Other water conservation measures proposed in the project should also be given. Quantity of water requirement for the project should be optimized.	Provided in chapter 2, page 19 and 20 of EIA report
20	Details of water balance taking into account reuse and re-circulation of effluents.	Provide in chapter 2, page 20 and chapter 5 page 98 and 113 of EIA report.
21	Details of green belt i.e. land with not less than 1500 trees per ha giving details of species, width of plantation, planning schedule etc.	Provided in chapter 5 page 105 to 108 of EIA report
22	Detailed plan for ash utilization / management.	Provided in chapter 5 page 99 to 103 of EIA report
23	Details of evacuation of ash	Provided in chapter 2 page 22 and 23 of EIA report
24	Details regarding ash pond impermeability including soil analysis report and whether it would be lined, if so details of lining etc.	Soil analysis report provided in chapter 3 page 43 and 44 of EIA report. Lining of ash pond discussed in chapter 5 page 99 to 103 of EIA report.
25	Detailed R&R plan / compensation package in consonance with the National /State R & R Policy of the project affected people including that due to fuel transportation system / pipeline and their ROW, if any, shall be prepared taking into account the socio-economic status of the area, homestead oustees, land oustees, landless laboureres.	Discssed in chapter 5 page 109 to 111 of EIA report
26	Details of flora and fauna duly authenticated should be provided. In case of any scheduled fauna conservation plan should be provided.	Provided in chapter 3 page 45 to 56 of EIA report. The authentication letter is attached as Annexure 2. .
27	Details regarding infrastructure facilities such as sanitation, fuel, restroom, medical facilities, safety	Provided in chapter 5 page 95 and 96 of EIA report

	during construction phase etc. to be provided to the labour force during construction as well as to the casual workers including truck drivers during operation phase.	
28	Public hearing points raised and commitment of the project proponent on the same. An action plan to address the issues raised during public hearing and the necessary allocation of funds for the same should be provided.	To be provided after Public hearing
29	Measures of socio-economic influence to the local community proposed to be provided by project proponent. As far as possible, quantitative dimension to be given.	CSR activities are discussed in chapter 7 page 137 and chapter 9 page 147 of EIA report. The existing CSR activities is provided in Annexure 5.
30	Impact of the project on local infrastructure of the area such as road network and whether any additional infrastructure would need to be constructed and the agency responsible for the same with the time frame.	Provided in chapter 4 page 89 and 90 of EIA report
31	EMP to mitigate the adverse impacts due to the project along with item wise cost of its implementation.	Provided in chapter 5 page 113 of EIA report
32	Risk assessment including fire and explosion issue due to storage and use of fuel should be carried out. It should take into account the maximum inventory of storage at the site any point in time. The risk contours should be plotted on the plant layout map clearly showing which of the proposed activities would be affected in case of an accident taking place. Based on the same proposed safeguard measures should also be provided. Measures to guard against fire hazards should also be provided.	Provided in chapter 6 page 115 to 126 of EIA report
33	Any litigation pending against the project and /or any direction / order passed by any Court of Low against the Project, if so details therefore of.	No litigation is involved with this project