# COMPREHENSIVE ENVIRONMENTAL IMPACT ASSESSMENT

FOR

## THE PROPOSED 3.25 LTPA CAPACITY GREENFIELD INTEGRATED ALUMINIUM SMELTER AND 750 MW COAL BASED CAPTIVE POWER PLANT AT BARGAWAN, SIDHI DISTRICT, MADHYA PRADESH

*Sponsor :*

HINDALCO

**HINDALCO INDUSTRIES LIMITED**
***(MAHAN ALUMINIUM PROJECT)***
**BARGAWAN**

*Prepared by :*

VIMTA LABS
Determining Quality

**Vimta Labs Ltd. 142,**
**IDA, Phase-II, Cherlapally,**
**Hyderabad-500 051**

**February, 2009**

**HINDALCO INDUSTRIES LIMITED**

# COMPREHENSIVE ENVIRONMENTAL IMPACT ASSESSMENT

**FOR**

**THE PROPOSED 3.25 LTPA CAPACITY GREENFIELD INTEGRATED ALUMINIUM SMELTER AND 750 MW COAL BASED CAPTIVE POWER PLANT AT BARGAWAN, SIDHI DISTRICT, MADHYA PRADESH**

For and on behalf of VIMTA Labs Limited

Approved by : **M. Janardhan**

Signed :

Position : **Vice President (Env)**

Date : February 26, 2009

This report has been prepared by Vimta Labs Limited with all reasonable skill, care and diligence within the terms of the contract with the client, incorporating our General Terms and Conditions of Business and taking account of the resources devoted to it by agreement with the client.

# Table of Contents


| Chapter # | | Title | Page # |
|---|---|---|---|
| | Table of Contents | | TC-1 |
| | List of Figures | | TC-3 |
| | List of Tables | | TC-4 |
| **1.0** | **Introduction** | | |
| | 1.1 | Purpose of the Report | C1-1 |
| | 1.2 | Identification of Project & Project Proponent | C1-1 |
| | 1.3 | Brief Description of the Project | C1-2 |
| | 1.4 | Scope of the Study | C1-8 |
| **2.0** | **Project Description** | | |
| | 2.1 | Proposed Project | C2-1 |
| | 2.2 | Size or Magnitude of Operation | C2-1 |
| | 2.3 | Project Schedule for Approval and Implementation | C2-1 |
| | 2.4 | Technology and Process Description | C2-2 |
| | 2.5 | Project Description | C2-5 |
| | 2.6 | Assessment of new and untested Technology for Risk of Technological Failure | C2-32 |
| | 2.7 | Sources of Pollution | C2-34 |
| **3.0** | **Baseline Environmental Status** | | |
| | 3.1 | Introduction | C3-1 |
| | 3.2 | Landuse Studies | C3-2 |
| | 3.3 | Soil Characteristics | C3-7 |
| | 3.4 | Meteorology | C3-14 |
| | 3.5 | Air Quality | C3-27 |
| | 3.6 | Water Quality | C3-35 |
| | 3.7 | Noise Level Survey | C3-46 |
| | 3.8 | Flora and Fauna Studies | C3-52 |
| | 3.9 | Demography and Socio Economic | C3-63 |
| **4.0** | **Impact Assessment** | | |
| | 4.1 | Introduction | C4-1 |
| | 4.2 | Impacts during Construction Phase | C4-1 |
| | 4.3 | Impacts during Operational Phase | C4-3 |
| **5.0** | **Environment Management Plan** | | |
| | 5.1 | Introduction | C5-1 |
| | 5.2 | Environment Management Plan during Construction Phase | C5-1 |
| | 5.3 | Environment Management Plan during Operational Phase | C5-2 |
| | 5.4 | Greenbelt Development | C5-7 |
| | 5.5 | Post Project Environment Monitoring | C5-9 |
| | 5.6 | Cost Provision for Environmental Measures | C5-10 |
| | 5.7 | Rain Water Harvesting | C5-10 |
| | 5.8 | compliance of CREP Guidelines | C5-11 |

## Table of Contents (contd.)


| Chapter # | | Title | Page # |
|---|---|---|---|
| **6.0** | | **Environmental Monitoring Program** | |
| | 6.1 | Environmental Monitoring | C6-1 |
| | 6.2 | Budgetary Allocation Environmental Monitoring | C6-4 |
| | 6.3 | Institutional Arrangements for Pollution Control | C6-4 |
| **7.0** | | **Risk Assessment and Disaster Management Plan** | |
| | 7.1 | Introduction | C7-1 |
| | 7.2 | Approach to the Study | C7-1 |
| | 7.3 | Hazard Identification | C7-2 |
| | 7.4 | Hazard Assessment and Evaluation | C7-3 |
| | 7.5 | Disaster Management Plan | C7-20 |
| | 7.6 | Off-Site Emergency Preparedness Plan | C7-29 |
| | 7.7 | Occupational Health and Safety | C7-35 |
| **8.0** | | **Project Benefits** | |
| | 8.1 | Employment Potential | C8-1 |
| | 8.2 | Community Development Action Plan | C8-1 |
| **9.0** | | **Additional Studies** | |
| | 9.1 | Rehabilitation & Resettlement Action Plans | C9-1 |
| **10.0** | | **Summary & Conclusions** | |
| | 10.1 | Justification for Implementation of the Project | C10-1 |
| | 10.2 | Summary of Anticipated Environmental Impacts and Mitigation | C10-1 |
| | 10.3 | Conclusion | C10-1 |
| **11.0** | | **Disclosure of Consultants** | |
| | 11.1 | Introduction | C11-1 |
| | 11.2 | The Quality Policy | C11-1 |
| | 11.3 | Milestones and Accreditations | C11-1 |
| | 11.4 | Services Offered | C11-2 |
| | 11.5 | Services | C11-3 |
| | 11.6 | Facilities | C11-4 |
| | 11.7 | Quality Systems | C11-5 |
| | 11.8 | Achievements | C11-5 |

**Annexure**

Annexure-I : Environmental Clearance
Annexure-II : Methodology for Sampling And Analysis
Annexure-III : Environnemental Législation
Annexure-IV : Emission Calculations
Annexure-V : Land Use Pattern
Annexure-VI : Ambient Air Quality Levels
Annexure-VII : Ecological Details
Annexure-VIII : Demography Details
Annexure -IX : Public Hearing Details

## List of Figures


| Figures # | Title | Page # |
|---|---|---|
| 1.1 | Geographical Location of the Project Site | C1-5 |
| 1.2 | Study Area 10km around Plant Boundary | C1-6 |
| 2.1 | Process Flow Diagram of Aluminium Production | C2-3 |
| 2.2 | Typical Gas Treatment Plant | C2-9 |
| 2.3 | Layout Plant of the Proposed Smelter Complex | C2-26 |
| 2.4 | Layout Plant of the Proposed Smelter Complex | C2-27 |
| 2.5 | Water Balance | C2-30 |
| 2.6 | Fluoride Balance | C2-37 |
| 3.2.1 | Study Area on Satellite Imagery Map | C3-5 |
| 3.2.2 | Landuse/Land Cover Thematic Map | C3-6 |
| 3.3.1 | Soil Sampling Locations | C3-8 |
| 3.4.1 | Site Specific Winter Season Wind Rose | C3-14 |
| 3.4.2 | Seasonal Wind Roses ( Pre-Monsoon) | C3-18 |
| 3.4.2 | Seasonal Wind Roses ( Monsoon) | C3-19 |
| 3.4.3 | Seasonal Wind Roses ( Post-Monsoon) | C3-20 |
| 3.4.3 | Annual Wind Rose | C3-21 |
| 3.4.6 | Seasonal Wind Roses | C3-24 |
| 3.5.1 | Air Quality Sampling Locations | C3-28 |
| 3.6.1 | Water Sampling Locations | C3-36 |
| 3.7.1 | Noise Sampling Locations | C3-48 |
| 3.8.1 | Terrestrial and Aquatic Ecological Sampling Locations | C3-55 |
| 4.1 | Noise Dispersion Contours | C4-14 |
| 5.1 | Design of Secured Landfill for Hazardous Waste Disposal | C5-5 |
| 5.2 | Greenbelt Development Plan | C5-8 |
| 6.1 | Organization Structure of Environment Division | C6-6 |
| 7.1 | On-site Emergency Organization Chart | C7-30 |

## List of Tables


| Tables # | Title | Page # |
|---|---|---|
| 1.1 | Details of Environmental Setting | C1-3 |
| 1.2 | Global Primary Aluminium Consumption | C1-7 |
| 1.3 | Environmental Attributes & Frequencies of Monitoring | C1-9 |
| 2.1 | Size/Magnitude of Operations of the Project | C2-1 |
| 2.2 | Parameters of Coal | C2-21 |
| 2.3 | Typical Composition of Fly Ash | C2-22 |
| 2.4 | Proposed Land use of the Site | C2-25 |
| 2.5 | Raw material Requirement | C2-25 |
| 2.6 | Water Requirement | C2-29 |
| 2.7 | Breakup of Manpower Requirement | C2-32 |
| 2.8 | Salient Environmental Features | C2-33 |
| 2.9 | Performance Standards of Built-in Control Equipment | C2-34 |
| 2.10 | CREP Specified Norms | C2-35 |
| 2.11 | Stack and Emission Details | C2-35 |
| 2.12 | Wastewater Generation | C2-38 |
| 2.13 | Details of Expected Solid Waste | C2-39 |
| 2.14 | Typical Analysis of Spent Pot Lining | C2-39 |
| 2.15 | Source Noise levels in the Proposed Plant | C2-40 |
| 3.2.1 | Landuse Pattern – Proposed Project Site | C3-2 |
| 3.2.2 | Landuse Pattern in the Study Area | C3-4 |
| 3.2.3 | Landuse/Land Cover Classification System | C3-4 |
| 3.2.4 | Landuse Breakup based on IRS-P6 Data | C3-5 |
| 3.3.1 | Details of Soil Sampling Locations | C3-7 |
| 3.3.2 | Soil Analysis Results-Winter | C3-9 |
| 3.3.3 | Soil Analysis Results- Pre-monsoon | C3-10 |
| 3.3.4 | Soil Analysis Results (Post-Monsoon) | C3-11 |
| 3.3.5 | Standard Soil Classification | C3-13 |
| 3.4.1 | Summary of the Meteorological Data Generated at Site | C3-15 |
| 3.4.2 | Summary of Wind Pattern at the Study Area | C3-15 |
| 3.4.3 | Climatological Data | C3-22 |
| 3.4.4 | Summary of Wind Pattern | C3-22 |
| 3.5.1 | Details of Ambient Air Quality Locations | C3-29 |
| 3.5.2 | Summary of Ambient Air Quality Results- Winter | C3-32 |
| 3.5.2 | Summary of Ambient Air Quality Results- Pre-Monsoon | C3-33 |
| 3.5.2 | Summary of Ambient Air Quality Results- Post-Monsoon | C3-34 |
| 3.6.1 | Details of Water Sampling Locations | C3-37 |
| 3.6.2 | Ground Water Quality- Winter | C3-41 |
| 3.6.3 | Surface Water Quality- Winter | C3-42 |
| 3.6.2 | Ground Water Quality- Pre Monsoon | C3-43 |
| 3.6.3 | Surface Water Quality- Pre Monsoon | C3-44 |
| 3.6.2 | Ground Water Quality- Post Monsoon | C3-45 |
| 3.6.3 | Surface Water Quality- Post Monsoon | C3-46 |
| 3.7.1 | Details of Noise Sampling Locations | C3-49 |
| 3.7.2 | Noise Levels in the Study Area | C3-50 |
| 3.8.1 | Details of Terrestrial Ecological Sampling Locations | C3-53 |
| 3.8.2 | Class wise Distribution of Plant Species in the Study Area | C3-56 |
| 3.8.3 | Fluoride Concentration in Leaf and Grass Sample | C3-57 |
| 3.8.4 | Forest Blocks in Study Area | C3-58 |
| 3.8.5 | Fauna and Their Conservation Status from Study Area | C3-59 |

## List of Tables (contd..)


| Tables # | Title | Page # |
|---|---|---|
| 3.8.6 | Details of Aquatic Sampling Locations | C3-62 |
| 3.8.7 | Aquatic Fauna from Study Area | C3-63 |
| 3.9.1 | Distribution of Population | C3-64 |
| 3.9.2 | Distribution of Population by Social Structure | C3-65 |
| 3.9.3 | Distribution of Literate and Literacy Rates | C3-65 |
| 3.9.4 | Occupational Structure | C3-66 |
| 4.1 | Stack Emissions Details | C4-5 |
| 4.2 | Predicted 24 hourly short Term Incremental concentrations | C4-6 |
| 4.3 | Resultant Concentrations due to Incremental GLCs | C4-6 |
| 4.4 | Predicted 24 hourly short Term Incremental concentrations Pre-Monsoon | C4-7 |
| 4.5 | Resultant Concentrations due to Incremental GLCs Pre-Monsoon | C4-8 |
| 4.6 | Predicted 24 hourly short Term Incremental concentrations Post-Monsoon | C4-8 |
| 4.7 | Resultant Concentrations due to Incremental GLCs Post-Monsoon | C4-7 |
| 4.8 | Expected Solid Waste From Smelter | C4-10 |
| 4.9 | Expected Solid Waste from CPP Project | C4-11 |
| 4.10 | Estimated Noise Levels from the Plant | C4-12 |
| 4.11 | Predicted Noise Levels at the Plant Boundaries | C4-13 |
| 4.12 | Incremental Concentrations due to CPP & Smelter | C4-15 |
| 4.13 | Plant Species Observed in Study Area | C4-15 |
| 4.14 | List of Animals Recorded in Study Area | C4-16 |
| 5.1 | Recommended Plant Species for Greenbelt | C5-9 |
| 5.2 | Cost Provision for Environmental Measures | C5-10 |
| 5.3 | Compliance of the CREP Guidelines | C5-11 |
| 6.1 | Implementation Schedule | C6-1 |
| 6.2 | Monitoring Schedule for Environmental Parameters | C6-2 |
| 6.3 | Cost of Environmental Monitoring | C6-4 |
| 7.1 | Hazardous Materials Stored, Transported and Handled | C7-2 |
| 7.2 | Category Wise Schedule of Storage Tanks | C7-3 |
| 7.3 | Properties of Fuels used | C7-3 |
| 7.4 | Applicability of GOI rules to Fuel Storage | C7-3 |
| 7.5 | Preliminary Hazard Analysis for Storage Areas | C7-4 |
| 7.6 | Preliminary Hazard Analysis for Whole Plant in General | C7-4 |
| 7.7 | Fire Explosion and Toxicity Index | C7-5 |
| 7.8 | Fire Explosion and Toxicity Index | C7-5 |
| 7.9 | Damage Due to Incident Radiation Intensities | C7-7 |
| 7.10 | Radiation Exposure and Lethality | C7-7 |
| 7.11 | Scenarios Considered for MCA analysis | C7-8 |
| 7.12 | Properties of Fuel Considered for Modeling | C7-8 |
| 7.13 | Occurrence of Various Radiation intensities – Pool Fire | C7-8 |
| 7.14 | disasters due to Electrical Explosions and Entrapping Water into Hot Metal | C7-11 |
| 7.15 | Fire due to Pitch, Coke & Inflammable fuels | C7-13 |
| 7.16 | Leakage of Toxic Gases and Preventive Measures | C7-15 |
| 7.17 | Hazard Analysis for Process in the CPP | C7-18 |
| 7.18 | Hazardous Events Contributing to On-site Facility Risk | C7-18 |
| 7.19 | Hazardous Events Contributing to Off-site Facility Risk | C7-18 |
| 7.20 | Off-site Action Plan | C7-34 |
| 10.1 | Anticipated Environmental Impacts and Mitigation Measures | C10-3 |

# 1.0 INTRODUCTION

## 1.1 Purpose of the Report

Hindalco Industries Limited (Hindalco) proposes to set-up a greenfield integrated aluminum smelter complex project under the name of 'Mahan Aluminium' with a production capacity of 3,25,000 TPA (Primary Aluminium Metal) near Bargawan village, Deosar Tehsil in Sidhi District, Madhya Pradesh.

Aluminium smelters are highly power intensive and electricity is considered as a major raw material for aluminium production. Therefore, to cater to the demand of power on continuous basis, 5 x 150 MW (750 MW) coal based Captive Power Plant (CPP) is also proposed in the complex.

As per the new Notification dated 14/09/2006, the project falls under **'A Category'** and it is mandatory to have Environmental Clearance (EC) from Ministry of Environment and Forests (MoEF), New Delhi. Therefore, Environmental Impact Assessment (EIA) report has been prepared for obtaining Environmental Clearance (EC) from MoEF. Based on the project proposal, submitted to MoEF along with Form-1, MoEF issued Terms of Reference (TOR) vide letter no. J-11011/217/2007/IA.II(I) dated 18/07/2007. Environmental Clearance obtained after conducting TOR meeting and Public Hearing. Environmental Clearance is presented in **Annexure-I.**

Hindalco has retained the services of M/s. Vimta Labs Limited, Hyderabad to undertake Comprehensive Environmental Impact Assessment (EIA) studies for assessing the impact of the proposed greenfield integrated aluminum complex project on various environmental parameters in the study area and to prepare an Environment Management Plan for negating the adverse impacts of the project. Environmental Impact Assessment / Environmental Management Plan have been prepared based on the TOR.

## 1.2 Identification of Project and Project Proponent

### 1.2.1 Identification of Project

Hindalco is currently embarking on a growth plan designed to make it a global-sized, globally-competitive metals producer. In their aluminium business, their competitive strengths include globally competitive cost structure, fully integrated operations, cost effective access to abundant supply of quality raw materials and domestic market leadership.

Towards realizing their vision of attaining global size and further improve their cost competitiveness in the global aluminium industry, Hindalco is embarking on several expansion plans at their existing facilities and green-field projects, both in alumina and aluminium.

Based on the encouraging growth rate in aluminium sector, Hindalco has proposed to install the aluminium complex near Bargawan village, district Sidhi in

Madhya Pradesh. The identified location has proximity to coal fields and alumina refinery located at Renukoot in Uttar Pradesh.

### 1.2.2 Project Proponent

Hindalco is a flagship company of the Aditya Birla Group, one of the largest industrial groups in India. With an outstanding record of capacity utilization, the company has grown into India's largest aluminium producer with a 40% share of production.

Hindalco is a leading producer of aluminium and copper in India and is also one of the leading metals and mining companies in Asia. According to CRU estimates, Hindalco is the fourth largest aluminium producing company based in Asia and the thirteenth largest in the world by volume. Hindalco was incorporated in 1958 and are listed on the Indian Stock Exchanges since 1968 and on the Société dela Bourse de Luxembourg since 1993.

Hindalco has alumina refining capacity of 1,160 KTPA located at Renukoot, Uttar Pradesh; Muri, Jharkhand and Belgaum, Karnataka. It is also the largest producer of primary aluminum with a capacity of 455,000 TPA located at Renukoot, Uttar Pradesh and at Hirakud, Orissa; Alupuram, Kerala. Its largest Alumina-Aluminium Complex is located at Renukoot which includes Alumina Refinery of 700,000 TPA capacity and Aluminium Smelter Plant of 345,000 TPA capacity along with downstream semi-fabrication facilities comprising of rolled products, extrusions and wire rods. The Renukoot plant receives bauxite ore from mines owned and operated by the company in Jharkhand and Chattisgarh States. The requirement of power for this complex is met by own co-generation (78 MW) and Hindalco's captive thermal power plant of 742 MW capacity at Renusagar.

Towards realizing their vision of attaining global size and further improve their cost competitiveness in the global aluminium industry, Hindalco is embarking on several expansions at their existing facilities and green-field projects, both in alumina and aluminium. These include:

- Ongoing expansion of existing facilities, both in alumina and aluminium;
- A green-field Utkal alumina project in Orissa;
- A fully integrated green-field smelter, alumina refinery and captive power project in Orissa; and
- An integrated green-field aluminum smelter with captive power project in Madhya Pradesh.

## 1.3 Brief Description of Project

### 1.3.1 Nature of the Project

The nature of the project is to produce 3.25 LTPA of aluminium from alumina to be sourced from captive sources in Orissa. The required power for aluminium production will be met from CPP having power generation capacity of 750 MW.

### 1.3.2 Size of the Project

The proposed green-field integrated Aluminum Complex project will include:

- 3,25,000 TPA (Primary Aluminium Metal) Aluminium Smelter;
- Captive Power Plant of 750 MW generating capacity;
- 35-km length of water pipeline and about 8-km length of ash pipeline; and
- Township and other infra-structural facilities in about 373.76-ha area.

The total land required for the proposed project (which includes smelter plant, captive power plant, township, ash disposal area, corridor for various utilities/facilities etc) is about 1500-ha.

Total cost of the proposed project is estimated to be about Rs.7,700 crores.

### 1.3.3 Location of the Project

The site selected for the proposed Mahan Aluminium project is located near Bargawan village, Deosar Tehsil in Sidhi District of Madhya Pradesh.

The plant site geographically extends from Longitude 82°25'31" E to 82°28'05" E and Latitude 24°12'31" N to 24°14'29" N and fall in Survey of India Topo sheet No. 63-L/8.

The site is located about 70-km east of Sidhi, which is the district Headquarter. The nearest railhead is at Bargawan on East-Central railway and is about 4-km from the proposed site. The site can be approached through Ranchi-Rewa National Highway (NH-75E), which is about 0.7-km from the site. Geographical location of the proposed project is shown in **Figure-1.1**.

Nearest town is Bargawan located about 4-km southwards and the nearest major town is Waidhan located at about 25-km from the project site. Coal requirement of CPP will be met from Mahan Coal Limited, which is located at about 18-km from the project site.

The proposed site is almost flat and is semi-agricultural, mostly Rayati land belonging to resettlement dwellers. The details of environmental setting are given in **Table-1.1.** The location map is shown in **Figure-1.2**.

**TABLE-1.1**
**DETAILS OF ENVIRONMENTAL SETTING**

| Sr. No. | Particulars | Details |
|---|---|---|
| 1 | **Location** | |
| a | Village | Orgari (Near Bargawan) |
| b | Tehsil | Deosar |
| c | District & State | Sidhi & Madhya Pradesh |
| d | Plant site coordinates | |

| Corner | Latitude | Longitude |
|---|---|---|
| A | 24°13'43" N | 82°25'31" E |
| B | 24°14'25" N | 82°26'22" E |
| C | 24°13'24" N | 82°27'46" E |

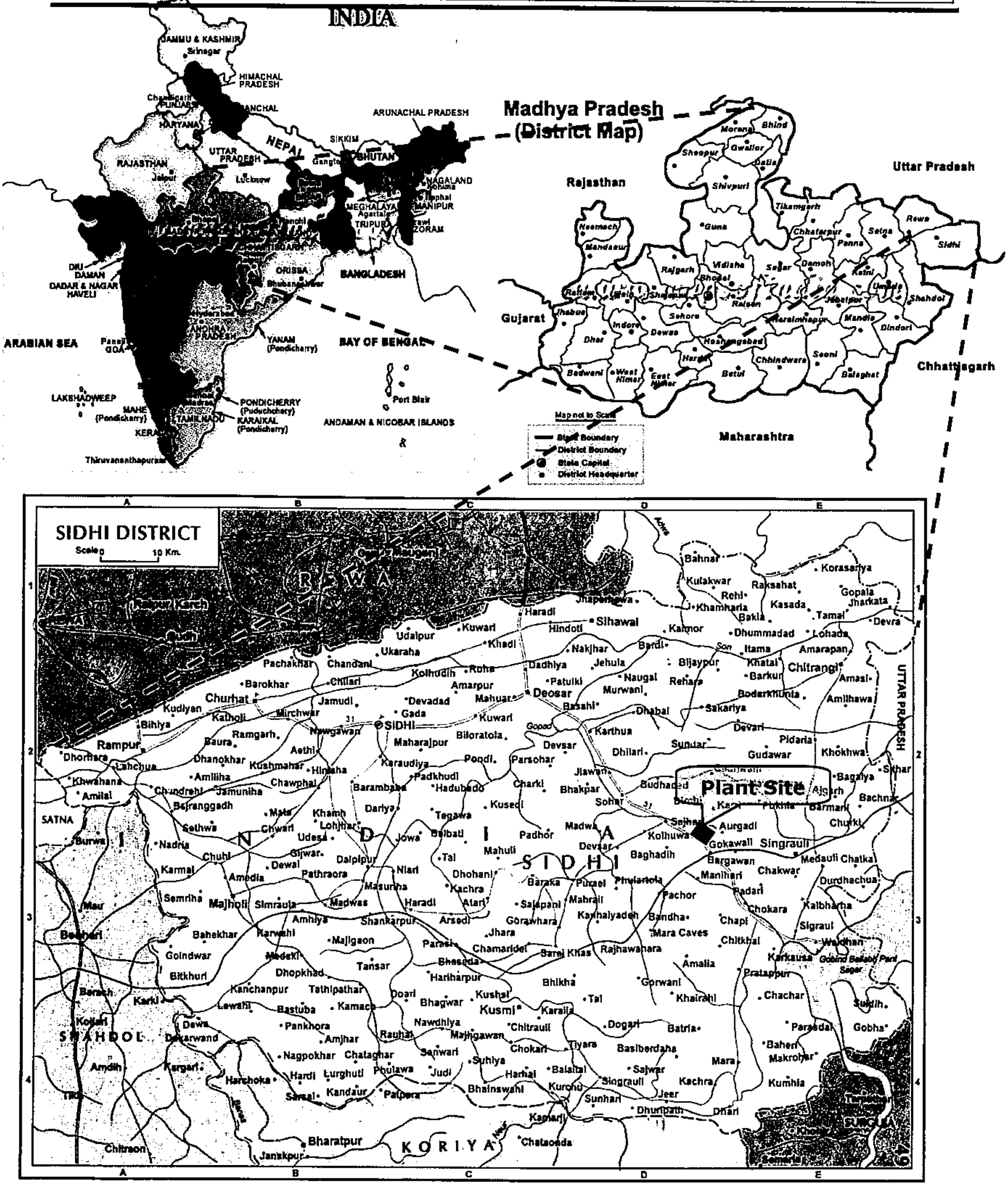
| Sr. No. | Particulars | Details | |
|---|---|---|---|
| | | D \| 24°12'41" N \| 82°26'53" E | |
| 2 | Elevation | 390 to 400 m above MSL | |
| 3 | Nearest habitation | Orgari, Gidher, Dhavalyatola, Barauniya and Barokhar Villages | |
| 4 | Nearest major town | Waidhan (25-km, SE) | |
| 5 | Nearest highway | NH-75 E (0.7-km, SW) | |
| 6 | Nearest railway station | Bargawan (1.8-km, S) | |
| 7 | Nearest airport | Varanasi (280-km, NNE) | |
| 8 | Nearest tourist places | Nil in 15-km radius | |
| 9 | Defense installations | Nil in 15-km radius | |
| 10 | Archaeological important | Nil in 15-km radius | |
| 11 | Ecological sensitive zones | No National Parks, Wildlife Corridors, Bio-Spheres and Sanctuaries exist within 25-km radius form the site | |
| 12 | Reserved/Protected forest | Orgari PF – 0.2 km, N<br>Mohanban RF-4.0-km, WSW<br>Teldah PF – 4.6 km, SE<br>Gidher PF – 2.7-km NW<br>Lohara PF – 4.5-km, NNW<br>Bichhi PF – 6.6-km, N<br>Bori PF-7.8, N | Jiwan RF-5.5-km, NNE<br>Majhigawan PF-7.0 NNE<br>Pachwar PF-9.9-km, NNE<br>Uska PF-6.3-km, E<br>Muher RF-9.2, SE<br>Parihasi PF-4.6-km, NNE<br>Pokhara RF-6.3-km, NE |
| 13 | Nearest streams/Rivers | Kanchan Nadi – 6.0-km, S<br>Khakhan Nadi – 1.2 km, N<br>Jurni Nadi – 4.2 km, W<br>Bandha Nadi – 9.0 km, SW | |
| 14 | Other Industries / Mines | Proposed opencast coal mine project of JAL at Majhauli (8.9-km, SSW) | |
| 15 | Socio-economic factors | Resettlement and Rehabilitation issues are involved and a separate report is prepared for R&R Plan | |
| 16 | Seismic zone | Zone-II as per IS-1893 (Part-1)-2002 | |

### 1.3.4 Details of Project Site

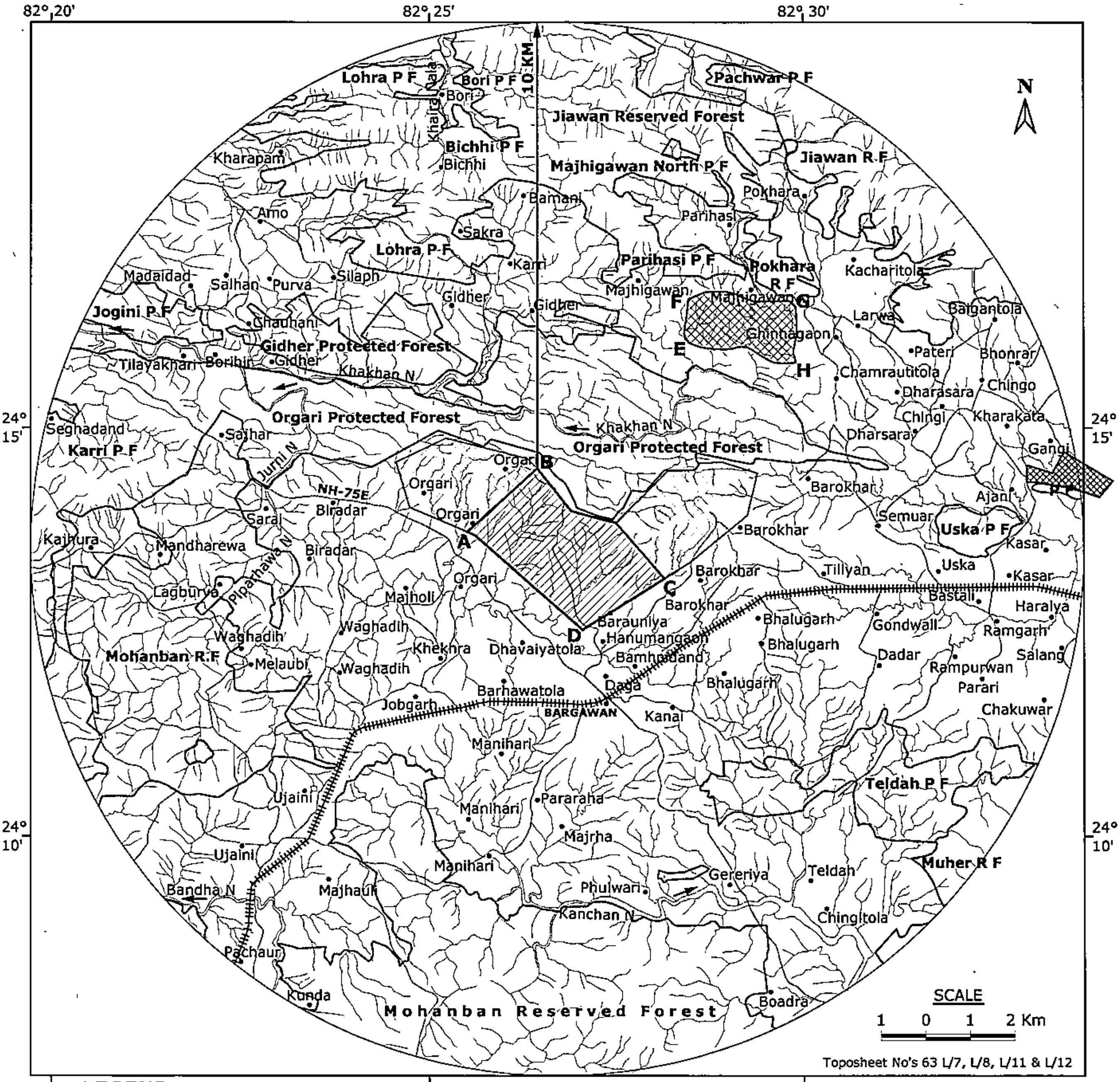
Majority of the proposed project site is barren and agricultural land. Only about 1% of the site is under forest patch. The project involves population displacement and land losers. Detailed Rehabilitation and Resettlement plan is under preparation. A few first and second order streams are passing though the plant site. One village road leading to Orgari forest area is also passing through the site.

### 1.3.5 Importance to the Country and Region

The proposed fully integrated greenfield project is aimed to meet the country's domestic requirements and to earn foreign exchange through exports. This will not only transform the region's economy from predominantly agricultural to significantly industrial but also increases government earnings and revenues, increase exports, provides job opportunities and accelerates the pace of industrial development in the region.




## FIGURE-1.1
## GEOGRAPHICAL LOCATION OF THE PROJECT




82° 20' 82° 25' 82° 30'

**LEGEND**

- Plant Area
- Railway Line
- Road
- Ash Pond
- Township
- R & R Colony
- Settlements
- Forest Boundary
- River/Nalla

**PLANT AREA**

| | | | |
|---|---|---|---|
| A | : 24° 13' 43" N<br>: 82° 25' 31" E | C | : 24° 13' 09" N<br>: 82° 28' 05" E |
| B | : 24° 14' 29" N<br>: 82° 26' 25" E | D | : 24° 12' 31" N<br>: 82° 27' 01" E |

**ASH POND**

| | | | |
|---|---|---|---|
| E | : 24° 16' 05" N<br>: 82° 28' 19" E | G | : 24° 16' 28" N<br>: 82° 29' 54" E |
| F | : 24° 16' 33" N<br>: 82° 28' 21" E | H | : 24° 16' 28" N<br>: 82° 29' 54" E |

**FIGURE-1.2**
**STUDY AREA OF 10-KM RADIUS AROUND PLANT BOUNDARY**

1.3.6 Justification of the Project

- ***Indian Aluminium Market***

The aluminium industry in India is cost competitive in the world aluminium business with the country having abundant reserves of high quality bauxite and cheap pit head coal cost for captive thermal power plants.

The aluminium industry in India has grown progressively, tracking the country's economy over the years. According to CRU estimates, aluminium production will reach 1,113,000 tonnes by calendar year 2008.

The domestic aluminium industry is expected to grow in the coming years, supported by growth in the Indian economy and increased domestic demand in end-user markets. CRU estimates that primary aluminium consumption in India will increase to 1,209,000 tonnes by 2009.

- ***Global Aluminium Market***

Aluminium is a lightweight, durable and corrosion resistant metal that can be extruded, rolled, formed and painted for use in a wide range of applications. According to the International Aluminium Institute, approximately 66% of global consumption is used in the construction, transportation and packaging sectors while the remaining 34% is used in consumer, capital goods and electricity transmission.

Global demand for aluminium has grown consistently at a compounded annual growth rate of 5.1% between 1999 and 2004. Global primary aluminium consumption was approximately 30 million tonnes in 2004 as compared to 27.5 million tonnes in 2003. Driven by strong demand in end-use markets, global demand is expected to rise to 31.8 million tonnes by 2005, before increasing further to 37.7 million tonnes in 2009. The actual and estimated regional consumption of aluminium from 2003 to 2009 is given in **Table-1.3**.

**TABLE-1.3**
**GLOBAL PRIMARY ALUMINIUM CONSUMPTION**

| Regions | 2003 | | 2004 | | 2005 | | 2009 [a] | |
|---|---|---|---|---|---|---|---|---|
| | Volume | % | Volume | % | Volume | % | Volume | % |
| North America | 6465 | 23.5 | 7205 | 23.8 | 7374 | 23.2 | 7907 | 20.9 |
| Western Europe | 6431 | 23.3 | 6677 | 22.0 | 6753 | 21.3 | 7313 | 19.4 |
| China | 4130 | 18.6 | 6006 | 19.8 | 6763 | 21.3 | 9689 | 25.7 |
| Rest of Asia [b] | 5420 | 19.7 | 5918 | 19.5 | 6095 | 19.2 | 7123 | 18.9 |
| Latin America | 941 | 3.4 | 1077 | 3.6 | 1155 | 3.6 | 1383 | 3.7 |
| Middle East | 949 | 3.4 | 1027 | 3.4 | 1087 | 3.4 | 1276 | 3.7 |
| Eastern Europe | 738 | 2.7 | 841 | 2.8 | 880 | 2.8 | 1086 | 2.9 |
| CIS [c] | 735 | 2.7 | 766 | 2.5 | 814 | 2.6 | 1022 | 2.7 |
| Africa | 360 | 1.3 | 392 | 1.3 | 411 | 1.3 | 498 | 1.3 |
| Australia | 384 | 1.4 | 388 | 1.3 | 398 | 1.3 | 454 | 1.2 |
| **Total** | **27553** | **100** | **30297** | **100** | **31730** | **100** | **37751** | **100** |

(a) Estimated; (b) Includes Japan; and (c) Commonwealth of Independent States.
**(Source : Hindalco Industries Limited)**

According to the International Aluminium Institute, primary aluminium production has grown at a compounded annual growth rate of 4.7% per annum from 1999 to 2004. Historically, industrialized nations accounted for a large share of global production. However, changing dynamics in energy availability and the rising cost of alumina have resulted in a shift in aluminium production to countries with access to greater bauxite supplies and affordable sources of power.

Notwithstanding the rise in aluminium production and capacities in the region, aluminium supplies in Asia have lagged behind demand. Given expectations of continued strong growth in China and other Asian markets, the demand-supply gap is likely to widen and is estimated to reach a high of 5.5 million tonnes by 2009.

## 1.4 Scope of the Study

The zone comprising of 10-km radius around the proposed smelter plant and captive power plant complex is considered as the study area. The scope of study broadly includes:

- To conduct literature review and to collect data relevant to the study area;
- Establishing the baseline environmental aspects in and around the proposed project area;
- Identifying various existing pollution loads;
- Predicting incremental levels of pollutants in the study area due to the proposed smelter and power plant operations;
- Evaluating the predicted impacts on various environmental attributes in the study area by using scientifically developed and widely accepted environmental impact assessment methodologies;
- To prepare an Environment Management Plan (EMP), outlining the measures for maintaining the environmental quality in view of future expansion for environmentally sustainable development; and
- Identifying critical environmental attributes that are required to be monitored in the post-project scenario.

Field studies have been conducted from *1st December 2007 to 31st December 2008* representing winter, pre-monsoon, monsoon and post-monsoon seasons of 2008. to determine existing conditions of various environmental attributes. Environmental attributes and frequency of monitoring as outlined in **Table-1.4.** The applicable environmental methodology and analysis for field monitoring are given in **Annexure-II**. The Environmental legislations are given **Annexure-III.**

## TABLE-1.4
## ENVIRONMENTAL ATTRIBUTES AND FREQUENCY OF MONITORING

| Sr. No. | Attributes | Parameters | Frequency |
|---|---|---|---|
| 1 | Ambient Air Quality | SPM, RPM, $SO_2$, $NO_x$, Fluoride, PAH and CO | The monitoring was carried out at 8 locations at a frequency of 24 hourly samples twice a week for nine months. CO samples were collected on 8-hour basis. |
| 2 | Meteorology | Wind speed and direction, Temperature, Relative humidity and Rainfall | a] Continuous with hourly recording through setting up of on-site meteorological station for one year<br><br>b] Data collected from secondary sources like IMD station at Sidhi |
| 3 | Water quality | Physical, Chemical and Bacteriological parameters at 13 locations. | Eight ground water and five surface water samples collected in three seasons during the study period. |
| 4 | Ecology | Existing terrestrial and aquatic flora and fauna in 10 Km radius circle. | Through field visits during winter and summer seasons. |
| 5 | Noise levels | Noise levels in dB(A) at 8 locations. | Once during study period at eight locations in three season during study period. |
| 6 | Soil Characteristics | Parameters related to agricultural and afforestation potential at 8 locations | Once during study period at eight locations in three seasons during study period |
| 7 | Land use | Trend of land use change for different categories | Based on data published in latest published district census handbooks and also through remote sensing studies ( satellite imagery ). |
| 8 | Socio-Economic aspects | Socio-economic characteristics, labour force characteristics, boom town effects. | Based on data from latest published district census handbooks. |
| 9 | Geology | Geological history | Based on data collected from secondary sources. |
| 10 | Hydrology | Drainage area and pattern, nature of streams, aquifer characteristics, recharge and discharge areas | Based on data collected from secondary sources. |
| 11 | Risk assessment and Disaster Management Plan | Identify areas where disaster can occur by fires and explosions and release of toxic substances | Based on Assessment. |
| 12 | Existing Pollution Aspects | Identification and quantification of pollution sources with respect to air emissions, water effluents and solid waste | - |

# 2.0 PROJECT DESCRIPTION

This chapter highlights the features of the proposed aluminium smelter, Captive Power Plant (CPP), its layout and design, details on the process, raw material requirement, utilities and services, infrastructural facilities and sources of waste generation, their quantity, treatment and disposal of the waste.

## 2.1 Proposed Project

The proposed project is a greenfield integrated aluminum project which will include:

- 3,25,000 TPA (Primary Aluminium Metal) Aluminium Smelter;
- Captive Power Plant of 750 MW generating capacity;
- 35-km length of water pipeline and about 8-km length of ash pipeline; and
- Township and other infra-structural facilities in about 373.76-ha area.

## 2.2 Size or Magnitude of Operation

The size/magnitude of operation of the proposed greenfield integrated aluminum complex project for production of primary aluminium metal are given in **Table-2.1**.

**TABLE-2.1**
**SIZE / MAGNITUDE OF OPERATIONS OF THE PROJECT**

| Sr. No. | Description | Details |
|---|---|---|
| 1 | Aluminium production capacity | 3,25,000 TPA Ingots |
| 2 | Captive power generation | 5 x 150 MW (750 MW) |
| 3 | Total land requirement | 1500-ha |
| 4 | Water requirement | 4600 $m^3$/hr (45.12 cusec) |
| 5 | Power requirement | 549 MW |
| 6 | Alumina requirement | 6.4 LTPA will be sourced from captive alumina refineries from Orissa/Jharkhand |
| 7 | Fuel requirement | |
| | Coal | 3.5 MTPA from Mahan Coal Ltd |
| | Fuel oil | 56,353 TPA |
| 8 | Manpower requirement | 1495 personnel |

## 2.3 Proposed Schedule and Approval for Implementation

### 2.3.1 Proposed Schedule for Implementation

The implementation period for various segments of the project is as follows (all dates/time mentioned here is w.r.t. Zero date):

- ***Aluminium Smelter***

| | |
|---|---|
| Mechanical completion (168 pots- Part) | : 32 months from zero date |
| Mechanical completion (336 pots- Comp.) | : 38 months from zero date |
| Commissioning (168 pots- Part) | : 34 months from zero date |
| Commissioning (336 pots- Comp.) | : 41 months from zero date |

- ***Captive Power Plant (Power Generation)***

| | |
|---|---|
| Unit 1 | : 30 months from zero date |
| Unit 2 & 3 | : 33 / 36 months from zero date |
| Unit 4 & 5 | : 39 / 41 months from zero date |

2.3.2 Approval for Implementation

The establishment of proposed greenfield integrated aluminum complex project activities will be commenced after getting Environmental Clearance from the MoEF New Delhi and Consent for Establishment (CFE) Madhya Pradesh State Pollution Control Board.

## 2.4 Technology and Process Description

2.4.1 Technology Description

Plant smelter technology will be of latest high amperage cells in view of productivity, efficient process and environmental control, lower specific energy configuration, etc. such as latest state of art AP-35 technology for Aluminium Pechiney (ALCAN Group) of France.

Hindalco will be using pre-bake cell technology with 360 KA current in aluminium smelter. The technology requires multiple anodes in each cell which are pre-baked in a separate facility and attached to rods that suspend the anodes in the cell. New anodes are exchanged for spent anodes. 'Anode butts' are recycled in the process of forming new anodes.

- ***General Specifications***

| | | |
|---|---|---|
| 1 | No of potlines | : 1 |
| 2 | Total no. of pots in operation | : 336 |
| 3 | Potline amperage | : 360 |
| 4 | Current efficiency (%) | : 94.5 |
| 5 | Specific alumina consumption (t/t) | : 1.92 |
| 6 | Net carbon consumption (kg/t) | : 415 |
| 7 | Average energy consumption (kWh/t) | : 13500 |
| 8 | Average pot voltage (v) | : 4.28 |
| 9 | Gross carbon consumption (kg/t) | : 533 |
| 10 | Nominal liquid metal production (kg/day) | : 2663 |
| 11 | Metal production/year (MT) | : 325000 |

2.4.2 Process Description

The general principles of the latest state of art Pre-baked AP35 technology are summarized below. The process flow diagram is shown in **Figure-2.1**.

Alumina is dissolved in molten cryolite (bath) at a temperature of about 950°C-960°C and DC current is passed through molten electrolyte for the reduction of alumina to form liquid aluminium at the cathode and oxygen collects at the anodes, where it combines with carbon. The process is continuous in nature. The pots are the point feeding type using pre-baked anodes.

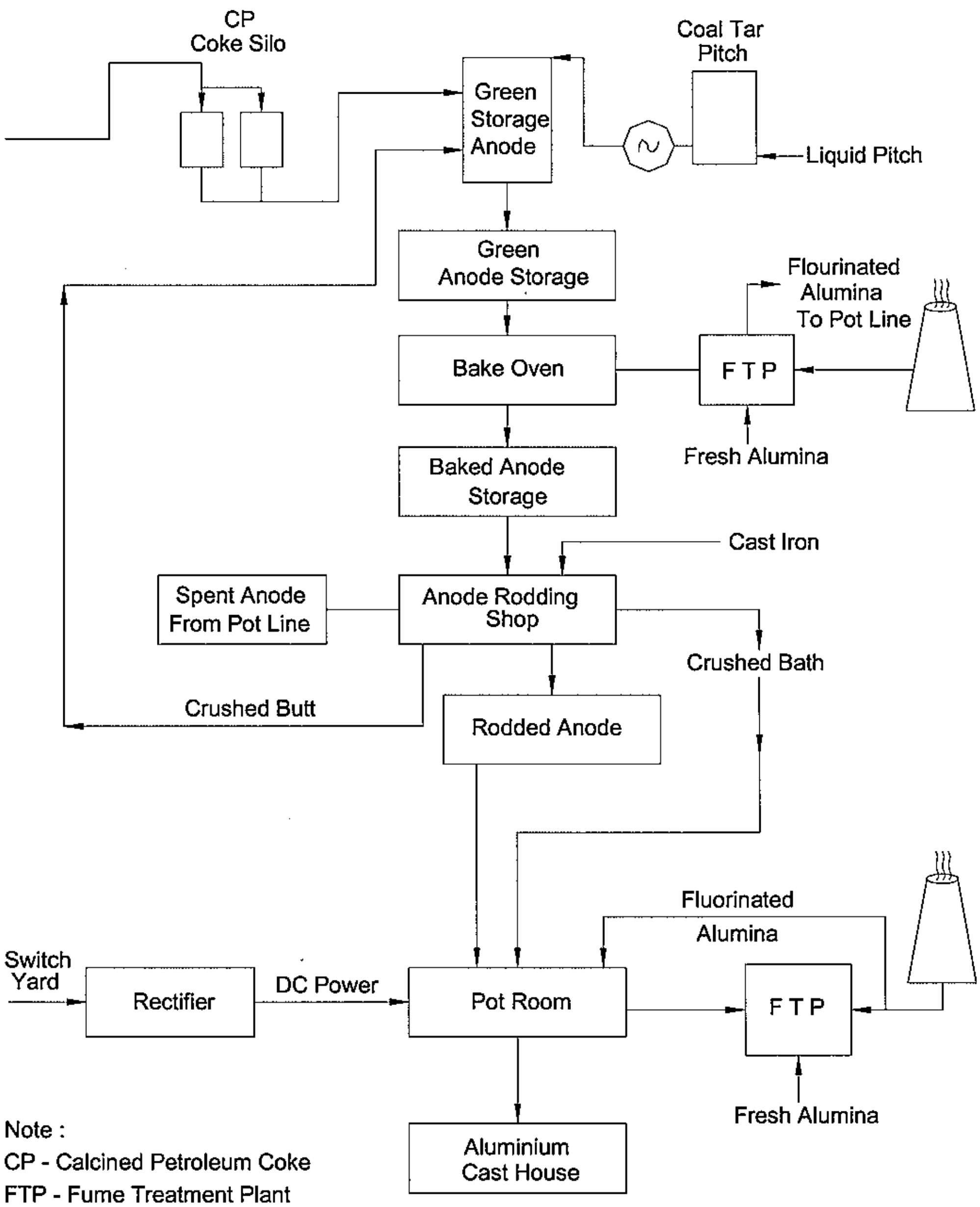



**FIGURE-2.1**
**PROCESS FLOW DIAGRAM OF ALUMINIUM PRODUCTION**

The liquid aluminium accumulates within the cathode cavity, which is lined with carbon material along with a refractory outer layer contained within a steel pot shell. The accumulated liquid metal is periodically siphoned from the pots into refractory lined ladles and transported to the cast house to form finished product.

The oxygen separated in the reduction of alumina reacts with carbon causing the anodes to be consumed. Periodically the consumed (spent) anodes are changed and replaced by new anodes. During the anode changing operation, the spent anodes along with bath crust are removed by specialized grabs fitted with cranes. A predetermined quantity of anode covering mix is added to the top and sides of the new anode after changing the spent anodes with new anodes.

Spent anodes are cooled and processed to remove the bath crust. The spent anode is further sent to rodding shop for removing the carbon part, which is recycled again as input material for new anodes. The bath crust is crushed and transported back to the pot line for the new anode covering material.

The alumina content in the molten electrolytic bath is kept within a set range by means of an automatically controlled feeding system. This alumina is transported from the Gas Treatment Centers (GTC) where it reacts with the pot off gases to adsorb the fluoride gas generated during electrolysis process. The entire pot exhaust gases and particulates are collected and cleaned at the GTC and the reacted alumina is recycled back to the pots. The addition of solid fluorinated products (in the form of aluminium fluoride, crushed bath) is required to maintain bath chemistry.

Cathode linings have a limited service life of approximately 60 months. For delining and relining the pot shell containing the spent lining is removed and transferred to delining shop and replaced by a reconditioned pot shell containing a new lining.

Carbon anodes are produced from petroleum coke, recycled spent anodes and liquid coal tar pitch. The solid carbon components are crushed and sized, blended with hot liquid pitch and mixed to form a dry green paste. The paste is then vibro-compacted to form green anode blocks that are cooled by water spray prior to natural cooling in the storage and handling station. Coal tar pitch volatiles are recovered in the pitch fume treatment plant to control environmental pollution.

The green anodes are then transported to an anode baking furnace, where it is heated to around 1200°C and converting (coking) the pitch and carbon into baked anode suitable for the electrolytic reduction process. After the heating process is complete, the baked anodes undergo a controlled cooling cycle prior to their removal from the anode baking furnace pits. Baked anode are cleaned and transported to interim storage before being transported to the rodding shop. Off gases, from the anode baking process containing fluoride are cooled with water sprays and reacted with fresh alumina in Fume Treatment Plant where the fluorides are absorbed. The reacted alumina is periodically transported back to the pot line for use as pot feed.

## 2.5 Project Description

### 2.5.1 Main Facility and Equipment for the Project

#### *2.5.1.1 Constitution of an Electrolytic Pot*

The main items representing the electrolytic cells are as follows:

- The pot shell is a rugged steel structure designed to contain the cathode lining and molten aluminium metal and molten bath;
- The cathode lining is made up of refractory and insulating materials under side of the bottom (cathode blocks) and the upper sidewalls. Steel conducting bars are joined in the cathode blocks using molten cast iron / paste to provide a current conducting path from the molten aluminium metal pad to the cathode bus bar;
- The superstructure fulfils several functions including support for the anode assemblies anodic system, bus bar beam to flow DC current and alumina hoppers. Jacking mechanism is to control vertical movements of the anode beam (to control pot resistance), and programmed pot feeding via crust breaking and feeding devices: and
- The automated process control and command system.

#### *2.5.1.2 Pots*

Direct current from the main substation is supplied from rectifiers through large aluminium conductors (bus bars) joined electrically from one pot to the next to form the series connection of the pot line. The size and positioning of the bus bars are designed to optimize current distribution and minimize magnetic field effects. The cathode bus bar system is located under the operating floor, around and under each pot. These conductors include:

- Flexible conductors that join the steel collector bars to the cathode bus bars;
- Pot to pot cathode bus bar; and
- Flexible anodic risers connected to the aluminium anode beams of the pot superstructure.

The pots are arranged side by side and consist of:

- Rigid steel shell with lining designed to contain the molten aluminium and electrolyte (bath);
- The cathode consists of 20 carbon blocks, each containing two sets of split collector bars joined to the cathode with cast iron to conduct the current from the cathode to the next pot via aluminium conductors. Refractory and insulating bricks provide the necessary thermal insulation of the cathode;
- The steel superstructure is fixed on the shell through insulating supports. The superstructure supports the entire anode system includes anode beam jacking system, the anode assemblies and clamping systems to ensure electrical continuity and even current distribution. This also contains the pot feeding system, alumina and aluminium fluoride storage, hooding and pot gas collection system;

- Alumina hoppers are integrated in the superstructure of each pot and are continuously supplied with fluorinated alumina by the HDPS;
- Pot off gases are collected within the superstructure and directed to an insulated pot collector duct joining the main GTC duct through orifice plates;
- All superstructure services are provided via electrically insulated / isolated connections for compressed air, anode motor power and controls power;
- Each pot is equipped with 20 / 40 anode assemblies comprising an aluminium rod connected to the aluminium anode beam via isostatic clamps. A steel bracket having six (6) steel pins welded with anode beam. The six (6) steel pins are sealed by cast iron to the two (2) carbon anode blocks;
- Each pot is equipped with a hooding system consisting of aluminium panels placed into the superstructure to enable pot operations and to prevent fumes to go outside;
- Each pot is equipped with a metallic door on the operating aisle to allow metal tapping, bath tapping and pot sampling;
- The removable floor slabs, and floor gratings are supported by the pot shell and the main floor framework of the building and form the working floor around the pots; and
- Each pot will be equipped with a pot microcomputer (pot micro) for standalone Level 1 automation control. Each pot room is connected to a Level II system in the main pot line control room.

*2.5.1.3 Reduction Buildings*

Aluminium smelter plant will consist of a single pot line, with 336 pots in operation in two separate buildings, with a central and end passageways linking the pot room buildings together. Separate entry points are provided at regular locations along each pot room to allow entry and movement of metal vehicles and anode transport vehicles.

Two independent Gas Treatment Centers (dry scrubbing system) will be located between the two pot room buildings. Each GTC will be connected to one half of the installed pots. Fresh alumina from the storage silos is transferred to the Gas Treatment Centres. The exhaust gases from the pots are sucked by exhaust fans and passed through reactor where the fresh alumina adsorbs the fluorides from the pot gases. These gases are then passed through bag filters before they are released into atmosphere through 80 m stack. The reacted alumina (fluoride rich) is stored in the silos at the outlet of the GTC. This reacted alumina is then supplied to the pots through an air slide system; thereby ensuring the fluoride is completely recycled. The air slide ensures that there is no generation of fines during transfer and it is completely closed system. Entire GTC and alumina HDPS is controlled through Central Process Computer to ensure stable operation. GTC is provided with spare exhaust fan to ensure uniform suction rate of 2.3 $Nm^3/s$ from all pots continuously. Continuous dust and HF monitors will be provided at the outlet of each stack.

Reduction area offices will be located in the pot line services buildings to provide production process and service support management for the pot line, GTC's and pot line services. The pot line design incorporates maximum natural ventilation around the pots. The pot line will be operating at 350 kA + 10 kA and around 1458 V(DC). The maximum design operating voltage is 1560 V(DC).

The central passageway is specifically designed to operate a crane transfer gantry to allow transfer of PTA's to and from a maintenance bay and to move pot shells to and from the delining / relining buildings using the heavy lift crane. The two (2) end passageways connecting the pot room will be around 15-m wide and provide storage areas and maintenance of pot tending equipment.

#### *2.5.1.4 Pot Tending and Servicing Assemblies*

Specialized overhead travelling cranes called pot-tending assemblies (PTAs) are used to carry out following operations:

- Changing anodes, including crust breaking, anode assembly removal, accurately repositioning the new anode and cleaning the anode cavity prior to placing the new anode;
- Covering new anodes with a mix of crushed bath and fluorinated alumina;
- Liquid metal tapping by siphoning into a ladle carried by the PTA and breaking the crust to allow the tapping pipe to be inserted;
- Periodic raising of the anode beam using Beam Raising Jig carried by the PTA; and
- Feeding of pot hopper with aluminium fluoride.

By use of above specialized cranes, the entire operations are carried out using the crane with minimum manpower. The pot door open time is also reduced to keep the fugitive emissions to lowest possible levels. Each PTA will be capable of being used in either pot room. A crane transfer gantry is used to:

- Move PTA's between the pot lines; and
- Move the heavy lift crane carrying spent and newly lined pots from the pot line to the delining and relining facilities.

#### *2.5.1.5 Gas Treatment Centres (GTC)*

The GTC is designed to treat the fumes coming out from Pot line comprising 336 pots. There shall be two GTC each catering to 168 Pots. Each of the GTC units will consist of following main components.

- Pot room ducting;
- Bag filters;
- Main fans, with standby exhaust fan;
- Stack;
- Fresh alumina storage silo;
- Fluorinated alumina storage silo and transport system;
- Electrical, instrumentation and control system;
- HF and dust monitoring system; and
- PLC control system.

- ***Pot Room Ducting***

The delivery of the pot room ducting system will start at the pot outlet flanges and will include isolating sleeves, regulating devices, expansion joints, ductwork and supports. The fume exhaust flow from each pot, at hood outlet, is estimated at ~2.3 $Nm^3/s$ at 105ºC-115ºC.

- ***Bag Filter System***

The bag filter system will consist of compartments to handle approximately 1,500,000 $Nm^3/hr$ in each GTC. A compressor with dryer for bag pulsing will be included, with plant air as emergency standby.

- ***Main Fans***

Six high capacity exhaust fans are proposed (5 working + 1 stand by) for each GTC. The fans will be supplied with expansion joints and variable multilouver inlet dampers. Multilouver outlet dampers will also be supplied.

- ***Fluorinated Alumina Facilities***

Fluorinated alumina is produced in the GTC's during the contact of the pot off gases and fresh alumina. Fluorinated alumina is transported by airlift and air slide to two 1,000 tonnes silos located between the pot rooms and discharged to each pot using the HDPS (Hyper Dense Phase System). The HDPS will be located on the narrow aisle side of each pot room. The silos will have truck-unloading stations for material returned from the anode baking fume treatment centre and for emergency supply of fresh alumina.

- ***Fresh Alumina Facilities in Pot Line***

Fresh alumina is transported by belt conveyor from the railway unloading station to the two (2) silos having capacity of 13,500 tonnes located at the outboard of the pot rooms. Alumina is extracted through conical fluidized silo bottom at the centre of silo and conveyed through airlifts and air slides. One alumina flow meter shall be installed at the battery limit of each GTC to send metered quantity of alumina in GTC.

*2.5.1.6 Pot Room Gas Treatment System*

- ***Gas Treatment Technology***

It is proposed to install latest dry scrubbing technology to treat the pot room fume. Before the pot room fume containing fluoride goes from the main fume duct to the bag filter, add the fresh alumina and circulated alumina into the reactor and main fume duct respectively. Due to sufficient contact of the two phases of gas and solid, the hydrogen fluoride is adsorbed by the alumina and the enriched alumina and the dust entrained with the pot room fume is separated in the bag filter for returning to the pots for reuse. The purified fume is sent by the exhaust fan to the stack for emitting to the atmosphere. Analysers for monitoring fluoride and Particulate Matter in stack gases shall be provided. The typical flow diagram of Gas Treatment Center (GTC) is shown in **Figure-2.2.**

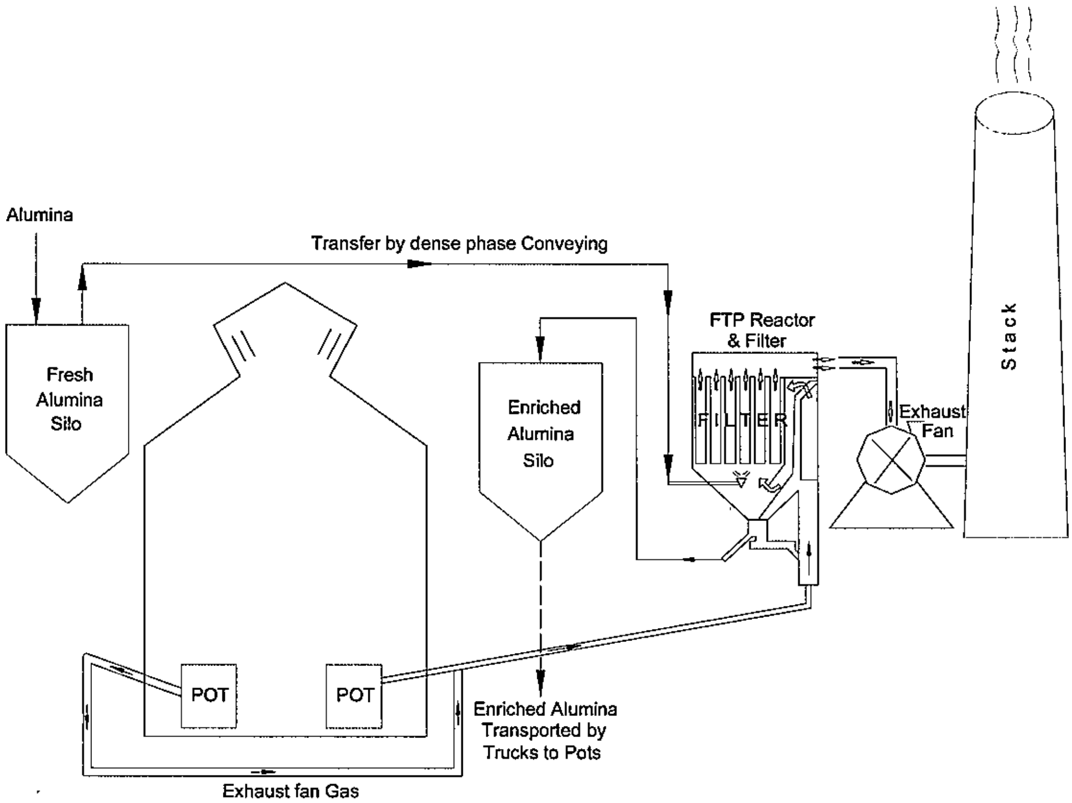



**FIGURE-2.2**
**TYPICAL GAS TREATMENT PLANT**

- ***Layout of Dry Scrubbers***

Two sets of dry scrubbers will be provided in the project, which will be arranged in between the two pot room buildings with a distance of 85-m. Each dry scrubbing system will be composed of two parts:

> **Fume Treatment**

All pots will be closed with cover plates and each will be having gas collection hoods. The duct connected to individual pot cells will be connected to the main horizontal duct pipe to carry the emitted gas to the reactor. There will be a cross flow of alumina and gas in the reactor where fluoride gas will be adsorbed on alumina particles, which will then be separated by bag filters. The alumina will be finally charged to pots and the purified gas will be released to atmosphere through stacks. The purified fume will be discharged into the atmosphere through an 80-m high stack.

> **Material Supply and Discharge for Dry Scrubbing**

The material supply and discharge system of the dry scrubbing system includes the conveyance of fresh alumina and circulated alumina. The fresh alumina from the fresh alumina silo of potroom is sent through the air slide and impact flow meter to the reactor where it contacts and reacts with the hydrogen fluoride gas. The circulated alumina is the enriched alumina reclaimed from the bag filter, part of which is sent to the enriched alumina silo through the air slide and air lifter so as to be used by the pots and the other part is returned to the fume duct for the circulating absorption reaction.

*2.5.1.7 Cathode Sealing Shop*

The cathode sealing facility is located adjacent to the rodding shop and contains the equipment required to seal the steel collector bars with the cathode blocks and has induction furnace to produce liquid cast iron used for sealing.

*2.5.1.8 Lining-Delining Shop*

In pot delining area the spent cathodes and refractory material are removed from the pot shell using an excavator. Pot shells are moved in and out of this building using a heavy lift crane.

In pot relining area pot shells receive a new refractory lining and new cathode blocks. The cathode ramming is done using TEPID type paste using ramming machine. Lining during construction will be completed in-situ in pot rooms.

- ***Lining Paste Reheating Shop***

Lining paste is a semi plastic carbon paste that is used to seal the gaps between the cathode blocks and side blocks. The material will be pre-conditioned to about 50°C prior to use and a separate heating room adjacent to the relining facility will be required.

*2.5.1.9 Ladle and Pipe Cleaning Shop*

The metal ladles, bath ladles, tapping pipes build up solid deposits of metal (sometimes frozen with aluminium) and bath are to be cleaned at regular intervals. These operations are carried out in the ladle cleaning shop. Ladles will be transported to and from this facility by metal transport vehicles.

The facility will consist of a ladle-cleaning machine that is capable of hot / cold cleaning metal ladles and bath ladles and will include lifting and rotating tables, and ladle holding capture system.

Tapping and siphoning pipes will require suitable maintenance stands, access platforms and lifting equipment for disassembling and reassembling cleaned ladles and pipes require heating after cleaning and prior to use in the pot lines to prevent molten metal explosions due to moisture.

Facilities will be provided to allow adequate pre-heating the ladles and pipe sets post cleaning and prior to use in the pot line.

*2.5.1.10 PTA Maintenance Shop / Pot line Equipment Maintenance Shop*

A separate building will be provided for maintenance PTA's. The facility will have adequate length to accommodate PTAs. Mobile access platforms, specialized stands for PTA tool modules, lifting equipment and general maintenance equipment have been considered for this shop.

Adjacent to the PTA maintenance facility an area for de-dusting the PTA's prior to maintenance has been considered. PTA's will be moved in and out of this area on the same type of rail system as the pot line and segmentation of the crane collector rail is required to ensure the proper isolation of PTA's and other cranes during cleaning and maintenance.

A pot line equipment maintenance facility has been considered along with PTA Maintenance Shop (integrated). This facility will house general maintenance equipment for the servicing of different super structure components.

2.5.2 Cast House

The cast house is designed to handle maximum annual liquid aluminium of 3,25,000 tonnes. An average of 75 metal ladles of 12 tonnes capacity each, will be transported each day by metal transport vehicle.

The metal preparation will consist of five 55 tonnes capacity electrically heated holding cummelting furnaces. Molten metal in crucibles received from the pot lines will be emptied using a siphoning process. The holding furnaces will then be tilted to feed the ingot casting machines. The skimming of the molten metal inside the holding furnace will be done with furnace tending vehicles.

The ingot production will consist of:

- A casting wheel;
- Ingot cooling chain; and
- A robotic stacking and strapping station.

A water-cooling and recycling facility will be provided to chill the ingots prior to de-moulding. The dross treatment will consist of dross presses located within the cast house building.

## 2.5.3 Carbon Area

### *2.5.3.1 Green Anodes*

The green anode consists of petroleum coke and recycled carbon products bonded together with liquid pitch. The carbon product-recycling rate will depend on the net carbon consumption on the pot and will be in the range of 20% to 30%. The pitch content will vary according to petroleum coke characteristics and will be in the range of 13% to 16%. This shop produces the green carbon blocks in four (4) successive stages.

In the green anode plant, pitch vapours (which contain PAH) are scrubbed with coke fines and then recycled into the green anode production. Hence, there would be practically no emissions of pitch vapours into atmosphere.

**Green Anode Paste Plant**

Facilities at paste plant include:

- Storage and handling facilities for receipt of C.P.Coke and Pitch;
- Crushing and classification of C.P.Coke and recycled anode butts into different sizes;
- Proportioning, heating, mixing and cooling;
- Liquid pitch distribution during mixing stage;
- Thermic fluid heating (electrically or by oil fired burners) and distribution of heated fluid to pitch handling and storage and dry product heating stage;
- Dust collection and bag filters; and
- Pitch fumes collection and treatment facilities.

**Anode Forming and Cooling Shop**

The shop consists of anode forming by vibro-compacting with desired output of 32 to 38 green blocks/ hour. The anodes would thereafter be cooled by circulating water before they are transferred to the storage area.

### *2.5.3.2 Anode Handling and Storage Shop*

This shop is designed to provide:

- The necessary green anode storage capacity to make up for deviations in production rates in paste plant and baking shop. Minimum safety stock will be 10 days of green anodes consumption; and

- The necessary baked anode storage to make up for deviations in production rates in baking shop and the anode rodding shop. Minimum safety stock will be 10 days of baked anodes.

### 2.5.3.3 Anode Baking Furnace

The baking process consists of calcining the pitch binder into coke. The anodes are baked in a single open type furnace of 66 sections with four (4) sets of fire. The fire will be fuel oil fired.

Both green and baked anode handling in the baking shop will be made with a conveyor running down the center of the two (2) furnace bays from the anode handling and storage facility to the current working sections. Anodes shall be handled with the help two no Furnace Tending Assemblies.

### 2.5.3.4 Anode Baking Furnace Fume Treatment Plant

The anode-baking furnace is connected to a fume treatment facility in order to:

- Maintain a constant draft required by the baking process; and
- Scrubbing of fumes generated by the baking process.

The fume treatment facility consists of:

- Contacting furnace off gases in a water spraying cooling process;
- Contacting cooled off gases in a dry scrubbing process using fresh alumina to adsorb the fluorides; and
- The fresh alumina required by the scrubbing process is trucked from the main alumina silo to the day silo near treatment area and then trucked back from the fume treatment centre to fluorinated silo.

**Baking Furnace Fume Treatment System**

The proposed baking furnace is state-of-art open ring type with auto firing and computerized temperature control system. The fume from baking furnace contains tar fume and dust. It is used in the up-to-date open ring type baking furnace and the volatile matters and tar could be controlled sufficiently and efficiently, so that the fume amount and pollutants content could be reduced effectively. The firing system will be controlled using a PLC controlled unit to regulate oil flow and ensure uniform heating of the flue walls.

It is proposed to use the treatment measure of dry type filter for the tar, dust contents of the fume. The baking furnace fume goes into the pre-precipitator firstly for removing the coarse dust, and then it is cooled by the spray-cooling device. After that, it enters into the dry type tar trap for removing the tar and dust the fume. The purified fume is released through stack.

### 2.5.3.5 Anode Rodding Shop

The anode assembly rodding shop consists of:

- Bath cleaning (2 stages pre-cleaning then finishing);
- Carbon butt shot blasting;
- Carbon butt stripping from the stem bracket assembly;

- Cast iron thimble stripping;
- Recycling the cast iron coming from thimble strippers;
- Melting the cast iron using induction furnaces;
- Aligning the anode assembly with the carbon block;
- Pouring cast iron to rod two (2) carbon blocks on a single stem bracket assembly;
- Overhead conveyors within the shop will transport the anode assemblies.

*2.5.3.6 Anode Assembly Storage*

The storage of anode assemblies fulfils the following functions:

- Storage and cooling of spent anode assemblies coming from the pot room (Approximately 24-32 hours);
- Storage of new anode assemblies coming from the rodding shop (24 hours inventory on pallet);
- Storage of stem bracket assemblies to and from outside repair; and
- Storage and cooling of crust bath bins coming from the pot room (24-32 hours).

The anode assemblies arrive in set of three (3) per transport pallet. The shop design provides adequate cooling of the spent anode assemblies.

*2.5.3.7 Bath Recycling Shop*

The bath recycling shop will process and recycle the bath coming from the pot room in following modes:

- Bath from the spent anode assembly cleaning process; and
- Bath from the bath crust bin.

The operations carried out are:

- Crushing using a semi autogenous mill and grain sizing;
- Aluminium and iron sorting as non-crushable materials from the mill; and
- Storage of crushed products in bath silo.

*2.5.3.8 Carbon Recycling Shop*

The carbon recycling shop will process and recycle the carbon product coming from pot room and carbon facilities in all various forms. Materials include:

- Scrap green anodes;
- Scrap paste;
- Scrap baked anodes; and
- Butts from carbon stripping machines.

The operations carried out are:

- Crushing;
- Iron sorting; and
- Storage of carbon products (2 qualities).

Both green and baked recycled products are transported to the paste plant by belt conveyors.

### 2.5.4 Description of Proposed 750 MW Captive Power Plant

The Captive Power Plant will be coal based and have an installed capacity of 750 MW (5 x 150 MW). The CPP will be located in the aluminium smelter complex.

#### *2.5.4.1 Power Generating Equipment*

- ***Thermodynamic Cycle***

To achieve efficiency without sacrificing availability, it is considered to limit the choice of steam parameters within the sub-critical range, in line with the established practice of most of the manufacturers of 150 MW units.

The fuel considered for the captive power plant is coal from the captive Mahan coal mine. The thermodynamic cycle will consist of the boiler, (steam generator), the steam turbine, the condenser, the condensate boiler feed systems, the condensate and feed water heaters along with all other necessary equipment for single reheat regenerative feed heating. A single reheat steam cycle with regenerative feed heating system is proposed.

The main steam from the boiler, after expansion through the HP turbine, would be sent back to the respective boiler for re-heating. The reheated steam, after expansion through the single casing double flow IP and LP turbine would be exhausted into the main condenser.

The exhaust steam from the LP turbine would be condensed by circulation of cooling water. Vacuum would be maintained by two (2), (1 working + 1 standby) 100% capacity vacuum pumps. A third vacuum pump would be considered for start-up. The LP feed heating system would consist of three (3) stages of low pressure heaters, one (1) gland steam condenser, one (1) drain cooler for the low pressure heater, drain flash and one (1) deaerator. The condensate from the hot well would be extracted by 2 x 100% capacity condensate extraction pumps (1 working + 1 standby) and pumped to the deaerator through gland steam condenser, drain cooler and the LP heaters. The feed water after being deaerated in the deaerator would be pumped to the boiler through the high-pressure heaters.

Provision would be kept for dosing hydrazine solution in the condensate extraction pump discharge and in deaerator feed tank or boiler feed suction line for oxygen scavenging and pH control of the feed condensate steam cycle. For each unit three (3) 50% capacity motor-driven boiler feed pumps (2 working + 1 standby) are envisaged.

The boiler feed pumps would be provided with lube oil system, automatic leak off and minimum flow re-circulation valves. Pumps would be provided with modulating variable speed hydraulic coupling. Condensate drain from the HP heaters would be cascaded to the deaerator feed storage tank and the condensate drains from the LP heaters would be cascaded to the condenser through the drain cooler.

The auxiliary steam for the station would be drawn from a suitable point of the boiler and after pressure reduction and de-superheating would be used for various services. The auxiliary steam supply system of the units would be interconnected and this would supply steam to the deaerators, turbine gland sealing system during light load and start-up conditions. Auxiliary steam will also be supplied to the fuel oil heating, atomisation system etc. Provision for steam supply to auxiliary steam system from cold reheat piping through pressure reducing and desuperheating station would also be provided.

Each unit will also be provided with HP and LP Turbine bypass system for quick start and large load rejections. The turbine generator unit would be so designed that it will be capable of cyclic duty and frequent start-ups and shutdowns during its lifetime. The salient features and parameters of major equipment of the 150 MW units are furnished hereinafter. The details of the units may vary to some extent as per vendors' standard product. The basis of technical parameters of the main plant and auxiliary equipment for 5 x 150 MW captive thermal power plant are discussed hereunder which describes the general requirements but is not intended to be exhaustive.

- ***Turbine Generator Unit***

The steam turbine would be standard multi-stage, multi-cylinder, tandem compound, single reheat, condensing type machine operating at 3000 rpm with minimum of six (6) uncontrolled extractions for regenerative feed heating. The turbine will be designed for main steam inlet parameters of around 13.24 MPa(a) pressure and 535°C (±5°C) temperature before the emergency stop valves of the HP turbine, reheat steam temperature of 535°C (±5°C), IP turbine inlet with a design exhausting condenser pressure of 76 mm Hg (abs.) with design condenser cooling water temperature. A two cylinder machine having combined HP / IP sections (opposed flow) and a double flow LP cylinders exhausting steam directly into the spring mounted surface type, two-pass condenser having divided water box is envisaged. Any other proven configuration may also be considered. The turbine-generator set would be designed for a maximum throttle steam flow at turbine valve wide open (VWO) condition of 105% of turbine Maximum Continuous Rating (MCR) flow.

Five (5) nos. steam turbine sets complete with all auxiliaries, accessories and controls for driving electric generator sets of 150,000 kW each operating on unit system with independent steam generator feeding the respective turbine are considered for the station.

The unit would be capable of generating at MCR and also with valves wide open (VWO) conditions continuously with maximum cooling water temperature of 32°C and 3% make-up to the heat cycle. It would also be capable of operating continuously under HP heaters out of service condition generating rated output. The design of the turbine would be based on the maximum pressure and temperature it is subjected to. The rotors would be dynamically balanced and heat stabilized with thermal deflection within prescribed limits of relevant codes. The steam turbine generator set will be equipped with hydraulic / motorized turning gear for uniform heating / cooling of the rotor during start-up / shut-down. Electro-hydraulic control system with redundancy in control and protection circuit should be provided with suitable hardware to ensure high speed of operation and safety.

Scope of supply of the Steam Turbine and Generator would be inclusive of, but not limited to, suitable emergency stop valve, reheat stop valve, interceptor valve, turbine control valves, HP - LP steam turbine bypass system, piping, all special insulation, spring supports, paints etc. Other protective devices like emergency governor, emergency hand trip, unloading gears, vacuum breaker etc. as required for a modern utility plant would be provided. The sets would be complete with self-contained control oil, lube oil, seal oil, hydrogen filling, purging and pressure / purity monitoring /control system etc. as required for continuous safe and trouble-free operation. Besides these, a fully automatic gland steam sealing system, electric motor driven / hydraulic turning gear, self-contained lube oil system would be provided.

The electric generator would be three-phase, directly coupled, two pole machine capable of generating 150,000 kW at generator terminals after meeting power requirement for excitation at a power factor 0.8 (lag). The rotor and the stator windings would be air / hydrogen cooled. The generator would be suitable for connection by means of isolated phase bus duct to the low voltage winding of the step-up transformer.

The TG set would be capable of delivering continuously the rated power at 0.8 (lag) power factor when the voltage variation is within ± 5% of rated value and also when frequency variation is within 47.5 Hz and 52.5 Hz.

- ***Condensing Equipment and Accessories***

The supply would be complete with divided flow, double-pass, horizontal, surface type, clarified water-cooled condenser. Each condenser unit would be transverse mounted and would condense exhaust steam by circulation of cooling water (inlet temperature 32°C max.) in a re-circulating cooling water system using wet type cooling tower. Condenser outlet water temperature may be maintained within 42°C. Clarified river water would be the cooling medium in the condenser and other auxiliary coolers. Stainless steel heat exchanger tubes, with rolled steel tube sheet, baffle plates, etc. are envisaged to ensure all steel construction. Cathodic protection with Zinc or Aluminium sacrificial anode would be provided, if required. The condenser would be designed as per HEI code or equivalent. The heat load of the condenser will correspond to the turbine operating condition with VWO having 105% MCR steam flow, 3% make-up, 85% tube cleanliness factor and a maximum cooling water inlet temperature of 32°C to maintain rated condenser pressure of 76 mm of Hg (absolute). The condenser should also be capable of accepting full HP - LP bypass steam flow safely without undue pressure rise, vibration, noise or other detrimental effects.

Oxygen content of condensate leaving condenser hot-well will not exceed 0.015 cc per litre over the entire load range. The condenser would be provided with 2 x 100% capacity (1 working + 1 standby) vacuum pumps to remove non-condensable gases and maintain vacuum in the condenser at the desired level during normal operation. One (1) additional vacuum pump is provided for start-up operation. The condenser would be spring mounted with rigid connection to the turbine exhaust. Alternatively, condenser may be on solid footing with corrosion resistant flexible metallic bellow connection with the turbine exhaust.

- ***Condensate Extraction Pumps***

The condensate / feed water cycle would also comprise two 100% capacity motor-driven, vertical condensate extraction pumps of CAN type construction. Connection between condenser and each pump will be through a block valve and removable strainer. The pumps will discharge through check valve and motor operated stop valves into a common discharge header. Connection for condensate supply to the following major services will be tapped off from this condensate discharge header.

- LP bypass de-superheating spray;
- Turbine exhaust hood spray; and
- Gland sealing de-superheating system.

Condensate will then pass in series through the gland steam condenser and drain cooler before being passed through the low pressure feed water heaters.

- ***Boiler Feed Water Pumps***

The feed water heating system will comprise three (3) nos. (2 working + 1 standby) 50% capacity electric motor driven boiler feed pumps of centrifugal, multi-stage, horizontal, barrel type construction. The head, capacity and net positive suction head (NPSH) would be so selected as to permit parallel operation at all loads and be compatible with the heat cycle considered to meet the boiler MCR without encroaching on normal margins. Booster pumps may be considered to ensure appropriate head at pump inlet. The pumps will be provided with mechanical seal, flushing arrangement as per API 610. The supply would be complete with and inclusive of variable speed hydraulic coupling, lube oil system, automatic leak-off, minimum flow recirculation valves, bypass valves, base plates, foundation bolts, couplings, 6.6 kV, 3 pH, 50 Hz electric motor drive.

- ***De-aerating Heaters & Closed Heaters***

The regenerative feed heating system would comprise vertical or horizontal shell and tube-type high pressure feed water heaters with bypass arrangement. Three (3) stage horizontal U-tube type low pressure heaters equipped with drain cooling and condensing zones and individual bypass system is envisaged. Besides these, separate drain cooler, gland steam condenser etc. as per suppliers' standard, horizontal spray or spray-cum-tray type deaerator with integral vent condenser to limit oxygen content to a maximum limit of 0.005 cc/litre at all operating conditions with minimum loss of steam are envisaged. The storage tank should be adequately sized to accommodate at least 10 minutes water requirement to provide feed water to respective boiler at the BMCR condition. Two (2) x 50% capacity high-pressure feed water heater streams would be considered. Each feed water heater stream will consist of two (2) high-pressure heaters in series. The heaters will be preferably horizontal U-tube type having de -superheating, condensing and drain cooling zones. All steel construction of condensate / feed water wetted surfaces is desired to facilitate uniform chemical conditioning of steam - condensate - feed water system. The recommendations of ASME standard TDP-1 (Part-1) for preventing water damage to turbine would be followed.

- ***Steam Generators (Boiler)***

The Steam Generators (SG) would be of semi-outdoor type, subcritical pressure, natural circulation, re-heat, balanced draft, single drum and dry bottom type (water impounded hopper) units, designed for pulverized coal firing using E - Grade coal, as the principal fuel and suitable for both constant and sliding pressure operation. A two-pass conventional type construction of boiler is proposed to be adopted for these units.

Capacity of steam generating units would be so selected as to ensure adequate margin over the requirement of turbine at VWO condition (105% MCR) in order to cater to:

- Auxiliary steam requirement for soot blowing operation, fuel oil system heating and also for start-up of adjacent unit.
- De-rating of the steam generating unit after prolonged use.

The Steam Generator would be designed to operate with "the HP heaters out of service" condition (resulting in lower feed water temperature at economiser inlet) and deliver steam to meet the Turbine Generator requirement at 100% MCR. The Steam Generator would also be suitable for operation with HP - LP turbine bypass system. Economiser section of the boiler would be non-steaming type with provision for recirculation during start-up, chemical cleaning etc.

Superheater and re-heater sections would be convection and radiation type and designed so as to maintain rated steam temperature of 540°C ± 5°C at superheater and re-heater outlet over the control range of 50% to 100% BMCR. Superheater and re-heater would be provided with de-superheating stations with provision for spraying water for temperature control. The de-superheating water would be supplied from the feed water header upstream of the feed control station.

Primary temperature control of re-heater would be by tilting burner arrangement, if applicable. Two (2) trisector re-generative air pre-heaters for primary and secondary air heating, each with duplicate electric motor drive as well as air motor back-up for 10 minutes' operation and manual cranking facility for emergency would be provided. Alternatively, two (2) tubular recuperative type air heaters may be provided. Each air pre-heater would be capable of meeting 60% boiler MCR load.

Steam coil air pre-heaters (SCAPH) would be provided in each FD fan discharge duct to maintain cold end temperature above acid dew point during boiler start-up and low load operating conditions.

The boiler would be provided with a set of soot blowers, automatic sequential electrically operated type with provision for manual retraction on emergency, arranged for on-load cleaning of the heat transfer surfaces e.g. water-walls, super-heaters, re-heaters, economizers and air-heaters.

The boiler furnace and flue gas passages would be designed for appropriate low gas velocities considered with the available coal quality in order to minimize erosion and slugging effect.

Suitable balanced draft system would be provided for the Steam Generator with two (2) Forced Draft and two (2) Induced Draft fans.

Each of these fans would be capable of meeting the air requirement at 60% boiler MCR load. The Forced Draft fans may be axial impulse type with inlet vane control arrangement or axial reaction type with hydraulic blade pitch control for regulation of airflow. The 60% capacity Induced Draft fans would be double suction radial type with speed control arrangement through variable speed hydraulic coupling or inlet vane control arrangement for regulation.. The Forced Draft fans would control total airflow to boiler and the Induced Draft fans would control furnace draft of the boiler through automatic control loops.

Each Steam Generator unit would be equipped with suitable pulverized coal firing arrangement comprising crushed Coal Bunkers, Volumetric or Gravimetric Raw Coal Feeders, Pulverizing Mills, Primary Air Fans and Seal Air Fans, Fuel and air pipes, Burners etc. as necessary.

Pulverizing of coal is normally associated with high abrasion of system components. This aspect is more relevant in Indian context especially in view of gradually deteriorating coal quality observed over last few decades. As a result, the life expectancy of mill grinding elements, piping and other components have gone down resulting in substantially reduced availability of pulverizing system.

Vertical pulverizing mills, which were originally developed in the United States, are the most commonly used equipment in utility power plants. They were efficient and performed reasonably well as long as coal quality was reasonably good. However, for poorer quality of coal, the performance of these mills were found to be less than satisfactory in terms of life of grinding elements as well as availability. Alternately, horizontal ball mills (tube mills), which have been reported to give a better demonstration of performance with power quality coal in other countries, are also in use.

Number of vertical pulverizers (if used) would be so selected as to have one (1) pulverizer available as standby for maintenance when the boiler is operated with worst coal at 100% BMCR. While operating at 100% BMCR with design coal, one (1) pulverizer would remain standby and another would be available for maintenance.

With standard size of tube mills available from recognized manufacturers, the total number of mills may be such that at least one (1) mill remains standby at MCR with worst coal.

The steam generating units would be provided with Light Diesel Oil (LDO) units for supplying LDO to the oil burners for hot start-up & for stabilization of combustion of pulverized coal. The LDO system would be of capacity sufficient to meet minimum 30% of BMCR load. High Speed Diesel (HSD) system (capacity 10%) would also be provided for cold start-up & warming up purposes. LDO facilities would be located near the railway track.

The boiler would be top supported type and would be provided with all supporting steel platforms, galleries and stairways for easy approach and maintenance of the unit. One passenger-cum-goods elevator would be provided for each pair of adjacent boilers for access to the boiler platforms. Adequate weather protection would be provided for instruments and operating personnel. Necessary lining and insulation along with skin casing to limit outside surface temperature to safe level would be provided. Monorails and hoists required for handling pulverizers, motors, fans etc. would be provided as required along with the steam generating units.

#### *2.5.4.2 Coal Quality and Requirement*

At an expected heat rate of the turbine cycle at 2060 kCal/kWh & considering boiler efficiency as 89%, i.e., at the plant heat rate of 2315 kCal/kWh and considering average GCV of coal as 4025 kCal/kg, the coal consumption is estimated to be around 388 tonnes per hour i.e. around 9316 tonnes per day or approximately 3.5 Million tonnes per year considering 2.0 – 2.5 % losses. The ash shall be reduced by face quality control so that a GCV of 4025 + 100 kCal/kg is obtained from the mine. The parameters of the coal to be used as fuel for the power plant are given in **Table-2.2.**

**TABLE-2.2**
**PARAMETERS OF COAL**

| Parameters | Range | Design Coal |
|---|---|---|
| Grade based on UHV | Grade E to F | Grade E to F |
| Fixed Carbon | 26 - 45% | 35% |
| Moisture | 4 – 9 % | 6 % |
| Ash content | 24 - 42% | 34% |
| Volatile matter | 24 - 28% | 25% |
| Gross calorific value (kcal/kg) | 3780- 4700 | 4025 - 4300 |
| Grindability (HGI) | 51 | 52 |

*2.5.4.3 Coal and Ash Handling System*

- ***Coal Handling System***

Coal from the captive mine to the CPP shall be transported by a 25-km long Merry-Go-Round (MGR) system. The coal handling system shall consist of crushing and handling systems suitable to meet the requirements of the proposed CPP. Four (4) coal bunkers / silos shall be provided for each boiler. Each bunker / silo shall be sized for 12 hours storage capacity. The pulverising system for the boilers shall consist of four mills per boiler of 33% of total capacity each.

- ***Ash Handling System***

The total ash generation from the proposed 750 MW CPP (5 x 150 MW) will be 3170 TPD consisting of both bottom and fly ash. The bottom ash and fly ash generation will be 20% and 80% respectively.

➢ ***Bottom Ash Handling System***

Bottom ash shall be removed by submerged conveyor. Estimated bottom ash quantity is 635 TPD. Bottom ash from furnace shall be collected in the hopper. The bottom ash will be disposed as mine fill in abandoned mines and landfill in low-lying areas.

➢ ***Fly Ash Handling System***

Estimated fly ash quantity from the boilers is expected to be 2535 TPD. The fly ash from various outlets such as economiser, air preheater and ESP hoppers shall be collected pneumatically in silos of sufficient capacities. Fly ash from the silos shall be disposed off to the designated ash disposal area through ash disposal pipeline using high concentrated ash slurry disposal method. The ash slurry pipe will be laid over ground on saddles.

The fly ash from the ash disposal area shall be commercially utilized in nearby cement industries, road embankment, etc. Typical composition of fly ash is given in **Table-2.3.**

**TABLE-2.3**
**TYPICAL COMPOSITION OF FLY ASH**

| Compounds | Composition (%) |
|---|---|
| Silica | 60.55 |
| Alumina | 23.43 |
| Iron oxide | 8.82 |
| Calcium oxide | 0.38 |
| Magnesium oxide | 0.39 |
| Sodium oxide | 0.23 |
| Potassium oxide | 0.78 |
| Phosphorous pentaoxide | 0.17 |
| Sulphur trioxide | 0.09 |
| Titanium | 1.11 |
| Alkaloids & undermined | 3.72 |

*2.5.4.4 Electrostatic Precipitators*

To limit the dust load at the inlet to the chimney to a value of 100 mg/Nm$^3$ as prescribed by the Ministry of Environment & Forests (MoEF), Government of India, adequately sized electrostatic precipitators are proposed to be provided for each unit.

Each of the steam generating units would be provided with four (4) sets of electrostatic precipitators. Each precipitator would have two (2) parallel gas paths, any of which can be isolated for maintenance, when required, keeping the other paths in operation. Each path would comprise minimum six (6) fields in series for collection of fly ash and would be capable of limiting the solid particulate matter (SPM) in the flue gases at the outlet of ESP to acceptable value with any one of its fields, transformers / rectifiers out of service while working at 100% BMCR with worst coal. The ESP would have an efficiency of around 99.78%. Each ESP would be provided with adequate number of ash hoppers having capacity suitable for storing ash generated in a shift of eight (8) hours duration under 100% BMCR.

*2.5.4.5 Stack*

The five (5) 150 MW units would be provided with two (2) multi-flue stacks, one for the group of three (3) units and other for two (2) units. A stack height of 220 m would be provided to meet the latest requirement of emission regulation.

*2.5.4.6 Flue Gas De-sulphurisation*

From the available data on sulphur content in coal, no Flue Gas Desulphurisation Plant (FGD) is considered necessary. However, space provision has been kept as per the latest guidelines of MoEF for the set size under consideration.

*2.5.4.7 Limits of NOx Emission*

To reduce the NOx emission from the steam generator necessary provisions will be made in the steam generator design and fuel firing system as per the present day standard of power industry. Low NOx burners in the steam generator will be incorporated to keep the NOx emission within the specified limiting values.

*2.5.4.8 Control & Instruments*

The purpose of the control system is to provide versatile automation system for relieving the operator from the complex operations and to ensure safe and efficient operation at all times. The proposed Plant Control System shall be implemented with the state-of-art microprocessor based Digital Distributed Control (DCS) System. The proposed DCS shall integrate the protection and interlocking systems, Closed Loop Control System and Monitoring System. The entire Control System shall be designed utilising proven and latest microprocessor based technology.

### 2.5.5 Utilities & Offsite Facilities

The proposed aluminium smelter plant will have the following utilities / facilities.

**Utilities**

- Clarified Water System;
- Cooling Water System;
- Drinking Water System;
- Fire Water System;
- Sprinkler Water System;
- Effluent Treatment Plant;
- Compressed Air System;
- Fuel Oil System;
- L.D.O System;
- United Substation & Power Distribution system; and
- Emergency Power supply System.

**Offsite Facilities**

- Main Ware House;
- Laboratory;
- Maintenance Shop;
- Vehicle Maintenance Shop;
- Administrative Building;
- Technical Building;
- Guest House;
- Canteen;
- Raw Water Reservoir;
- Time Office;
- First Aid;
- Fire Station;
- Road Weigh Bridge;
- Car / Scooter Parking;
- Fire Protection System;
- Permanent Storm Water System;
- Sanitary Sewer System; and
- Watch Towers.

### 2.5.6 Infrastructural Facilities

The major infrastructure facilities required for the proposed smelter complex are as follows:

- Land;
- Raw material;
- Power;
- Water;
- Transportation; and
- Township.

*2.5.6.1 Land Requirement*

The total land required for the proposed project complex, which includes smelter plant, power plant, township, ash disposal area, corridor for various utilities/facilities, etc. is about 1500-ha. The land use break-up of the proposed site area is given in **Table-2.4.** The general layout plan of the plant is presented in **Figure-2.3.**

**TABLE-2.4**
**PROPOSED LAND USE OF THE SITE**

| Sr. No. | Land use | Area (ha) |
|---|---|---|
| 1 | Aluminium smelter plant | 306.76 |
| 2 | Captive power plant | 428.98 |
| 3 | Township | 173.76 |
| 4 | Ash disposal area | 222.56 |
| 5 | R & R colony | 102.07 |
| 6 | Management Colony | 266.00 |
| **Total** | | **1500** |

*2.5.6.2 Raw Material Requirement*

The raw material required for the proposed smelter plant and captive power plant is given in **Table-2.5.**

**TABLE-2.5**
**RAW MATERIAL REQUIREMENT**

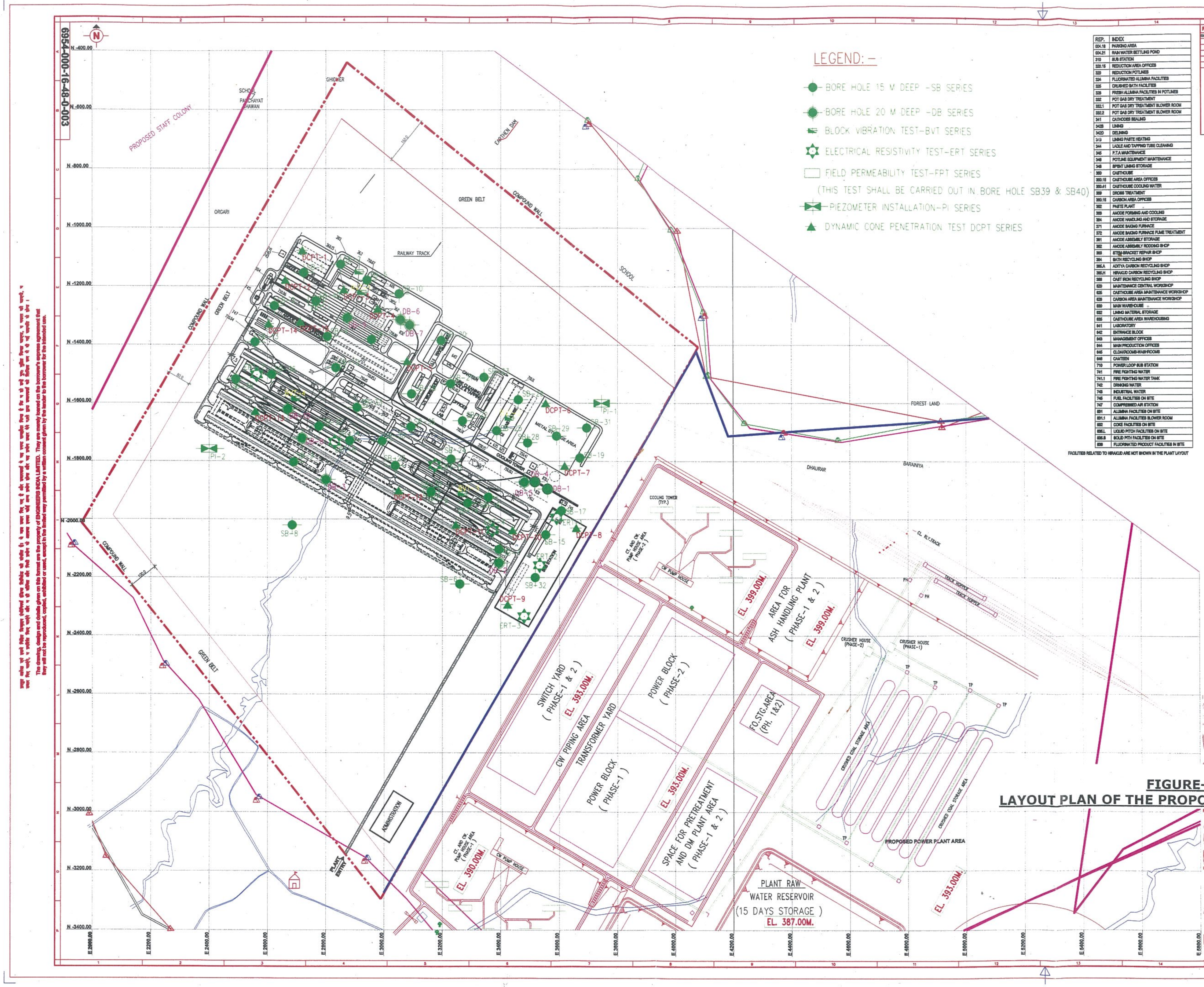
| Sr.No. | Raw Materials | Consumption per annum |
|---|---|---|
| ***Smelter Plant*** | | |
| 1 | C.P.Coke | 1,20,450 MT |
| 2 | Alumina | 6,31,450 MT |
| 3 | Pitch (HSP) | 29,200 MT |
| 4 | Furnace oil | 21,353 MT |
| 5 | Aluminium fluoride | 5,475 MT |
| 6 | Raw water | 7.23 Million KL |
| ***Captive Power Plant*** | | |
| 1 | Coal | 35,00,000 MT |
| 2 | Fuel oil | 35,000 KL |
| 3 | Raw Water | 29.7 Million KL |

### *Alumina ($Al_2O_3$)*

The average daily alumina consumption will be about 1730-tonnes. Alumina is the main raw material of the process and will be received from its own alumina refineries in Orissa/ Jharkhand. Special captive alumina wagons will be provided for transportation of alumina to the proposed smelter plant site.

### *Calcined Petroleum Coke*

Owing to its low ash, volatile content, bulk density and thermal stability at high temperature, calcined petroleum coke is the most preferred raw material for the anode manufacturing in an aluminum smelter all over the world. This is derived from petroleum industry as an ultimate product of prolonged thermal cracking. This will be received in gunny bags.




| REF. | INDEX |
|---|---|
| 004.18 | PARKING AREA |
| 004.21 | RAIN WATER SETTLING POND |
| 310 | SUB STATION |
| 320.15 | REDUCTION AREA OFFICES |
| 320 | REDUCTION POTLINES |
| 324 | FLUORINATED ALUMINA FACILITIES |
| 325 | CRUSHED BATH FACILITIES |
| 328 | FRESH ALUMINA FACILITIES IN POTLINES |
| 332 | POT GAS DRY TREATMENT |
| 332.1 | POT GAS DRY TREATMENT BLOWER ROOM |
| 332.2 | POT GAS DRY TREATMENT BLOWER ROOM |
| 341 | CATHODES SEALING |
| 342B | LINING |
| 342D | DELINING |
| 343 | LINING PASTE HEATING |
| 344 | LADLE AND TAPPING TUBE CLEANING |
| 345 | P.T.A MAINTENANCE |
| 346 | POTLINE EQUIPMENT MAINTENANCE |
| 348 | SPENT LINING STORAGE |
| 350 | CASTHOUSE |
| 350.15 | CASTHOUSE AREA OFFICES |
| 350.41 | CASTHOUSE COOLING WATER |
| 359 | DROSS TREATMENT |
| 360.15 | CARBON AREA OFFICES |
| 362 | PASTE PLANT |
| 363 | ANODE FORMING AND COOLING |
| 364 | ANODE HANDLING AND STORAGE |
| 371 | ANODE BAKING FURNACE |
| 372 | ANODE BAKING FURNACE FUME TREATMENT |
| 381 | ANODE ASSEMBLY STORAGE |
| 382 | ANODE ASSEMBLY RODDING SHOP |
| 383 | STEM-BRACKET REPAIR SHOP |
| 384 | BATH RECYCLING SHOP |
| 385.A | ADITYA CARBON RECYCLING SHOP |
| 385.H | HIRAKUD CARBON RECYCLING SHOP |
| 386 | CAST IRON RECYCLING SHOP |
| 620 | MAINTENANCE CENTRAL WORKSHOP |
| 625 | CASTHOUSE AREA MAINTENANCE WORKSHOP |
| 626 | CARBON AREA MAINTENANCE WORKSHOP |
| 630 | MAIN WAREHOUSE |
| 632 | LINING MATERIAL STORAGE |
| 635 | CASTHOUSE AREA WAREHOUSING |
| 641 | LABORATORY |
| 642 | ENTRANCE BLOCK |
| 643 | MANAGEMENT OFFICES |
| 644 | MAIN PRODUCTION OFFICES |
| 645 | CLOAKROOMS-WASHROOMS |
| 646 | CANTEEN |
| 710 | POWER LOOP SUB STATION |
| 741 | FIRE FIGHTING WATER |
| 741.1 | FIRE FIGHTING WATER TANK |
| 742 | DRINKING WATER |
| 743 | INDUSTRIAL WATER |
| 745 | FUEL FACILITIES ON SITE |
| 747 | COMPRESSED AIR STATION |
| 831 | ALUMINA FACILITIES ON SITE |
| 831.1 | ALUMINA FACILITIES BLOWER ROOM |
| 832 | COKE FACILITIES ON SITE |
| 836.L | LIQUID PITCH FACILITIES ON SITE |
| 836.S | SOLID PITH FACILITIES ON SITE |
| 838 | FLUORINATED PRODUCT FACILITIES IN SITE |

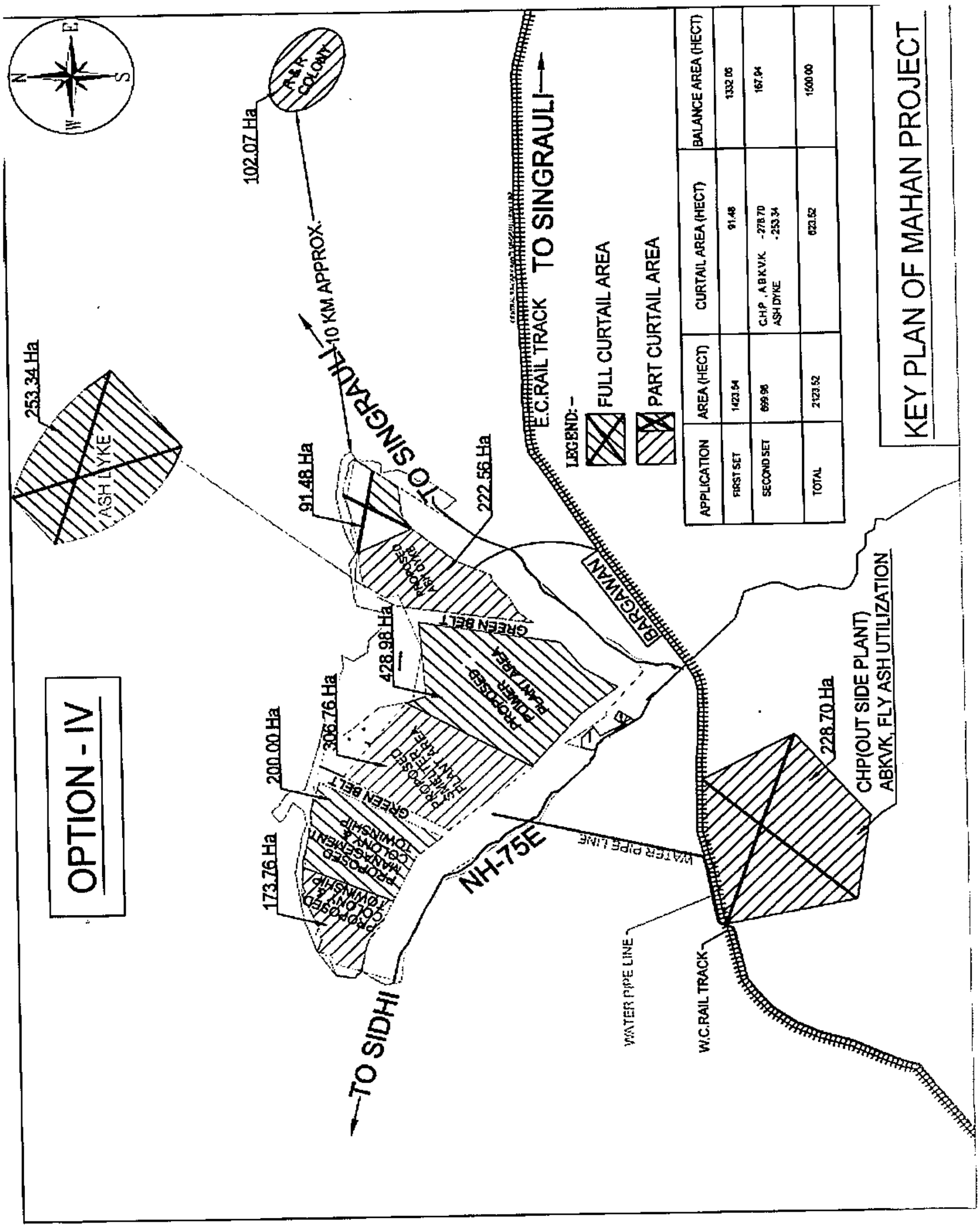
FACILITIES RELATED TO HIRAKUD ARE NOT SHOWN IN THE PLANT LAYOUT

* BORE HOLES ARE ALREADY EXECUTED AT SITE

| | CO-ORDINATE | |
|---|---|---|
| | EAST | NORTH |
| SB1 | 2725 | -1153 |
| SB2 | 2851 | -1125 |
| SB3 | 2624 | -1266 |
| SB4 | 2806 | -1372 |
| SB5 | 2941 | -1179 |
| * SB6 | 3260 | -2223 |
| * SB7 | 3394 | -2103 |
| * SB8 | 2665 | -2020 |
| * SB9 | 2690 | -1803 |
| SB10 | 3052 | -1226 |
| SB11 | 2957 | -1382 |
| SB12 | 2836 | -1479 |
| SB13 | 2558 | -1390 |
| * SB14 | 3287 | -1944 |
| * SB15 | 3653 | -2062 |
| * SB16 | 3368 | -1924 |
| * SB17 | 3607 | -1970 |
| SB18 | 3095 | -1589 |
| * SB19 | 3671 | -1786 |
| SB20 | 3198 | -1385 |
| SB21 | 3228 | -1533 |
| SB22 | 3269 | -1661 |
| SB23 | 3343 | -1511 |
| * SB24 | 3230 | -1793 |
| SB25 | 3386 | -1695 |
| SB26 | 3460 | -1586 |
| * SB27 | 3039 | -1815 |
| SB28 | 3492 | -1736 |
| SB29 | 3600 | -1713 |
| * SB30 | 2994 | -1731 |
| SB31 | 3694 | -1685 |
| SB32 | 3618 | -2200 |
| * SB33 | 2908 | -1818 |
| * SB34 | 2883 | -1729 |
| SB35 | 3092 | -1682 |
| SB36 | 2615 | -1502 |
| * SB37 | 2777 | -1580 |
| SB38 | 2492 | -1518 |
| SB39 | 3182 | -1905 |
| SB40 | 2786 | -1250 |
| | | |
| DCPT1 | 2720 | -1078 |
| DCPT2 | 2882 | -1179 |
| DCPT3 | 2862 | -1212 |
| DCPT4 | 2978 | -1277 |
| DCPT5 | 3079 | -1456 |
| DCPT6 | 3553 | -1600 |
| DCPT7 | 3618 | -1815 |
| DCPT8 | 3668 | -2030 |
| DCPT9 | 3434 | -2293 |
| DCPT10 | 3441 | -2097 |
| DCPT11 | 3247 | -2019 |
| DCPT12 | 3060 | -1901 |
| DCPT13 | 2889 | -1629 |
| DCPT14 | 2604 | -1328 |
| DCPT15 | 2713 | -1322 |
| | | |
| DB1 | 3560 | -1895 |
| * DB2 | 3394 | -2150 |
| * DB3 | 2801 | -1864 |
| DB4 | 3617 | -1871 |
| * DB5 | 3461 | -1872 |
| DB6 | 3057 | -1314 |
| DB7 | 3088 | -1332 |
| * DB8 | 2719 | -1721 |
| DB9 | 2874 | -1308 |
| DB10 | 2671 | -1621 |
| | | |
| ERT1 | 3691 | -1994 |
| ERT2 | 3633 | -2189 |
| ERT3 | 3480 | -2334 |
| ERT4 | 3373 | -2036 |
| ERT5 | 3175 | -1816 |
| ERT6 | 2832 | -1736 |
| ERT7 | 2684 | -1503 |
| | | |
| BVT1 | 2924 | -1222 |
| BVT2 | 3429 | -1862 |
| BVT3 | 3288 | -1912 |
| BVT4 | 2897 | -1586 |
| | | |
| PI1 | 3745 | -1600 |
| PI2 | 2400 | -1758 |
| | | |
| FPT1 | 2786 | -1250 |
| FPT2 | 3182 | -1905 |

**FIGURE-2.3**

**LAYOUT PLAN OF THE PROPOSED SMELTER COMPLEX**




## FIGURE-2.4
## LAYOUT PLAN OF THE PROPOSED SMELTER COMPLEX

*Coal Tar Pitch*

Coal tar pitch is used as binder for manufacturing carbon anode and cathode. The electrode paste is prepared by mixing 15-18% with carbon dry aggregate of various fractions. Coal tar pitch is received in liquid form and stored in melting or storage tanks.

*Aluminium Fluoride*

Aluminium fluoride is added to the bath to maintain an excess of acidity, which improves the efficiency of the cells. Aluminium fluoride will be received in 50-kg bags. These bags will be delivered through truck, unloaded manually and stacked in fluoride storage building.

*Fuel Oil*

Fuel oil will be required for anode backing, furnace firing and holding cum melting furnaces. Fuel oil will be transported to the plant site by rail tanker wagons and will be stored in steel tanks common with the adjacent captive power plant. There will be two HFO storage tanks of 1000 KL capacity each. In addition, one 200 KL day storage tank of HFO will also be provided. Besides, one tank of 200 KL capacity will be provided to store LDO. The layout of the smelter is designed to minimize the transport distance of raw materials and intermediate products. The project will be employing best material handling techniques.

- **Raw Materials Handling and Feeding**

Alumina will be received through rail wagons and stored in silos. There will be a total of eight alumina silos corresponding to four sets of pot room fume treatment systems of which, four silos will be used to store enriched alumina and remaining will be for fresh alumina.

- Fresh alumina will be transported from rail wagon unloading system to main alumina silos. From the silos alumina will be sent to fresh alumina silos of pot room fume treatment system;
- Enriched alumina from the enriched alumina silos of pot room treatment systems to the material bins on the pots will be conveyed by type dense phase conveying system;
- Other chemicals will be received at the plant site by trucks. Calcined petroleum coke will be transported to the plant by truck or by railway wagons. After unloading, calcined petroleum coke will be stored in three silos having capacity for about one month;
- Coal tar pitch will be transported to the plant site by trucks and stored in 3 tanks. The storage tanks will be indirectly heated, sufficient for 1.0 month requirement; and
- From the silos/tanks, different material will be transported to the consumption areas by suitable conveying system.

*2.5.6.3 Power Requirement*

Aluminium smelters are highly power intensive and electricity is considered as a major raw material for aluminium production. The total power requirement of the proposed smelter project is about 549 MW. The break-up of the power requirement is given as below:-

- Pot Room : 508 MW
- Pot line Auxiliary : 15 MW
- Carbon Area : 10 MW
- Cast House : 6 MW
- Auxiliaries & Miscellaneous : 5 MW
- Township : 5 MW

**Total : 549 MW**

The power requirement will be met from the proposed 750 MW (5 x 150 MW) coal based captive thermal power plant with one unit of 150 MW as standby. At any given time only five units will be in operation and one unit will be in standby mode. The power requirement for construction and station start-up together with emergency back-up power will be met from the nearby located Morwa sub-station of MSEB.

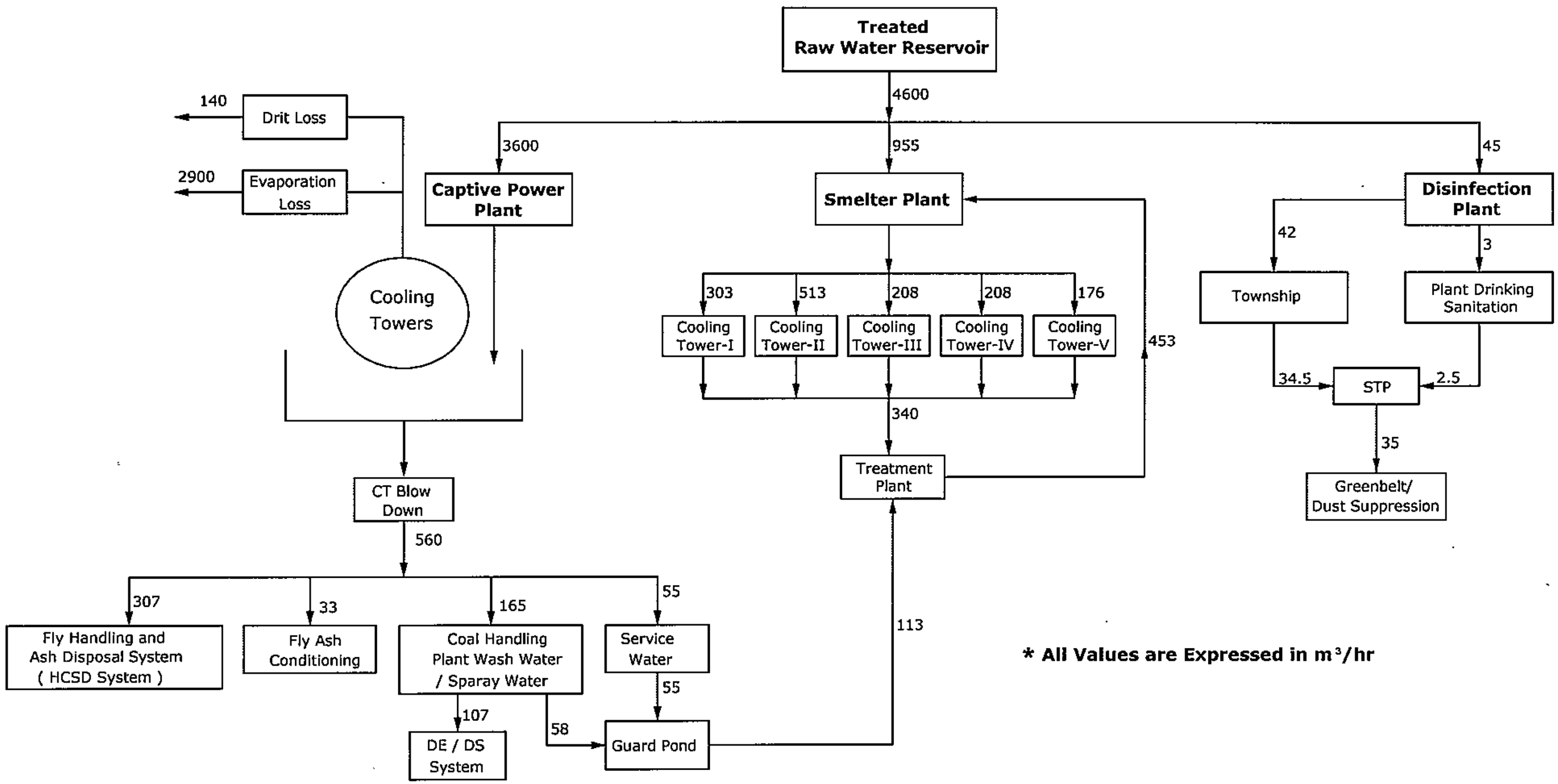
*2.5.6.4 Water Requirement*

The total water requirement during operation phase of the project will be 4600 $m^3$/hr, which includes domestic, industrial and allied activities including water requirement for greenbelt development. The break up of the water required is as given in **Table 2.6.** The water balance of proposed smelter complex is shown in **Figure-2.5.**

**TABLE-2.6**
**WATER REQUIREMENT (OPERATIONAL PHASE)**

| Particulars | Water Consumption ($m^3$/hr) |
|---|---|
| Smelter plant | 1408 |
| Captive Power Plant | 3600 |
| Potable water in plant and Colony | 45 |
| Green belt | 35 |
| **Total Gross Water Requirement** | **5088** |
| Water Recycling | 488 |
| **Net Fresh Water Requirement** | **4600** |

The total water requirement of the project will be 5088 $m^3$/hr. About 453 $m^3$/hr of wastewater will be generated in the CPP and smelter, which will be treated and reused in the smelting process. The treated domestic wastewater of 35-$m^3$/hr from the colony and plant will be utilized in greenbelt development. Therefore the net fresh water requirement of the project will be *4600 $m^3$/hr*. The fresh water requirement of 4600 $m^3$/hr shall be met from Gopad River, which is at a distance of about 35 km by laying pipe line. Energy Department of Madhya Pradesh has already allocated 45.12-cft/sec (4600 $m^3$/hr) of water from Gopad River for the project. Suitable arrangement will be made for drawl & conveying of water to the project site.




*** All Values are Expressed in m³/hr**

**FIGURE-2.5**
**WATER BALANCE**

After conducting the hydrological study of the water intake system from Gopad river the suitable means will be developed for the water off take from river.

Raw water will be drawn from Gopad river through pipelines after constructing a pump house on Gopad river and sent to in plant raw water reservoir which will be provided with at least 5 days storage of consumptive use of water to meet any exigency. Part of the pipeline will run above ground on trestles and part will be laid underground.

Raw water from the reservoir will be sent to the captive power plant's water treatment plant & pumping station. Clarified and filtered water will be directly pumped to the township and aluminium smelter water storage tank.

*2.5.6.5 Transportation*

The proposed aluminium smelter complex site is situated at about 0.7-km on National Highway (NH-75E) connecting Ranchi to Rewa via Singrauli. As part of the infrastructural facilities for transportation of heavy equipment and material, a heavy-duty approach road connecting National Highway and plant site needs to be constructed. An approach road to township will connect the main approach road between plant and national highway (NH-75E).

The main raw material viz., alumina for the proposed smelter will be transported by special alumina rail wagons from the Hindalco's alumina refinery at Orissa. The movement of Calcined Petroleum coke (CP coke), Furnace Oil and 50% of the finished product will be transported through railway system.

Hindalco will own special alumina wagons under Railway's policy of "own your wagon scheme". A turn around time of 7 to 8 days have been estimated while calculating number of alumina wagons required for transportation of alumina from alumina refinery to smelter at Bargawan. It is estimated that approximately 280 number of alumina wagons are required including 10% for breakdown and maintenance.

The coal for the captive power plant shall be transported by a Merry-Go-Round (MGR) system of 25-km. For this a rake of 41 N-Box wagons with average 55 tonnes load in each wagon will be required. The rake will make 3 - 4 round trips in 24 hours.

*2.5.6.6 Township*

The proposed township shall cater to the requirement of aluminium smelter as well as the needs of captive power plant, security personnel and supporting staff. Provision will be kept for future expansion of township. Considering the location of the proposed township about 70% satisfaction level of the accommodation of the employees has been taken into account.

### 2.5.7 Employment Potential

The proposed project presents vast opportunities of employment to various positions under various cadres viz. Management, supervisory, skilled workmen, semi-skilled workmen and unskilled workmen besides casual workmen.

Large number of local personnel would be mostly recruited in unskilled, semi skilled office assistant categories etc. These personnel need training and orientation before project starts. The employment of local people in primary and secondary sectors of project shall upgrade the prosperity of the region. But many skilled and highly skilled personnel have to be brought from outside / nearby the project area.

The total manpower required for the proposed mining project under various categories is 1495 persons. The break-up of the manpower requirement is shown in **Table-2.7.**

**TABLE-2.7**
**BREAK-UP OF MANPOWER REQUIREMENT**

| Unit | Technical | Non-Technical | Total |
|---|---|---|---|
| Smelter | 780 | 90 | 870 |
| Captive power plant | 390 | 235 | 625 |
| **Total** | **1170** | **325** | **1495** |

## 2.6 Assessment of New and Untested Technology for the Risk of Technological Failure

Plant smelter technology will be of latest high amperage cells in view of productivity, efficient process and environmental control, lower specific energy configuration, etc such as AP-35 technology for Aluminium Pechiney (ALCAN Group) of France.

Electrolytic operations are proposed to be carried out at a cell amperage of 360-KA. Generally, higher cell amperages are conducive to more economical production and tendency has been to achieve higher current intensities.

The process has remained basically the same since the end of last century. However, immense improvement in current efficiency has been carried out since then. In the most modern technology available now, the amperage of cell has been increased to 360-KA and above. Other trends in technological developments are with respect to anode design, cathode design, cell design, voltage control, bus bar arrangement, pot fume exhaust system and dry scrubbing etc.

Hindalco will be using pre-bake cell technology with 360-KA current in aluminium smelter. The technology requires multiple anodes in each cell which are pre-baked in a separate facility and attached to rods that suspend the anodes in the cell. New anodes are exchanged for spent anodes. "Anode butts" are recycled in the process of forming new anodes.

Advantages of Pre-baked Technology

The use of centre-worked pre-bake cells with automatic multiple feeding points are considered to be best available technology for the production of primary aluminium with following advantages:

- Point feeders enable more precise, incremental feeding for better cell operation. They are generally located at the centre of the cell and thereby cut down on the diffusion required to move dissolved alumina to the anodic reaction sites;
- Point feeders enable "just-in-time alumina supply" to permit optimum cell operation;
- The controlled addition of discrete amounts of alumina enhances the dissolution process, which aids in improving cell stability and control, minimizing anode effects and decreasing the formation of undissolved sludge on the cathode. By anode effects < 0.1 /day, GHCs evolution like $C_2F_6$, $CF_4$ are minimal;
- PAHs are evolved due to incomplete combustion of hydrocarbons in pitch used to form the anodes. The use of pre-bake anodes will virtually eliminate the emissions of PAHs. The baking furnace is provided with a fume treatment plant to trap most of this condensed tar let out;
- Complete hood coverage of the cells, which will be connected to a gas exhaust and filter. The use of robust cell covers and adequate fume extraction rates ensures minimum fugitive emissions;
- Control firing of furnaces to optimize the energy use and reduce PAH and $NO_x$ emissions;
- Destruction of cyanides, tars and hydrocarbons in an afterburner if they have not been removed by other abatement techniques; and
- Use of sealed or indirect cooling systems for reducing the contamination of the water and reduction of the water consumption.

The salient environmental protection features are given in **Table-2.8.**

**TABLE-2.8**
**SALIENT ENVIRONMENT FEATURES**

| Area | Pollutant Controlled | Method of Control |
|---|---|---|
| Carbon Paste Plant | Coal Dust<br>CTPV | Dust suppression and collection system<br>CP coke based dry scrubber |
| Anode Bake Oven | CTPV<br>Fluoride fumes | Efficient combustion<br>Dry scrubbing |
| Alumina Transfer | Fugitive alumina dust | Dense phase conveying |
| Pot rooms | Fluoride fumes | FTP with Dry alumina scrubbing |

| Area | Pollutant Controlled | Method of Control |
|---|---|---|
| | GHG emissions | Technology<br>Reduced anode effect frequency and duration by automatic multiple point feeding system for alumina feeding<br>Highest energy efficiency<br>Minimum carbon consumption |

The above pollution control measures will give best performance standards as given in **Table-2.9.**

**TABLE-2.9**
**PERFORMANCE STANDARDS OF BUILT-IN CONTROL EQUIPMENT**

| Particulars | MoEF Standards | Present Indian Smelters | Mahan's Proposed Project | Best Demonstrated Technology |
|---|---|---|---|---|
| Total Fluoride emissions (Kg/t of Al) | 0.8 | 1.0 | 0.7 | 0.7 |
| Dust emissions (mg/Nm$^3$) | | | | |
| Pot rooms | 100 | 150 | 100 | 100 |
| Anode baking furnace | 50 | 150 | 50 | 50 |
| PFC emissions (Kg/t of Al) | NA | 0.3 | 0.07 | 0.05 |
| PAH emissions (Kg/t of Al) | NA | 0.05 | 0.02 | 0.01 |
| SPL generation (Kg/t of Al) | NA | 30-50 | 18 | 15 |

It can be observed that the Point Feeder Pre-Bake (PFPB) is worldwide proven and environmentally friendly technology.

## 2.7 Sources of Pollution

The various types of pollution from the proposed aluminium smelter complex are categorized under the following types:

- Air pollution;
- Water pollution;
- Pollution emanating due to solid waste; and
- Noise pollution.

Electrolytic cells in smelter are the major sources of gaseous emissions. In addition, wastewater and solid waste will also be generated. The quantities and the composition of the gaseous, liquid and solid waste that will be generated in the plant will be regulated and treated such that their final disposal into the environment meets all the statutory requirements and the environmental impacts are minimized.

### 2.7.1 Pollution Load from the Smelter Plant and CPP

The major pollutants emitting from the smelter plant and CPP will be gaseous ($SO_2$, CO, F and NOx) and particulates. These gaseous pollutants in the smelter plant would come from pot room, fume treatment plant, baking furnace and cast house and stacks attached to CPP. Proper control measures will be installed by project proponents to minimize the stack emissions and to maintain the air quality below the stipulated/permissible limits prescribed by National Ambient Air Quality Standards. Effluents will be generated from cooling tower blowdown, wash water and wastewater from sanitary facilities. Sanitary effluents will be treated in sanitary wastewater treatment plant. The cooling water blow down will be treated and reused in the process. The solid waste generated will be encapsulated and will be disposed in secured landfill as per CREP guidelines. The ash will be disposed of as High Concentrate Slurry in ash pond. The details of the emission load and its control measures are elaborated in the following sections. The pollution load of particulate matter and fluorides are calculated based on the CREP norms. The norms specified are given in **Table-2.10**.

**TABLE-2.10**
**CREP SPECIFIED NORMS**

| Sr. No. | Source of Emission | Pollutant | Limit |
|---|---|---|---|
| 1 | Anode Bake Oven | Particulate Matter | 50 mg/Nm$^3$ |
| 2 | Pot room through FTP | Particulate Matter | 100 mg/Nm$^3$ |
| 3 | Anode Bake Oven | Fluoride | 0.8 kg/t of aluminium produced |
| 4 | Fume Treatment Plant | Fluoride | |
| 5 | Pot room | Fluoride | |
| 6 | CPP | Particulate Matter | 100 mg/Nm$^3$ |

*2.7.1.1 Air Emissions*

There will be nine point emission sources connected to various units in the proposed smelter. The important stacks will be monitored on regular basis. The details of expected stack emissions are given in **Table-2.11**. Hindalco will implement the various air pollution control measures to reduce the air emissions.

- Advanced dry-scrubbing system will be provided with efficient collection system for reducing fluoride emissions from pot lines;
- Hooded cells to reduce fugitive losses;
- Larger anodes will be used to reduce emissions;
- Hyper dense phase system for dust free alumina transfer will be used;
- Dust suppression systems will be practiced;
- Regular monitoring of the air pollution control system;
- Low NOx burners to control NOx emissions from CPP; and
- Highly efficient ESP to control emissions of particulate matter in CPP.

**TABLE-2.11**
**STACK AND EMISSION DETAILS**

| Sr. No. | Stacks Attached | Dia (m) | H (m) | Exit Vel (m/s) | Exit Temp (°C) | Flow (Nm$^3$/sec) | Emission Rate (g/s) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $SO_2$ | $NO_X$ | SPM | F | PAH |
| **Captive Power Plant** | | | | | | | | | | | |
| 1 | CPP-1 | 3.5 | 120 | 23.6 | 140 | 164 | 215.6 | 194.0 | 16.4 | -- | -- |
| 2 | CPP-2 | 3.5 | 120 | 23.6 | 140 | 164 | 215.6 | 194.0 | 16.4 | -- | -- |
| 3 | CPP-3 | 3.5 | 120 | 23.6 | 140 | 164 | 215.6 | 194.0 | 16.4 | -- | -- |
| 4 | CPP-4 | 3.5 | 120 | 23.6 | 140 | 164 | 215.6 | 194.0 | 16.4 | -- | -- |
| 5 | CPP-5 | 3.5 | 120 | 23.6 | 140 | 164 | 215.6 | 194.0 | 16.4 | -- | -- |

| Sr. No. | Stacks Attached | Dia (m) | H (m) | Exit Vel (m/s) | Exit Temp (°C) | Flow ($Nm^3$/sec) | Emission Rate (g/s) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $SO_2$ | $NO_X$ | SPM | F | PAH |
| **Aluminium Smelter** | | | | | | | | | | | |
| 6 | Gas Treatment Plant | 4.3 | 80 | 20.0 | 90 | 238.4 | 55.4 | - | 23.8 | 0.4 | -- |
| 7 | Gas Treatment Plant | 4.3 | 80 | 20.0 | 90 | 238.4 | 55.4 | - | 23.8 | 0.4 | -- |
| 8 | Baking Furnace | 1.9 | 50 | 20.0 | 250 | 32.3 | 20.6 | - | 1.6 | 0.1 | 0.1 |

The details of the emission rate calculations for the above stacks are presented in **Annexure-IV.**

*2.7.1.2 Fluoride Emissions*

- ***Fluoride Emissions from Aluminium Smelter***

The fluoride balance is based on fluoride consumption of 10 kg/t of aluminium as specified by CREP.

With the excellent hood design coupled with automated cell operation, pots will be operated with higher gas collection efficiency, which limits the fugitive emissions to 0.6 kg/t of aluminium. Fluorides from the collected gases are then removed by GTP, limiting the stack emissions of fluoride to 0.08 kg/t of aluminium. Thus, the total fluoride emissions from pot room will be 0.68 kg/t of aluminium. In the bake oven plant, fluoride emissions will be limited to 0.01 kg/t of aluminium by installing scrubbers. Consequently, the total fluoride emissions from smelter will be 0.69 kg/t of aluminium as against a standard of 0.8 kg/t of aluminium. The annual fluoride emission load from proposed smelter plant will be 224.2 tonnes. The fluoride balance is shown in **Figure-2.6.**

The fluoride emissions are mainly emitted from the following point sources as outlined in fluoride balance:

- Emissions through Fume Treatment Plant stacks (0.08 kg/ton of output);
- Fugitive emissions from pot rooms (0.6 kg/ton of output); and
- Anode baking furnace (0.01 kg/ton of output).

2.7.2 Liquid Waste Generation from Smelter

Blow down from cooling towers will be the main sources of the wastewater from CPP and smelter. Besides this, domestic waste from canteen and toilets will be generated in the plant. The wastewater generated in CPP and smelter will be treated and reused in smelting process. The treated domestic wastewater from colony and plant will be used in greenbelt development. The wastewater generated in the proposed project is given in **Table-2.12.**

| Input | | F as Kg/T of Al | Out put | |
|---|---|---|---|---|
| Fluoride | 10.00 | Pots | | 0.69 |
| | 13.00 | | SPL and Bath | 9.31 |
| | | | | 13.00 |
| | 23.00 | | | 23.00 |

**FIGURE-2.6**
**FLUORIDE BALANCE**

**TABLE-2.12**
**WASTEWATER GENERATION**

| Sr. No. | Wastewater Source | Wastewater Quantity ($m^3/hr$) | Losses ($m^3/hr$) | Reuse ($m^3/hr$) | Remark |
|---|---|---|---|---|---|
| 1 | Cooling tower blowdown from CPP | 560 | 307 | -- | Ash handling |
| | | | 33 | -- | Fly ash conditioning |
| | | | 107 | -- | Coal Handling |
| | | | | 58 | Smelting process |
| | | | | 55 | Smelting process |
| 2 | Smelter | 340 | | 340 | Smelting process |
| 3 | Domestic waste | 35 | | 35 | Greenbelt |
| **Total** | | **935** | **447** | **488** | |

Total wastewater generation the smelter project and CPP will be 935-$m^3$/hr. About 447-$m^3$/hr will be lost in evaporation and balance 488 $m^3$/hr will be utilized in the smelting process and greenbelt development. The water balance of smelter is shown in **Figure-2.5**.

*2.7.2.1 Storm Water Management*

During first showers in monsoon season, the fugitive emissions of fluorides, which get deposited on roof top and other areas, will be washed out and this rainwater will be collected in storm water pond. The necessary drains will be constructed within the plant area to collect the run-off water. Storm water collection pond will be constructed with appropriate lining to prevent contamination of ground water. The stored storm water will be utilized in smelter operation. This will help to conserve the fresh water sources. If the storm water tank starts over flowing, the water will be analyzed for fluoride content before discharging outside. The discharging water will be treated in de-fluoridation system if the fluoride content is found to be more than stipulated standards.

2.7.3 Solid Waste

The major categories of solid waste expected during aluminum smelter operation will be from Spent Pot Lining (SPL) and impregnation from electrolysis unit, coke fines (burnt) and refractory from bake oven, sundry waste from plant, ladle cleaning refractory, cast house refractory, effluent treatment plant sludge and domestic solid waste etc.

In pots, solid waste will be generated in the form of butts, which will be cleared from attached waste material and utilized in anode plant. The waste material from the butts will be reused in bath preparation in pot.

The major solid waste generated in the smelter plant will be Spent Pot Lining (SPL) in reduction plant (Pot room), used oil from various units and dross from cast house. Quantitative estimation of solid waste generation from the above units is presented in **Table-2.13**.

**TABLE-2.13**
**DETAILS OF EXPECTED SOLID WASTE**

| Sr. No. | Type of Waste | Unit | Quantity | Mode of Disposal |
|---|---|---|---|---|
| **Smelter Project** | | | | |
| 1 | Spent Pot Lining (from 5th year onwards) | TPA | 5800 | This will be disposed-off in secured landfill as per CPCB guidelines. |
| 2 | Used Oil | KLPA | 7.0 | This will be sent to authorized recyclers |
| 3 | Used Batteries | Banks/year | 35 | This will be sent back to suppliers |
| 4 | Dross | TPA | 1400 | Sold to secondary recyclers |
| **Captive Power Plant** | | | | |
| 1 | Ash<br>Total<br>Bottom ash<br>Fly ash | <br>TPD<br>TPD<br>TPD | <br>3170<br>635<br>2535 | Will be utilized in various construction material & land fill and balance will be disposed off in ash pond |

The cathode consists of carbon blocks with refractory material lining for insulation. The life of these cathodes is approximately 2500 days. Over this period of time, the carbon in blocks gets graphitised and impregnated with fluoride salts resulting in reduction of pot efficiency. These spent linings contain 10 to 12% fluoride. These are designated as hazardous wastes as per the schedule of Hazardous Wastes Rules. The quantity of SPL generated depends upon number of pot failures and hence is a function of smelter operation. The failure of one pot generates approximately 17 to 20 tonnes of SPL. The typical analysis of spent pot lining is given in **Table-2.14**.

**TABLE-2.14**
**TYPICAL ANALYSIS OF SPENT POT LINING**

| Sr.No. | Parameter | Characteristics in % (Except pH) | |
|---|---|---|---|
| | | Carbon Block | Insulation Brick |
| 1 | pH | 10 | 10 |
| 2 | Carbon | 45-50 | - |
| 3 | Aluminium | 4-6 | 25 |
| 4 | Silica | 1.0-1.5 | - |
| 5 | Iron | 0.5-1.0 | - |
| 6 | Sodium | 15-20 | 19 |
| 7 | Fluoride | 10-12 | 8 |
| 8 | Aluminium Carbide | 0.2-0.5 | - |
| 9 | Others | 10-15 | - |

*Source: CPCB (COINDS/51/1994-95)*

2.7.4 Noise Pollution

The noise levels from various noise generating sources of proposed plant are expected to range as given in **Table-2.15**.

## TABLE-2.15
## SOURCE NOISE LEVELS IN THE PROPOSED PLANT

| Sr. No. | Unit | Noise Level dB(A) [1m away] |
|---|---|---|
| **Smelter Plant** | | |
| 1 | Reduction Plant | |
| | Pot line | 80-86 |
| | Alumina storage area | 80-86 |
| 2 | Carbon Plant | |
| | Compressor House | 85-95 |
| | CP coke unloading area | 80-90 |
| | Anode paste plant | 80-85 |
| 3 | Casting Plant | 80-85 |
| 4 | Work Shop Area | 80-85 |
| **Captive Power Plant** | | |
| 1 | Turbine unit | 80-85 |
| 2 | Cooling tower | 65-70 |
| 3 | Air compressors | 80-85 |
| 4 | Transformer | 70-75 |
| 5 | Boilers | 80-85 |

- ***Noise Control***

Acoustic enclosures will be provided wherever required to control the noise level below 85 dB(A). Wherever, it is not possible technically to meet the required noise levels, personal protection equipment will be provided to the workers. The wide green belt around the plant will attenuate the noise levels out side the plant boundary.

# 3.0 DESCRIPTION OF THE ENVIRONMENT

## 3.1 Introduction

This chapter illustrates the description of the existing environmental status of the study area with reference to the prominent environmental attributes. The study area covers the area falling within 10-km radius around the proposed project site.

The existing environmental setting is considered to adjudge the baseline environmental conditions, which are described with respect to climate, hydro-geological aspects, atmospheric conditions, water quality, soil quality, vegetation pattern, ecology, socio-economic profiles of people, land use. The objective of this section is to define the present environmental status which would help in assessing the environmental impacts due to the proposed project.

This report incorporates the baseline data generated through primary survey covering three seasons: winter, pre-monsoon and post-monsoon.

| | | |
|---|---|---|
| Winter 2007 | - | 1st December 2007 to 28th February 2008 |
| Pre-monsoon 2008 | - | 1st March 2008 to 30th May 2008 |
| Post-monsoon2008 | - | 1st September 2008 to 31st December 2008 |

The description of the existing environmental quality with seasonal variations are depicted in the following sections.

### 3.1.1 Methodology

Appropriate methodologies have been followed in developing the EIA/EMP report. The methodology adopted for the study is outlined below:

- Conducting reconnaissance surveys for knowing the study area; and
- Selecting sampling locations for conducting various environment baseline studies.

The sampling locations have been selected on the basis of the following:

- Predominant wind directions recorded by the India Meteorological Department (IMD) at Sidhi;
- Existing topography;
- Drainage pattern and location of existing surface water bodies. like lakes/ponds, rivers and streams;
- Location of villages/towns/sensitive areas; and
- Areas, which represent baseline conditions.

The field observations have been used to:

- Assess the positive and negative impacts due to the proposed project; and

- Suggest appropriate mitigation measures for negating the adverse environmental impacts, if any; and
- Suggesting post-project monitoring requirements and suitable mechanism for it.

## 3.2 Land Use Studies

Studies on land use aspects of eco-system play an important role in identifying sensitive issues and taking appropriate actions by maintaining 'Ecological Homeostatis' for development of the region.

The objectives of land use studies are:

- To determine the existing land use pattern in the study area;
- To analyze the impacts on land use in the study area; and
- To give recommendations for optimizing the future land use pattern vis-a-vis proposed project in the study area and its associated impacts.

### 3.2.1 Land use Pattern of Study Area

The landuse pattern within 10-Km radius zone around the proposed site has been studied by collecting remote sensing data.

The 10-km zone around proposed site falls in Deosar Tehsil of Sidhi District and covers about 51 villages. The village-wise land use pattern based on secondary data (Census of India, 2001 Census) is presented in **Annexure-V**.

#### *3.2.1.1 Land Use Pattern Based on Remote Sensing Data*

Remote sensing satellite imageries were collected and interpreted for the 10-km radius study area for analyzing the landuse pattern of the study area. Based on the satellite data landuse/ land cover maps have been prepared.

The present land use / land cover maps were prepared based on the classification system of National standards. For explanation for each of the land use category the details as given in **Table-3.2.1** were considered.

**TABLE-3.2.1**
**LAND USE/LAND COVER CLASSIFICATION SYSTEM**

| Sr. No. | Level-1 | Level-2 |
|---|---|---|
| 1 | Built-up Land | Town/cities |
| | | Villages |
| | | Institution/Industry/Godown etc |
| | | Plotted Area/Layout |
| 2 | Agriculture Land | Crop Land |
| | | Plantations |
| | | Fallow |
| 3 | Forest | Evergreen/Semi evergreen |
| | | Deciduous |
| | | Forest Plantation |

| Sr. No. | Level-1 | Level-2 |
|---|---|---|
| 4 | Wastelands | Rocky/Stony Waste |
| | | Land with /without scrubs |
| | | Saline/sandy & Marshy/swampy |
| 5 | Water Bodies | River/Stream |
| | | Lake/Reservoir/Tanks |
| 6 | Others | Orchard/Other Plantation |
| | | Shifting cultivation |
| | | Salt Pans, Snow covered/Glacial |
| | | Barren/Vacant Land |

IRS-P6 Geo-Coded FCC on 1:155,000 scale of LISS-3 was acquired for May, 2007 and was used for the mapping and interpretation. Besides, other collateral data as available in the form of maps, charts, census records, other reports and especially topographical survey of India maps on 1:50,000 scale are used. In addition to this, ground truth survey was also conducted to verify and confirm the ground features.

The methodology adopted for preparation of landuse/landcover thematic map is monoscopic visual interpretation of geo-coded scenes of IRS-P6 satellite LISS-3 and field observations are taken. The various steps involved in the study are preparatory field work, field survey and post field work.

- ***Pre-field Interpretation of Satellite Data***

The False Color Composite (FCC) of IRS-P6 satellite data at 1:155,000 scale are used for pre-field interpretation work. Taking the help of topo sheets, geology, geomorphology and by using the image elements the features are identified and delineated the boundaries roughly. Each feature is identified on image by their image elements like tone, texture, colour, shape, size, pattern and association. A tentative legend in terms of land cover and landuse, physiography and erosion was formulated. The sample areas for field check are selected covering all the physiography, landuse / landcover feature cum image characteristics.

- ***Ground Truth Collection***

Both topo sheets and imagery were taken for field verification and a transverse plan using existing road network was made to cover as many representative sample areas as possible to observe the broad landuse features and to adjust the sample areas according to field conditions. Detailed field observations and investigations were carried out and noted the landuse features on the imagery.

- ***Post Field Work***

The base maps of the study area were prepared, with the help of Survey of India Toposheets on 1:50,000 scale. Preliminary interpreted land use and the land cover features boundaries from IRS-P6 False Colour Composite were modified in light of field information and the final thematic details were transferred onto the base maps. The final interpreted and classified thematic map was cartographed. The cartographic map was coloured with standard colour coding and detailed description of feature with standard symbols. All the classes noted and marked by the standard legend on the map.

The final output would be the landuse/land cover map on 1: 50000 scale, numerals were given different colour code for each category as shown in map. Area estimation of all features of Land use/Land cover categories were noted.

- ***Observations***

The following are the main interpreted landuse/land cover classes of the study area and their respective areas are given in hectares in **Table-3.2.2** for the year 2007. The land use pattern within 10-km radius based on IRS-P6 for the year May 2007 is shown in **Figure-3.2.1**. The landuse/ land cover thematic map of the area is given in **Figure-3.2.2**.

**TABLE-3.2.2**
**LANDUSE BREAKUP BASED ON IRS-P6 DATA**

| Sr. No. | Land Use | Area (ha) | Percentage |
|---|---|---|---|
| 1 | Built-up Area | 2763.07 | 6.2 |
| 2 | Degraded/Reserved/Protected Forest | 17986.70 | 40.7 |
| 3 | Plantation | 112.26 | 0.3 |
| 4 | Mixed/Dense Jungle | 2900.29 | 6.5 |
| 5 | Agricultural Area | 8732.33 | 19.7 |
| 6 | Waste Land with/without Scrub | 7103.46 | 16.0 |
| 7 | Stony/Rocky/Barren Area | 3778.41 | 8.5 |
| 8 | Water Body | 934.34 | 2.1 |
| **Total** | | **44310.85** | **100.0** |

Note: Data collected for May 2007

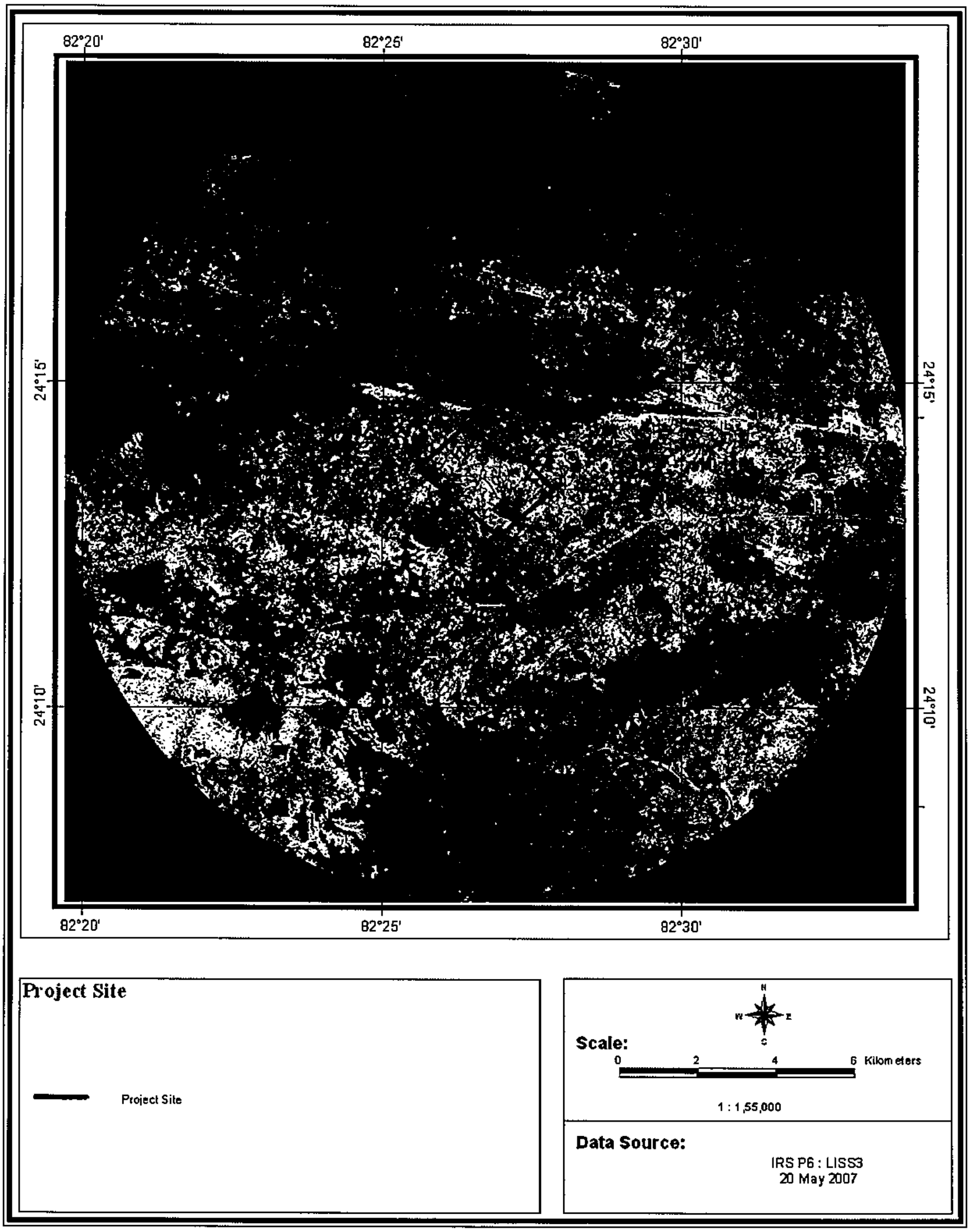



**FIGURE-3.2.1**
**STUDY AREA ON SATELLITE IMAGERY MAP**

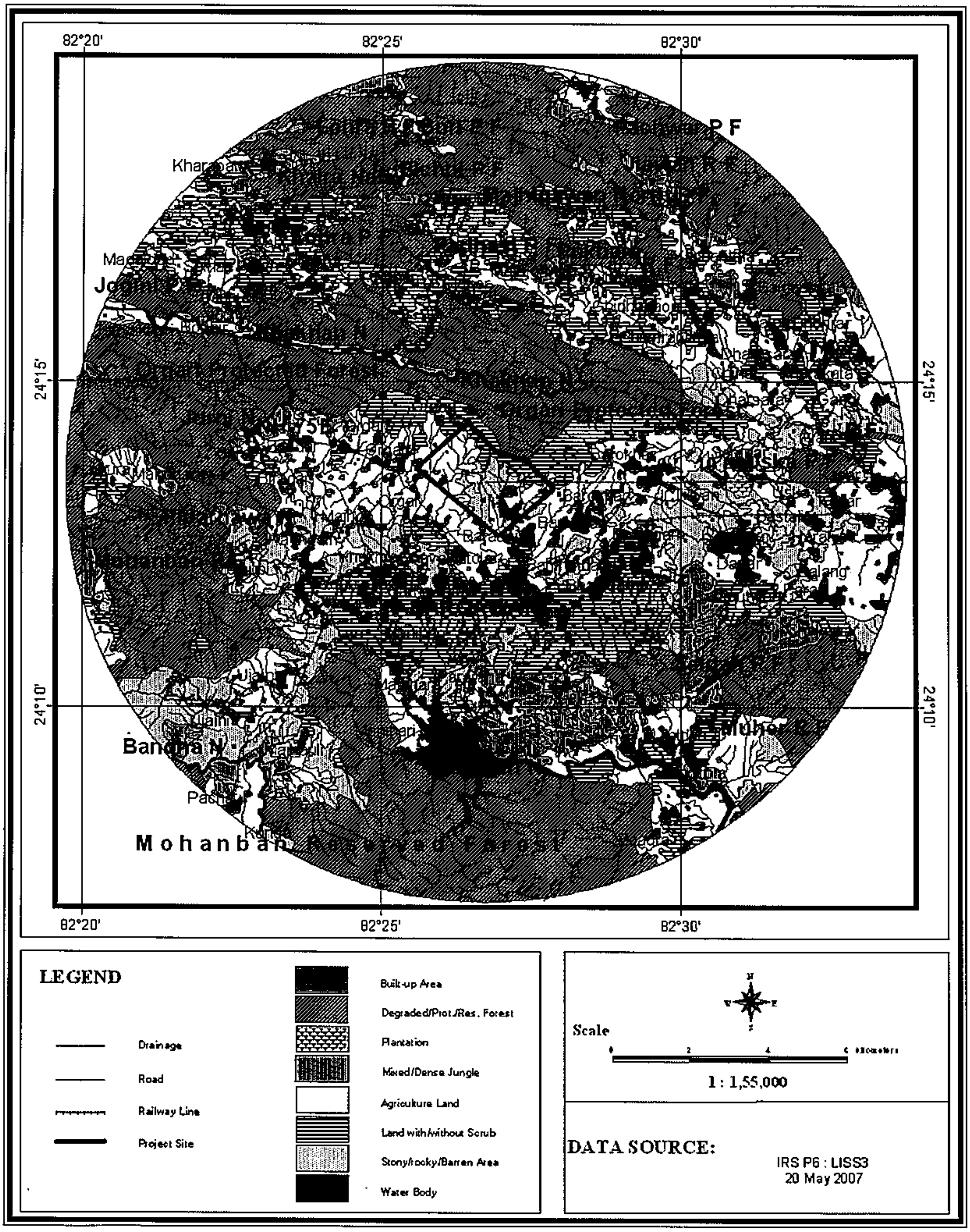



**FIGURE-3.2.2**
**THEMATIC MAP SHOWING LAND USE/LAND COVER**

## 3.3 Soil Characteristics

It is essential to determine the potentiality of soil in the area and to identify the impacts of plant activities on soil quality. Accordingly, the soil quality assessment has been carried out.

The sampling locations have been identified with the following objectives:

- To determine the baseline soil characteristics of the study area;
- To determine the impact of proposed project on soil characteristics; and
- To determine the impact on soils more importantly from agricultural productivity point of view.

### 3.3.1 Data Generation

For studying soil profile of the region, a total of ***eight*** sampling locations were selected to assess the existing soil conditions in and around the proposed project site. The details of the soil sampling locations are given in **Table-3.3.1** and are shown in **Figure-3.3.1**.

**TABLE-3.3.1**
**DETAILS OF SOIL SAMPLING LOCATIONS**

| Code No | Location | Distance from proposed site (Km) | Direction w.r.t Proposed site | Present land use |
|---|---|---|---|---|
| S1 | Proposed plant site | -- | -- | Agricultural |
| S2 | Bargawan Village | 3.5 | S | Agricultural |
| S3 | Gidher Village | 5.0 | N | Agricultural |
| S4 | Orgari Village | 1.9 | NW | Agricultural |
| S5 | Barauniya Village | 1.2 | SE | Agricultural |
| S6 | Borakhar Village | 3.3 | ESE | Agricultural |
| S7 | Wagadih Village | 4.8 | WSW | Agricultural |
| S8 | Majhigawan village | 5.0 | NE | Agricultural |

Composite soil samples were collected by ramming a core-cutter into the soil to a depth of 30, 60 and 90-cm at each location. The physical, chemical and heavy metal concentrations were determined in each composite soil sample. The soil quality at all the locations during the study period is given in **Table-3.3.1**. The results are compared with standard classification given in **Table-3.3.2 to Table-3.3.4**. Standard soil classification is given in **Table-3.3.5.**

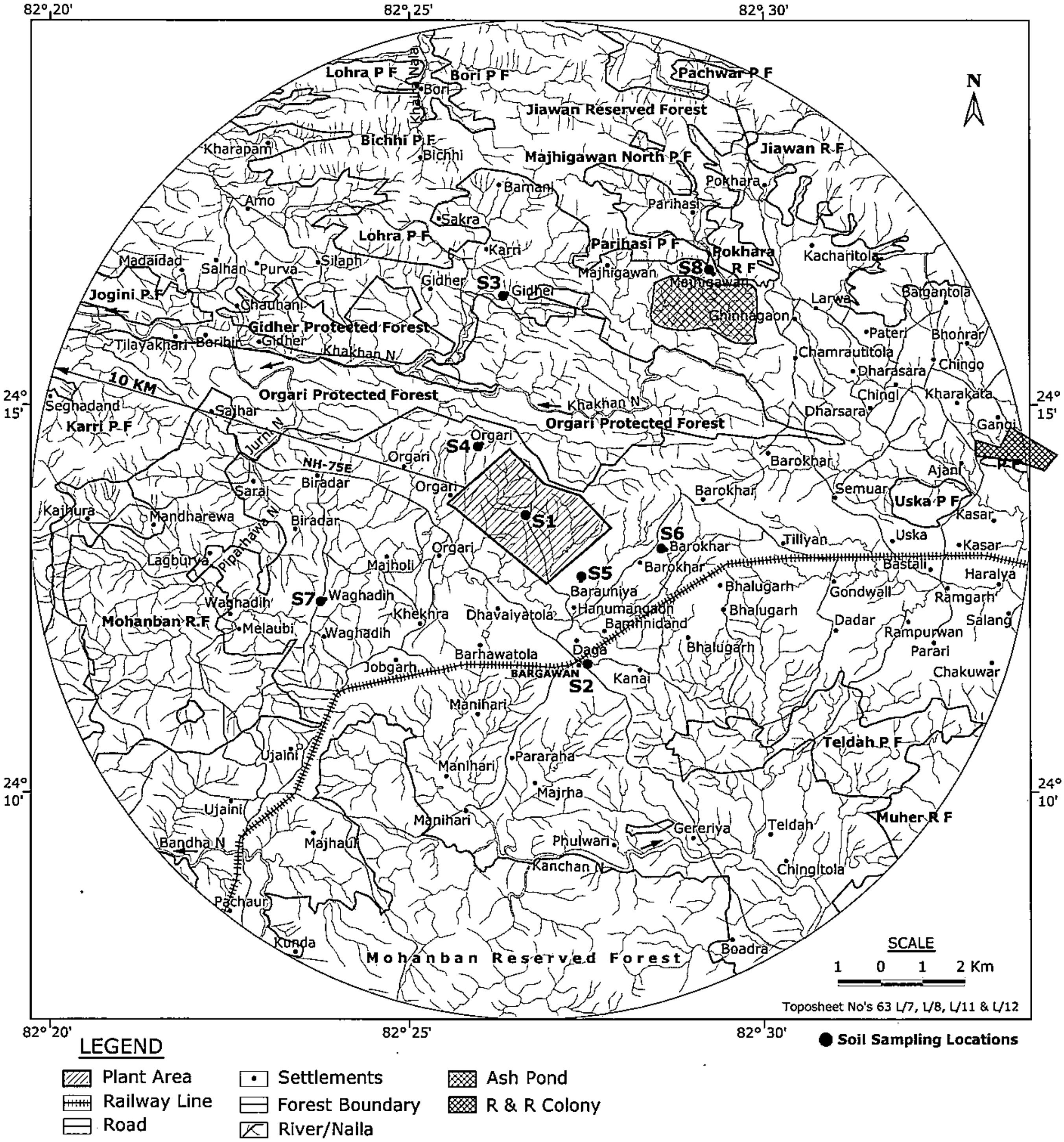



**FIGURE-3.3.1**
**SOIL SAMPLING LOCATIONS**

## TABLE-3.3.2
## SOIL ANALYSIS RESULTS (WINTER)

| Sr. No | Parameter | UOM | Proposed Plant site (S1) | Bargawan (S2) | Gidher (S3) | Orgari (S4) | Barauniya (S5) | Barokhar (S6) | Waghadih (S7) | Majhigawa (S8) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | -- | 8.0 | 7.8 | 7.9 | 8.1 | 7.8 | 8.0 | 7.9 | 8.0 |
| 2 | Conductivity | µs/cm | 201 | 187 | 149 | 153 | 161 | 159 | 214 | 167 |
| 3 | Texture | -- | Silt clay | Silt clay | Clay | Clay | Clay | Clay | Silt clay | Clay |
| 4 | Sand | % | 19 | 25 | 23 | 18 | 21 | 26 | 12 | 18 |
| 5 | Silt | % | 35 | 30 | 25 | 38 | 38 | 40 | 43 | 34 |
| 6 | Clay | % | 46 | 45 | 52 | 44 | 41 | 42 | 45 | 48 |
| 7 | Bulk Density | g/cc | 1.1 | 1.2 | 1.3 | 1.1 | 1.1 | 1.1 | 1.2 | 1.2 |
| 8 | Exchangeable Calcium as Ca | mg/kg | 2214 | 2986 | 3214 | 2454 | 3121 | 3372 | 3082 | 2581 |
| 9 | Exchangeable Magnesium as Mg | mg/kg | 247 | 384 | 326 | 249 | 258 | 308 | 258 | 311 |
| 10 | Exchangeable Sodium as Na | mg/kg | 135.2 | 130.2 | 128.4 | 111.8 | 101.6 | 113.8 | 130.9 | 121.9 |
| 11 | Available Potassium as K | Kg/ha | 512.4 | 513.6 | 761.4 | 698.5 | 511.2 | 605.2 | 654.1 | 611.2 |
| 12 | Available Phosphorous | Kg/ha | 158.6 | 213.5 | 266.4 | 248.4 | 208.5 | 148.2 | 201.5 | 188.4 |
| 13 | Available Nitrogen as N | Kg/ha | 56.6 | 60.4 | 86.8 | 78.7 | 53.7 | 56.5 | 59.5 | 61.7 |
| 14 | Fluorides as F | mg/kg | 46.5 | 48.2 | 53.6 | 45.9 | 51.3 | 56.3 | 50.6 | 48.6 |
| 15 | Organic Matter | % | 1.38 | 1.41 | 1.75 | 1.64 | 1.59 | 1.52 | 1.37 | 1.51 |
| 16 | Water soluble chloride as Cl | mg/kg | 141.2 | 146.1 | 158.8 | 151.2 | 153.2 | 133.2 | 126.9 | 131.4 |
| 17 | Water soluble sulphates as SO4 | mg/kg | 12.1 | 21.2 | 12.9 | 15.7 | 17.8 | 14.8 | 15.5 | 15.1 |
| 18 | Sodium Absorption Ratio | mg/kg | 0.16 | 0.11 | 0.07 | 0.10 | 0.13 | 0.20 | 0.15 | 0.16 |

## TABLE-3.3.3
## SOIL ANALYSIS RESULTS (PRE-MONSOON)

| Sr.No | Parameter | UOM | Plant site (S1) | Bargawan (S2) | Gidher (S3) | Orgari (S4) | Barauniya (S5) | Barokhar (S6) | Waghadih (S7) | Majhigawa (S8) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | -- | 7.2 | 7.4 | 7.1 | 6.9 | 7.5 | 7.2 | 7.4 | 7.1 |
| 2 | Conductivity | µs/cm | 80 | 103 | 58 | 73 | 89 | 73 | 66 | 57 |
| 3 | Texture | -- | Sandy Clay | Sandy Clay | Sandy Clay | Sandy Clay | Sandy Clay | Sandy Clay | Sandy Clay | Sandy Clay |
| 4 | Sand | % | 52 | 56 | 59 | 51 | 48 | 45 | 51 | 59 |
| 5 | Silt | % | 22 | 16 | 24 | 17 | 18 | 22 | 12 | 18 |
| 6 | Clay | % | 26 | 28 | 17 | 32 | 34 | 33 | 37 | 23 |
| 7 | Bulk Density | g/cc | 1.2 | 1.1 | 1.2 | 1.1 | 1.2 | 1.1 | 1.1 | 1.1 |
| 8 | Exchangeable Calcium as Ca | mg/kg | 1999 | 1760 | 556 | 2076 | 2696 | 2626 | 1076 | 515 |
| 9 | Exchangeable Magnesium as Mg | mg/kg | 291 | 267 | 169 | 194 | 434 | 435 | 315 | 120 |
| 10 | Exchangeable Sodium as Na | mg/kg | 59 | 75 | 98 | 76 | 92 | 67 | 81 | 88 |
| 11 | Available Potassium as K | Kg/ha | 281 | 328 | 371 | 445 | 418 | 298 | 393 | 453 |
| 12 | Available Phosphorous as P | Kg/ha | 101 | 81 | 95 | 77 | 70 | 65 | 96 | 85 |
| 13 | Available Nitrogen as N | Kg/ha | 48 | 39 | 32 | 54 | 70 | 73 | 55 | 30 |
| 14 | Organic Matter | % | 0.41 | 0.37 | 0.28 | 0.51 | 0.6 | 0.69 | 0.51 | 0.28 |
| 15 | Organic Carbon | % | 0.24 | 0.21 | 0.16 | 0.3 | 0.35 | 0.4 | 0.3 | 0.16 |
| 16 | Water soluble chloride as Cl | mg/kg | 70.9 | 52.92 | 70.65 | 52.71 | 70.62 | 52.89 | 70.66 | 70.6 |
| 17 | Water soluble sulphates as SO4 | mg/kg | 58.71 | 69.67 | 43.72 | 20.78 | 26.35 | 32.73 | 28.61 | 38.87 |
| 18 | Sodium Absorption Ratio | mg/kg | 0.15 | 0.2 | 0.42 | 0.19 | 0.19 | 0.14 | 0.25 | 0.41 |
| 19 | Aluminum | % | 1.92 | 2.32 | 1.88 | 1.94 | 1.87 | 1.98 | 2.06 | 1.81 |
| 20 | Total Iron | % | 1.36 | 1.49 | 1.92 | 1.73 | 1.88 | 1.66 | 1.83 | 1.42 |
| 21 | Manganese | mg/kg | 125.8 | 182.8 | 162.4 | 174.2 | 142.4 | 188.4 | 146.8 | 171.5 |
| 22 | Boron | mg/kg | 36.8 | 42.8 | 39.2 | 49.4 | 32.4 | 36.3 | 29.6 | 34.2 |
| 23 | zinc | mg/kg | 137.2 | 164.8 | 124.2 | 124 | 142.8 | 108.2 | 92.8 | 104.5 |

## TABLE-3.3.4
## SOIL ANALYSIS RESULTS (POST-MONSOON)

| Sr.No | Parameter | UOM | Plant site (S1) | Bargawan (S2) | Gidher (S3) | Orgari (S4) | Barauniya (S5) | Barokhar (S6) | Waghadih (S7) | Majhigawa (S8) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | -- | 5.6 | 5.8 | 6.1 | 6.5 | 6.5 | 6.8 | 6.1 | 6.4 |
| 2 | Conductivity | µs/cm | 80 | 103 | 58 | 73 | 89 | 73 | 66 | 57 |
| 3 | Texture | -- | Sandy clay | Sandy clay | Silty Clay | Sandy Clay | Sandy Clay | Sandy Clay | Silty Clay | Sandy Clay |
| 4 | Sand | % | 47 | 46 | 45 | 48 | 47 | 51 | 45 | 52 |
| 5 | Silt | % | 15 | 18 | 43 | 8 | 14 | 8 | 45 | 8 |
| 6 | Clay | % | 38 | 36 | 12 | 44 | 39 | 41 | 10 | 40 |
| 7 | Bulk Density | g/cc | 1.2 | 1.1 | 1.2 | 1.1 | 1.2 | 1.1 | 1.1 | 1.2 |
| 8 | Exchangeable Calcium as Ca | mg/kg | 1999 | 1760 | 556 | 2076 | 2696 | 2626 | 1076 | 515 |
| 9 | Exchangeable Magnesium as Mg | mg/kg | 291 | 267 | 169 | 194 | 434 | 435 | 315 | 120 |
| 10 | Exchangeable Sodium as Na | mg/kg | 59 | 75.5 | 98.3 | 76.3 | 91.7 | 67.1 | 80.7 | 88.2 |
| 11 | Available Potassium as K | Kg/ha | 280.7 | 328.1 | 371.2 | 444.9 | 417.6 | 298.5 | 428.5 | 452.8 |
| 12 | Available Phosphorous as P | Kg/ha | 101 | 81 | 95 | 77.3 | 70.5 | 65.1 | 104.7 | 84.6 |
| 13 | Available Nitrogen as N | Kg/ha | 47.9 | 39 | 32.3 | 54.2 | 69.8 | 73.1 | 59.5 | 29.6 |
| 14 | Organic Matter | % | 0.41 | 0.37 | 0.28 | 0.51 | 0.6 | 0.69 | 0.51 | 0.28 |
| 15 | Organic Carbon | % | 0.24 | 0.21 | 0.16 | 0.3 | 0.35 | 0.40 | 0.30 | 0.16 |
| 16 | Water soluble chloride as Cl | mg/kg | 70.9 | 52.9 | 70.7 | 52.7 | 70.6 | 52.9 | 70.7 | 70.6 |
| 17 | Water soluble sulphates as SO4 | mg/kg | 58.7 | 69.7 | 43.7 | 20.8 | 26.3 | 32.7 | 28.6 | 38.9 |
| 18 | Sodium Absorption Ratio | mg/kg | 0.15 | 0.2 | 0.42 | 0.19 | 0.19 | 0.14 | 0.25 | 0.41 |
| 19 | Aluminum | % | 1.77 | 1.82 | 0.75 | 1.61 | 1.55 | 1.01 | 1.57 | 1.43 |
| 20 | Total Iron | % | 0.75 | 0.89 | 0.45 | 1.02 | 1.08 | 0.95 | 1.22 | 1.18 |
| 21 | Manganese | mg/kg | 102.3 | 86.5 | 137.9 | 294.1 | 312.6 | 188.2 | 243.2 | 201.2 |
| 22 | Boron | mg/kg | 11.9 | 14.4 | 13.2 | 9.4 | 10.5 | 16.2 | 7.6 | 11.2 |
| 23 | zinc | mg/kg | 75.9 | 46.5 | 38.6 | 61.4 | 56.3 | 62.0 | 37.3 | 44.4 |

### 3.3.2 Baseline Soil Status winter Season (2007-08)

It has been observed that the texture of soil is mostly clay in the study area. It has been observed that the pH of the soil ranged from 7.8 to 8.1, indicates moderately alkaline in nature.

The electrical conductivity was observed to be in the range of 149 - 214 μS/cm, with the maximum observed at Wagadih village (S7) and the minimum at Gidher village (S3) during the study period.

The phosphorus values ranged between 148.2 - 266.4 Kg/ha. The maximum value (266.4) was found at Gidher village (S3) and the minimum value (148.2) at Barokhar village (S6). The phosphorous values are varying from sufficient to more than sufficient category.

The nitrogen values ranged between 53.7- 86.8 Kg/ha. The maximum value was observed at Gidher village. The minimum value was observed at Barauniya village. The nitrogen values are varying from very less to less category, hence not very suitable for agriculture.

The potassium values ranged between 511.2-761.4 kg/ha. The maximum value was found at Gidher village and the minimum value was observed at Barauniya village. The potassium values are varying from less to more than sufficient category.

### 3.3.3 Baseline Soil Status Pre-Monsoon Season (2008)

It has been observed that the texture of soil is mostly clay in the study area. It has been observed that the pH of the soil ranged from 6.9 to 7.5, indicates moderately alkaline in nature.

The electrical conductivity was observed to be in the range of 57 - 103 μS/cm, with the maximum observed at Bargawan village (S2) and the minimum at Majhigawa village (S8) during the study period.

The phosphorus values ranged between 65 - 101 Kg/ha. The maximum value (101) was found at Plant Site and the minimum value (65) at Barokhar village. The phosphorous values are varying from on an average sufficient to more than sufficient category.

The nitrogen values ranged between 30- 73 Kg/ha. The maximum value was observed at Barokhar village. The minimum value was observed at Majhigawa village. The nitrogen values are varying from very less to less category, hence not very suitable for agriculture.

The potassium values ranged between 281-453 kg/ha. The maximum value was found at Majhigawa village and the minimum value was observed at plant site. The potassium values are varying from average to more than sufficient category.

### 3.3.4 Baseline Soil Status Post-Monsoon Season (2008)

It has been observed that the texture of soil is mostly clay in the study area. It has been observed that the pH of the soil ranged from 5.6 to 6.8, indicates moderately alkaline in nature.

The electrical conductivity was observed to be in the range of 57 - 103 μS/cm, with the maximum observed at Bargawan village (S2) and the minimum at Majhigawa village (S8) during the study period.

The phosphorus values ranged between 65.1-104.7 Kg/ha. The maximum value (104.7) was found at Waghadih village (S7) and the minimum value (65.1) at Barokhar village(S6). The phosphorous values are varying from on an average sufficient to more than sufficient category.

The nitrogen values ranged between 29.6- 73.1 Kg/ha. The maximum value was observed at Barokhar village(S6). The minimum value was observed at Majhigawa village. The nitrogen values are varying from very less to less category, hence not very suitable for agriculture.

The potassium values ranged between 280.7-452.8 kg/ha. The maximum value was found at Majhigawa village (S8) and the minimum value was observed at Plant site (S1). The potassium values are varying from average to more than sufficient category.

**TABLE-3.3.5**
**STANDARD SOIL CLASSIFICATION**

| Sr. No. | Soil Test | Classification |
|---|---|---|
| 1 | pH | <4.5 extremely acidic<br>4.51- 5.50 very strongly acidic<br>5.51-6.0 moderately acidic<br>6.01-6.50 slightly acidic<br>6.51-7.30 neutral<br>7.31-7.80 slightly alkaline<br>7.81-8.50 moderately alkaline<br>8.51-9.0 strongly alkaline<br>9.01 very strongly alkaline |
| 2 | Salinity Electrical Conductivity (mmhos/cm)<br>(1 ppm = 640 mmho/cm) | Upto 1.00 average<br>1.01-2.00 harmful to germination<br>2.01-3.00 harmful to crops (sensitive to salts) |
| 3 | Organic Carbon | Upto 0.2: very less<br>0.21-0.4: less<br>0.41-0.5 medium,<br>0.51-0.8: on an average sufficient<br>0.81-1.00: sufficient<br>>1.0 more than sufficient |
| 4 | Nitrogen (Kg/ha) | Upto 50 very less<br>51-100 less<br>101-150 good<br>151-300 better |

| Sr. No. | Soil Test | Classification |
|---|---|---|
| | | >300 sufficient |
| 5 | Phosphorus (Kg/ha) | Upto 15 very less<br>16-30 less<br>31-50 medium,<br>51-65 on an average sufficient<br>66-80 sufficient<br>>80 more than sufficient |
| 6 | Potash (Kg/ha) | 0 -120 very less<br>120-180 less<br>181-240 medium<br>241-300 average<br>301-360 better<br>>360 more than sufficient |

*Source: Handbook of Agriculture, ICAR, New Delhi*

## 3.4 Meteorology

The meteorological data recorded during the monitoring period is very useful for proper interpretation of the baseline information as well as for input prediction models for air quality dispersion. Historical data on meteorological parameters will also play an important role in identifying the general meteorological regime of the region.

The year may broadly be divided into four seasons:

- Winter season : December to February
- Pre-monsoon season : March to May
- Monsoon season : June to September
- Post-monsoon season : October to November

On-site monitoring was undertaken for various meteorological variables in order to generate the site-specific data. The central micro-meteorological station was installed near Barauniya village at a height of about 4-m from ground level free from any obstruction. Data was collected at every hour continuously from $1^{st}$ December 2007 to $29^{th}$ February 2008, $1^{st}$ March to $31^{st}$ May 2008 and $1^{st}$ September 2008 to $31^{st}$ December 2008. The data generated is then compared with the meteorological data generated by nearest India Meteorological Department (IMD) station located at Sidhi. The available meteorological data of IMD, Sidhi station has been collected and analyzed.

### 3.4.1 Meteorological Data Generated at site

The meteorological parameters were recorded on hourly basis during the study period and comprises of parameters like wind speed, wind direction (from 0 to 360 degrees), temperature, relative humidity, atmospheric pressure, rainfall and cloud cover. The maximum, minimum and average values for all the parameters except wind speed and direction are presented in **Table-3.4.1**.

**TABLE-3.4.1**
**SUMMARY OF THE METEOROLOGICAL DATA GENERATED AT SITE**

| Month | Temperature ($^0C$) | | Relative Humidity (%) | | Rainfall (mm) | Atmospheric Pressure (mb) | |
|---|---|---|---|---|---|---|---|
| | Max | Min | Max | Min | | Max | Min |
| December, 2006 | 24.3 | 8.0 | 65 | 50 | 0.0 | 987.1 | 984.3 |
| January, 2007 | 31.4 | 9.2 | 68 | 47 | 0.0 | 988.4 | 983.5 |
| February, 2007 | 32.3 | 12.2 | 66 | 44 | 0.0 | 986.6 | 981.4 |
| March-2008 | 38.5 | 16.6 | 48 | 28 | 0.0 | 980 | 978 |
| April, 2008 | 44.4 | 25.9 | 37 | 24 | 0.0 | 979 | 975 |
| May, 2008 | 44.8 | 28.9 | 50 | 36 | 0.0 | 975 | 973 |
| June, 2008 | 41.0 | 25.1 | 70 | 60 | 200.0 | 970 | 966.0 |
| July-2008 | 36.7 | 25.0 | 84 | 78 | 650.2 | 965 | 961.5 |
| August-2008 | 35.6 | 24.8 | 82 | 70 | 125.5 | 971.5 | 967.8 |
| Septermber-2008 | 35.1 | 22.9 | 85 | 72 | 187.6 | 975.7 | 972.1 |
| October-2008 | 34.5 | 14.6 | 95 | 48 | 10.2 | 978.5 | 974.2 |
| November-2008 | 30.1 | 8.0 | 70 | 50 | 25.3 | 980.5 | 978.6 |

- ***Wind Speed/ Direction***

The windrose for the study period representing winter, pre-monsoon, monsoon and post-monsoon season is shown in **Figure-3.4.1 to Figure-3.4.5** and presented in **Table-3.4.2.**

**TABLE-3.4.2**
**SUMMARY OF WIND PATTERN AT THE STUDY AREA**

| Season | First Predominant Wind Direction | Second Predominant Wind Direction | Predominant Wind Speeds (kmph) | Calm (%) |
|---|---|---|---|---|
| Post Monsoon (2008) | N (13.6%) | WNW (8.9%) | 1 - 19 | 33.0 |
| Winter (2007-08) | W (11.5%) | E (3.3%) | 1 - 19 | 70.0 |
| Pre-Monsoon (2008) | WNW (1.5%) | W (14.6%) | 1-19 | 34.8 |
| Monsoon ( 2008) | W(26.3%) | E(6.72%) | 1-19 | 52.3 |

*Note: Figures in parenthesis indicates percentage of time wind blows*

**Winter Season**

Predominant winds from West direction were observed for 11.5 % of the total time. In E direction the winds were observed for 3.3 % where as in WNW direction winds were observed for 2.7 %. In other directions, the percentage frequencies observed were NW (1.6%), NNW (2.3%), N (2.2%), NNE (0.6%), NE (0.6%), ENE (0.5%), ESE (0.6%), SE (0.0%), SSE(0.5%), S (1.5%), SSW (1.0%), SW (0.6%) and WSW (0.5 %). Calm conditions prevailed for 70.0 % of the total time.

**Pre-Monsoon**

Predominant winds from WNW direction were observed for 15 % of the total time, with wind speeds (% frequencies) in the range of 1.0-5.0 kmph (25.5%). In the

West direction the winds were observed for 14.6% of the total time, with wind speeds (% frequencies) in the range of 1.0-5.0 kmph (10.3 %), 5.0-11.0 kmph (3.8 %). Where as in E direction the winds were observed for 5.4% of the total time. In other directions the percentage frequencies observed were NW (5.1%), NNW (1.6%), N (0.7%), NNE (0.8%), NE (2.3%), ENE (1.9%), ESE (2.8%), SE (1.8%), SSE (1.8%), S (2.2%) SSW (3.1%) SW (2.6%) and WSW (3.5%). Calm conditions prevailed for 34.8% of the total time.

**Monsoon Season**

Predominant winds from West direction were observed for 17.3% of the total time, with wind speeds (% frequencies) in the range of 1.0-5.0 kmph (17.3%). In the South West direction the winds were observed for 8.2% of the total time, with wind speeds (% frequencies) in the range of 1.0-5.0 kmph (6.8 %), 5.0-11.0 kmph (1.4 %). Where as in E direction the winds were observed for (7.3%) of the total time. In other directions the percentage frequencies observed were WNW (2.1%), NW (2.7%), NW (2.2%), N (1.9%), NNE (2.3%), NE (1.2%), ENE (1.2%), ESE (0.7%), SE (1.9%) SSE (0.6%) S (1.3%), SSW(0.7%), and WSW (1.4%). Calm conditions prevailed for 47.0% of the total time.

**Post-monsoon Season**

Predominant winds from North direction were observed for 13.6% of the total time. In WNW direction the winds were observed for 8.9% where as in NW direction winds were observed for 7.6%. In other directions, the percentage frequencies observed were NNW (5.0%), NNE (2.9%), NE (2.3%), ENE (1.5%), E (3.0%), ESE (3.1%), SE (1.2%), SSE (1.1%), S (1.9%), SSW (1.9%), SW (2.1%), WSW (4.9%), and W (6.0%) . Calm conditions prevailed for 33.0% of the total time.

### 3.4.2 Secondary Data collected from IMD- Sidhi

Secondary data from IMD- Sidhi has been collected for pressure, temperature, relative humidity, rainfall, evaporation, wind speed and direction. The data at IMD is usually measured twice a day viz., at 0830 and 1730 hr.

#### *3.4.2.1 Meteorological Data*

The secondary meteorological data is collected from the IMD-Sidhi which is the nearest IMD station to the proposed project. The data collected from IMD includes wind speed, wind direction (recorded in sixteen directions), temperature, relative humidity, atmospheric pressure, rainfall and cloud cover over a period of 10 years. The monthly maximum, minimum and average values are collected for all the parameters except wind speed and direction. The collected data is tabulated in **Table-3.4.3.**

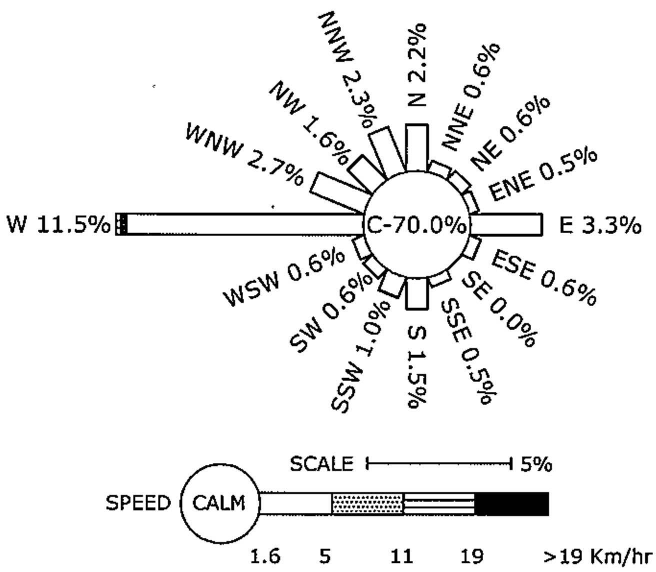



**FIGURE-3.4.1**
**SITE SPECIFIC WINDROSE-WINTER SEASON**

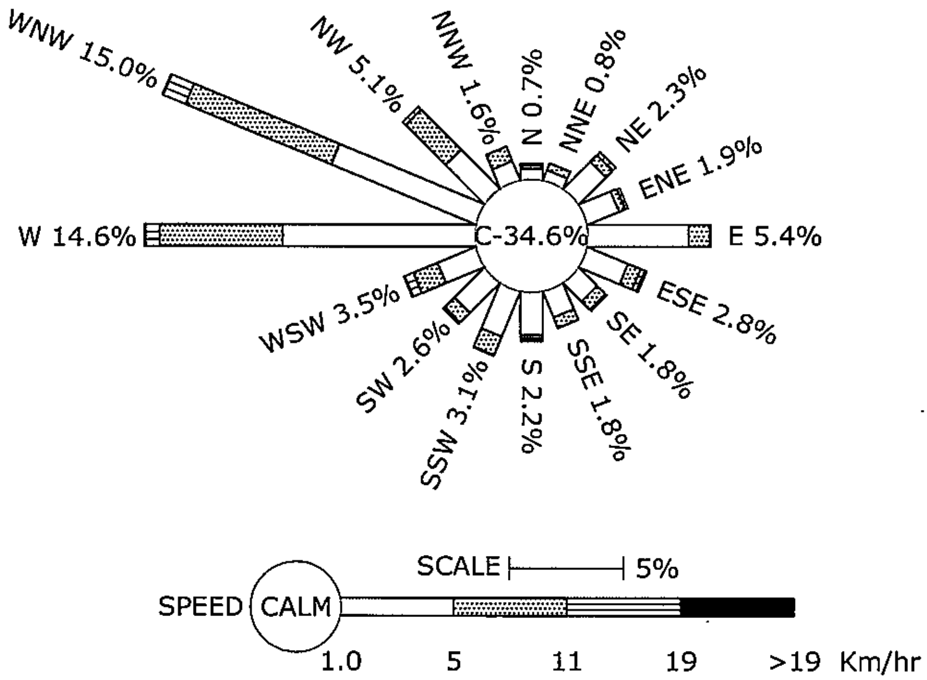



**FIGURE-3.4.2**
**SITE SPECIFIC WINDROSE-PRE-MONSOON SEASON**

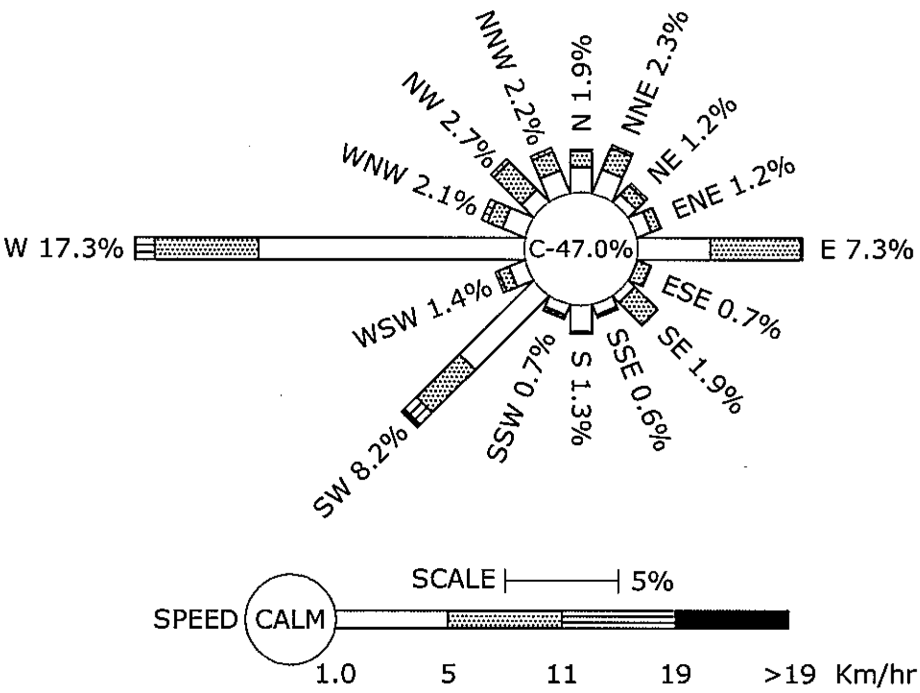



**FIGURE-3.4.3**
**SITE SPECIFIC WINDROSE-MONSOON SEASON**

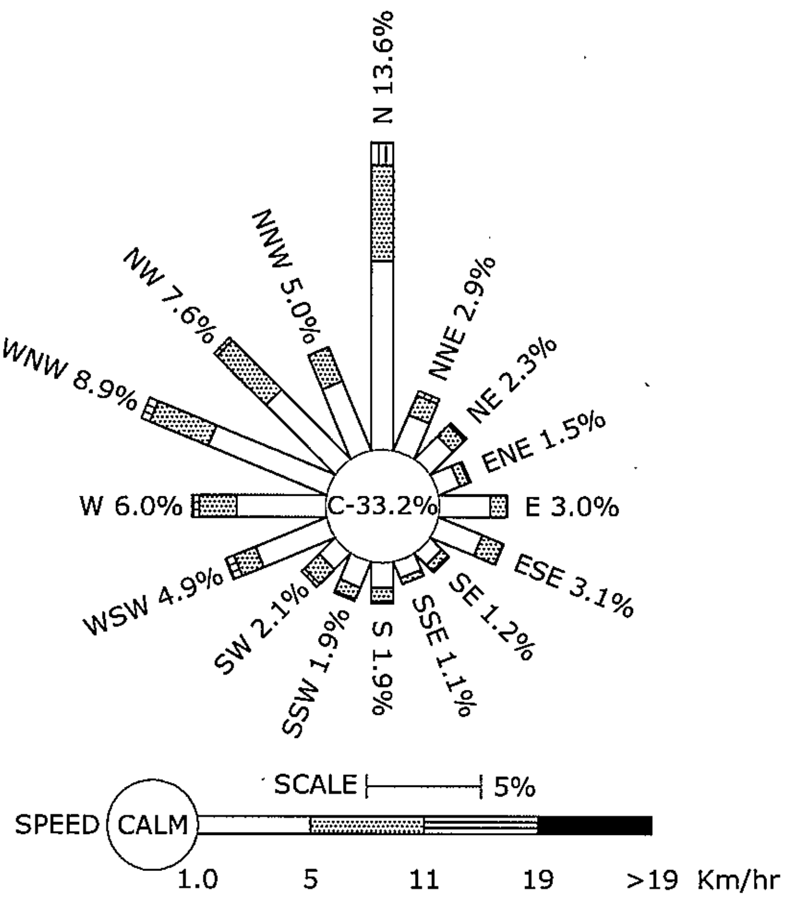



**FIGURE-3.4.4**
**SITE SPECIFIC WINDROSE-POST MONSOON**

**TABLE-3.4.3**
**CLIMATOLOGICAL DATA-STATION: IMD, SIDHI**

| Month | Atmospheric Pressure (Mb) | | Temperature (°C) | | Relative Humidity (%) | | Rainfall (mm) |
|---|---|---|---|---|---|---|---|
| | 0830 | 1730 | Max | Min | 0830 | 1730 | |
| January | 985.4 | 982.1 | 32.4 | 8.5 | 73 | 42 | 0.0 |
| February | 983.4 | 980.0 | 31.2 | 11.0 | 67 | 36 | 0.0 |
| March | 981.0 | 977.0 | 37.6 | 15.5 | 46 | 25 | 0.0 |
| April | 977.0 | 972.8 | 43.4 | 22.8 | 34 | 20 | 0.0 |
| May | 972.8 | 968.4 | 44.8 | 27.6 | 49 | 33 | 40.0 |
| June | 969.0 | 965.4 | 41.0 | 26.9 | 70 | 59 | 177.0 |
| July | 968.5 | 965.7 | 37.8 | 25.5 | 82 | 77 | 665.8 |
| August | 969.9 | 967.2 | 36.0 | 25.7 | 80 | 72 | 147.4 |
| September | 974.2 | 971.0 | 35.6 | 23.8 | 84 | 75 | 204.4 |
| October | 980.0 | 976.8 | 37.4 | 20.3 | 68 | 46 | 0.0 |
| November | 984.1 | 980.8 | 34.0 | 14.4 | 64 | 50 | 0.0 |
| December | 985.9 | 982.6 | 29.6 | 8.0 | 66 | 49 | 0.0 |
| Total Rainfall | | | | | | | 1234.6 |

*3.4.2.2 Wind Speed / Direction*

Generally, light to moderate winds prevails throughout the year. Winds were light and moderate particularly during the morning hours. While during the afternoon hours the winds were stronger. The wind roses for the study period representing winter, pre-monsoon, monsoon and post-monsoon seasons along with annual windrose are shown in **Figure-3.4.6** and **Figure-3.4.7** and presented in **Table-3.4.4.**

**TABLE-3.4.4**
**SUMMARY OF WIND PATTERN – IMD SIDHI**

| Season | First predominant winds | | Second predominant winds | | Calm condition (%) | |
|---|---|---|---|---|---|---|
| | 0830 | 1730 | 0830 | 1730 | 0830 | 1730 |
| **Winter** | West (4.5 %) | West (10.7 %) | East (2.2 %) | East (3.3 %) | 93.0 | 80.0 |
| **Pre-Monsoon** | West (16.7 %) | West (47.3 %) | East (4.3 %) | East (6.4 %) | 75.6 | 35.3 |
| **Monsoon** | West (29.2 %) | West (25.2 %) | East (8.0 %) | East (7.5 %) | 55.8 | 59.5 |
| **Post Monsoon** | West (4.0 %) | West (4.5 %) | East (1.5 %) | East (2.5 %) | 93.5 | 91.5 |
| **Annual** | West (13.6 %) | West (21.8 %) | East (4.0 %) | East (4.9 %) | 79.5 | 66.6 |

*Note: Figures in parenthesis indicates % of time wind blows*

3.4.3 Comparison of Primary and Secondary Data

The India Meteorological Department (IMD) records the data at two times a day viz. 0830 hr and 1730 hr while the site-specific data has been recorded at an hourly interval. On comparison of site specific data generated for study period vis-à-vis the IMD data, slight variations were observed. The following observations are brought out:

- The temperature recorded on site when compared vis-à-vis the IMD data, slight variations were found. The mean maximum and mean minimum temperatures recorded at site during study period were 44.8°C and 8.0° C, whereas the maximum and minimum values recorded at IMD-Sidhi during the same period are 32.4°C and 8.0°C respectively;

- The Relative Humidity was observed to range from 20–84% during the study period at the site, whereas according to IMD-Sidhi the Relative Humidity was observed to be in the range of 36–73% during the same season;

- The wind pattern of the study area is broadly in compassion with the IMD data.

The data generated at project site when compared with the data recorded at IMD, it is observed that the data generated at the site is broadly in comparison with regional meteorology, except for minor variations.

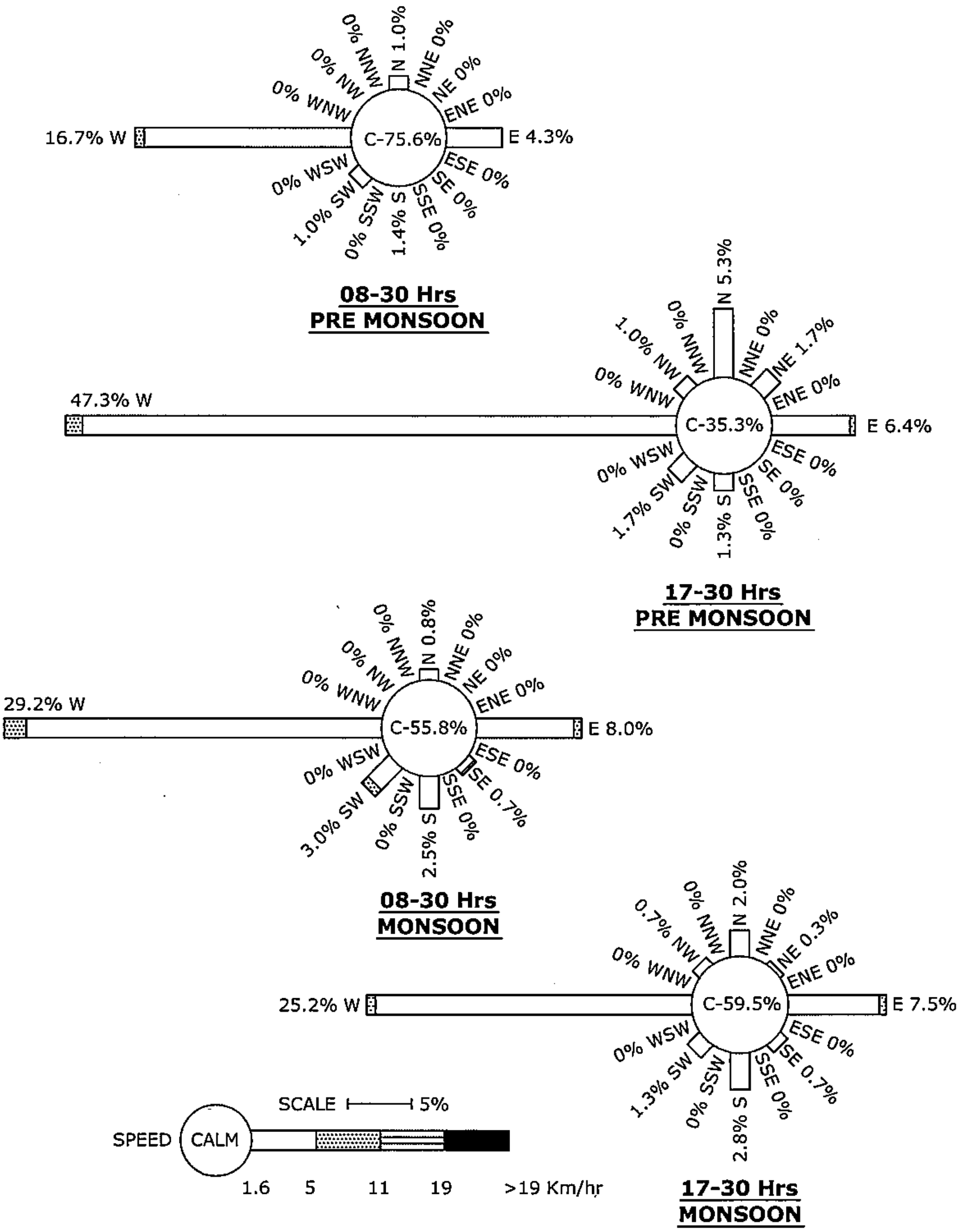
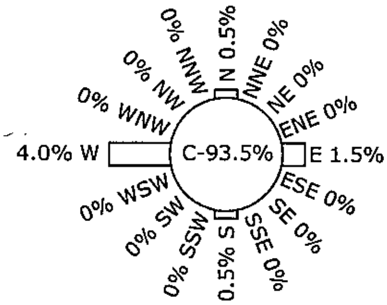
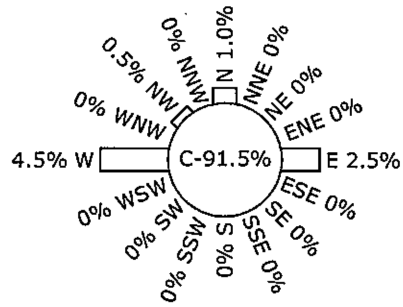


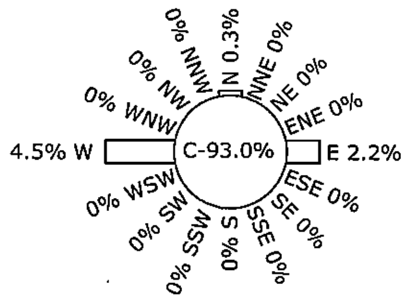

**FIGURE-3.4.6 (A)**
**SEASONAL WINDROSES - IMD SIDHI**



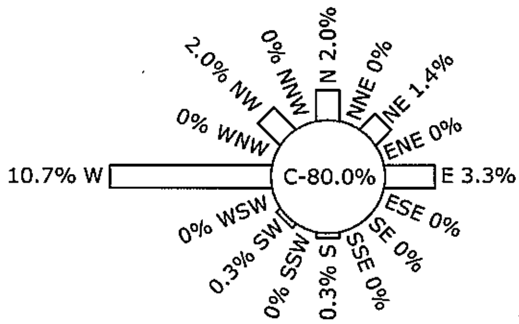

**08-30 Hrs**
**POST MONSOON**




**17-30 Hrs**
**POST MONSOON**




**08-30 Hrs**
**WINTER**




**17-30 Hrs**
**WINTER**

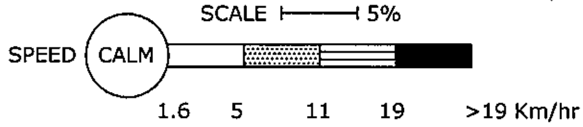
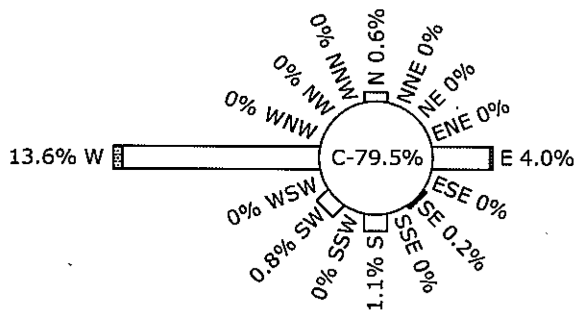
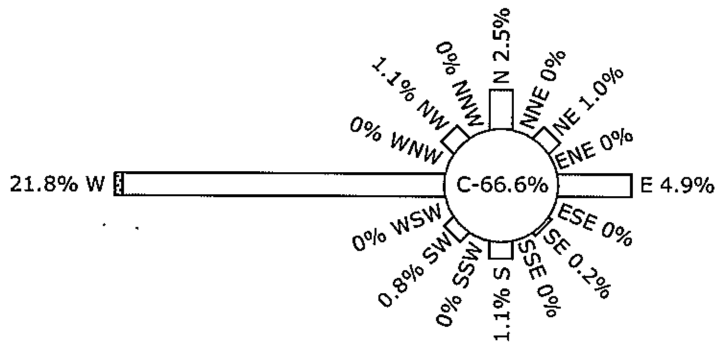



**FIGURE-3.4.6 (B)**
**SEASONAL WINDROSES – IMD SIDHI**




**08-30 Hrs**




**17-30 Hrs**

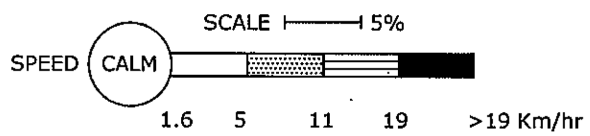



**FIGURE-3.4.7**
**ANNUAL WIND ROSE (IMD- SIDHI)**

## 3.5 Ambient Air Quality

The ambient air quality with respect to the study zone of 10-km radius around the proposed project site forms the baseline information. There are no industries in the study area. Vindhyanagar / Jayant - Singrauli Industrial areas are located more than 25-km from the proposed smelter site.

The primary sources of air pollution in the region are transportation and domestic activities. In addition at locations near the National Highway NH-75 traffic movement could be a major contributor. Dusty environment also contribute to the air pollution. The prime objective of the baseline air quality study was to assess the existing ambient air quality of the area. The study area represents mostly rural environment.

This section describes the selection of sampling locations, methodology adopted for sampling, analytical techniques and frequency of sampling. The AAQ monitoring has been carried out in the study area during 1st December 2007 to 28th February 2008 covering winter season, 1st March 2008 to 31st May 2008 covering pre-monsoon and 1st September to 31st December 2008 covering post-monsoon season.

### 3.5.1 Methodology adopted for Air Quality Survey

*3.5.1.1 Selection of Sampling Locations*

The baseline status of the ambient air quality has been assessed through a scientifically designed ambient air quality-monitoring network. The design of monitoring network in the air quality surveillance program has been based on the following considerations:

- Meteorological conditions on synoptic scale;
- Topography of the study area;
- Representatives of regional background air quality for obtaining baseline status; and
- Representatives of likely impact areas.

Ambient Air Quality Monitoring (AAQM) stations were set up at ***eight*** locations with due consideration to the above mentioned points. **Table-3.5.1** gives the details of environmental setting around each monitoring station. The location of the selected stations with reference to the project site is given in the same table and shown in **Figure-3.5.1**.

*3.5.1.2 Frequency and Parameters for Sampling*

Ambient air quality monitoring has been carried out with a frequency of two days per week at all locations during study period. The baseline data of air environment has been generated for the following parameters:

- Total Suspended Particulate Matter (TSPM);
- Respirable Particulate Matter (RPM);
- Sulphur dioxide ($SO_2$);
- Oxides of Nitrogen (NOx);
- Carbon Monoxide (CO);
- Fluoride (F); and
- PAH.

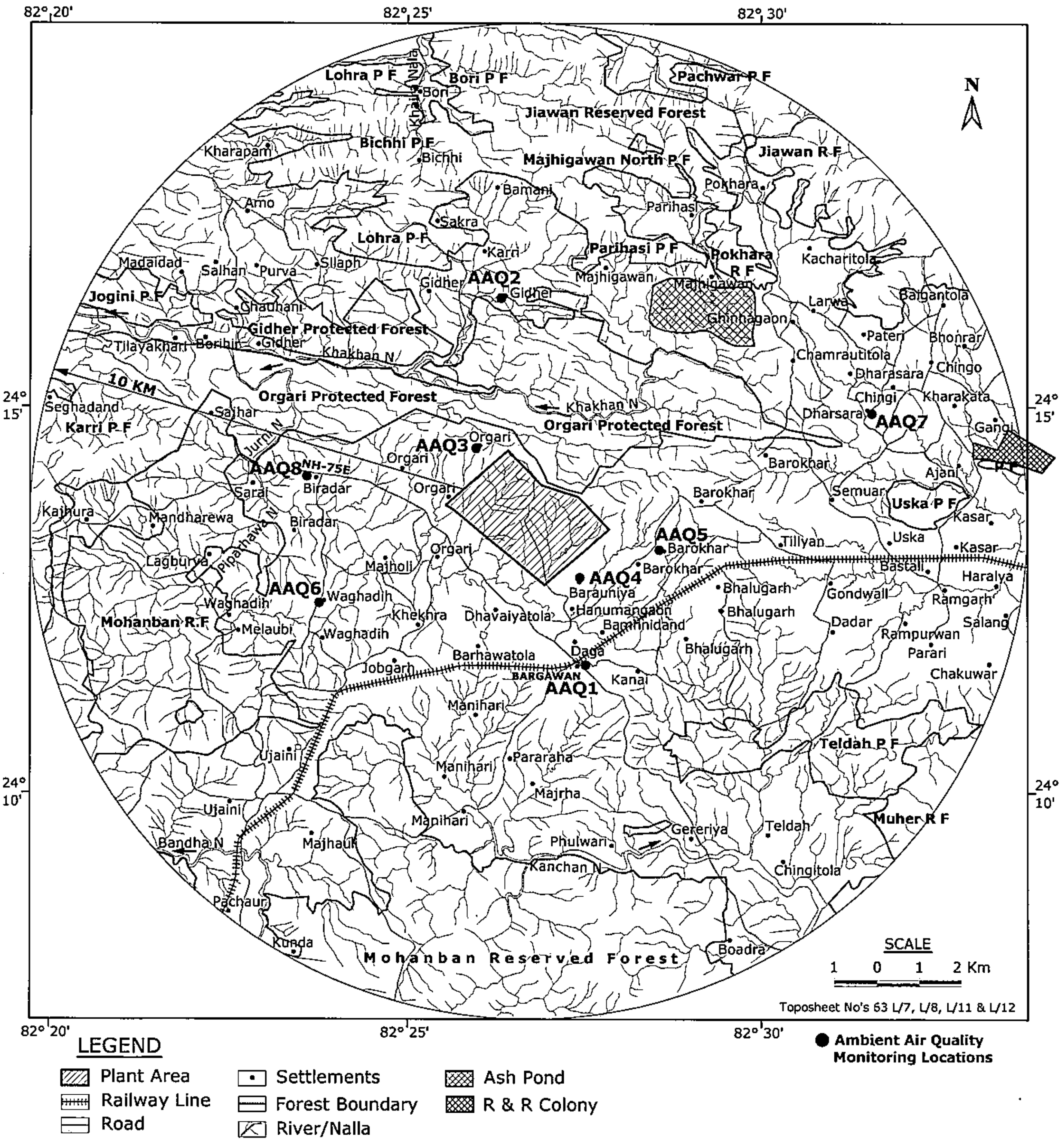



**FIGURE-3.5.1**
**AIR QUALITY SAMPLING LOCATIONS**

**TABLE-3.5.1**
**DETAILS OF AMBIENT AIR QUALITY MONITORING LOCATIONS**

| Station Code | Name of the Station | Distance from proposed site (km) | Direction w.r.t Proposed site | Environmental Setting |
|---|---|---|---|---|
| AAQ1 | Bargawan Village | 3.5 | S | Rural / Commercial |
| AAQ2 | Gidher Village | 5.0 | N | Rural residential |
| AAQ3 | Orgari Village | 1.9 | NW | Rural residential |
| AAQ4 | Barauniya Village (close to plant boundary) | 1.2 | SE | Rural residential |
| AAQ5 | Barokhar Village | 3.3 | E | Sensitive /residential |
| AAQ6 | Waghadih Village | 4.8 | W | Rural residential |
| AAQ7 | Dharsara Village | 7.5 | NE | Rural residential |
| AAQ8 | Biradar Village | 3.4 | W | Rural residential and also close to the NH – 75E |

*3.5.1.3 Duration of Sampling*

The sampling duration for Suspended Particulate Matter (RSPM & TSPM), $SO_2$, NOx, F and PAH is twenty-four hourly continuous samples per day. This is to allow a comparison with the present revised standards mentioned in the latest Gazette Notification of the Central Pollution Control Board (CPCB) (May 20, 1994). 8-hourly samples are collected for CO measurements.

*3.5.1.4 Method of Sampling and Analysis*

The method of sampling of various pollutants in ambient air and the analytical tests followed are given in **Annexure-III.**

The air samples were analyzed as per standard methods specified by Central Pollution Control Board (CPCB), IS: 5184 and American Public Health Association (APHA).

*3.5.1.5 Selection of Instruments for Air Quality Sampling*

Respirable Dust Samplers have been used for monitoring Total Suspended Particulate Matter (TSPM), Respirable fraction (<10 microns), Fluorides, PAH and gaseous pollutants like $SO_2$ and NOx. Glass tubes are deployed for collection of grab samples of Carbon monoxide.

3.5.2 Presentation of Primary Data – Baseline Air Quality

Various statistical parameters like $98^{th}$ percentile, average, maximum and minimum values have been computed from the observed raw data for all the AAQ monitoring stations. The summary of these results for winter, pre-monsoon and post-monsoon seasons are presented in **Table-3.5.2, 3.5.3 & 3.5.4.** The results of monitoring carried out for three months are presented in **Annexure-VI.** These are compared with the standards prescribed by Central Pollution Control Board (CPCB) for rural and residential zone.

- **Summary of Observations**

The results of the monitored data indicate that the ambient air quality of the region in general is in conformity with respect to rural / residential norms of the National Ambient Air Quality Standards of CPCB, with present level of activities.

- **winter season (2007-08)**

1] **TSPM**: The maximum value for TSPM is observed at Bargawan (AAQ1) station, as 143.7 μg/m$^3$ with the minimum value observed at Dharsara village (AQQ7) station as 59.4 μg/m$^3$ during the study period.

2] **RPM**: The maximum value for RPM is observed at Biradar village (AAQ8), as 47.5 μg/m$^3$ with the minimum value observed at Gidher village (AQQ2) as 20.7 μg/m$^3$ during the study period.

3] **$SO_2$:** The maximum value for $SO_2$ is observed to be 10.2 μg/m$^3$ at Biradar village (AAQ8) and the minimum concentration of $SO_2$ was observed at Waghadih Village (AAQ6) as 6.1 μg/m$^3$ during the study period.

4] **NOx:** The concentrations for NOx were ranged in 7.2 - 10.8 μg/m$^3$ in the study area with the maximum concentration of 10.8 μg/m$^3$ at Biradar Village (AAQ8) and the minimum value (8.2 μg/m$^3$) were observed at Dharsara (AAQ7)

5] **CO:** The maximum values of 399 μg/m$^3$ and 398 μg/m$^3$ of CO was observed at Biradar village (AAQ8) and Bargawan Village (AAQ1) respectively, where as the minimum concentration of 247 μg/m$^3$ of CO was observed at Gidher Village (AAQ2).

6] **Fluorides:** At all the location the fluoride concentrations were observed to be below the detectable limits of 0.1 μg/m$^3$.

7] **PAH:** The concentrations of PAH were observed less than 0.01 μg/m$^3$ in all locations during study period.

- **Pre-monsoon season (2008)**

1] **TSPM**: The maximum value for TSPM is observed at Bargawan (AAQ1) station, as 160.1 μg/m$^3$ with the minimum value observed at Dharsara village (AQQ7) station as 70.4 μg/m$^3$ during the study period.

2] **RPM**: The maximum value for RPM is observed at Biradar village (AAQ8), as 58.6 μg/m$^3$ with the minimum value observed at Orgari village (AQQ3) as 21.3 μg/m$^3$ during the study period.

3] **$SO_2$:** The maximum value for $SO_2$ is observed to be 8.2 μg/m$^3$ at Biradar village (AAQ8) and the minimum concentration of $SO_2$ was observed at Waghadih Village (AAQ6) as 4.0 μg/m$^3$ during the study period.

4] **NOx:** The concentrations for NOx were ranged in 6.3 - 10.7 $\mu g/m^3$ in the study area with the maximum concentration of 10.7 $\mu g/m^3$ at Biradar Village (AAQ8) and the minimum value (6.3 $\mu g/m^3$) were observed at Dharsara (AAQ7)

5] **CO:** The maximum values of 409 $\mu g/m^3$ and 404 $\mu g/m^3$ of CO was observed at Biradar village (AAQ8) and Bargawan Village (AAQ1) respectively, where as the minimum concentration of 257 $\mu g/m^3$ of CO was observed at Gidher Village (AAQ2).

6] **Fluorides:** At all the location the fluoride concentrations were observed to be below the detectable limits of 0.1 $\mu g/m^3$.

7] **PAH:** The concentrations of PAH were observed less than 0.01 $\mu g/m^3$ in all locations during study period.

- **Post Monsoon Season (2008)**

1] **TSPM**: The maximum value for TSPM is observed at Bargawan (AAQ1) station, as 139 $\mu g/m^3$ with the minimum value observed at Dharsara village (AQQ7) station as 60.9 $\mu g/m^3$ during the study period.

2] **RPM**: The maximum value for RPM is observed at Biradar village (AAQ8), as 46.0 $\mu g/m^3$ with the minimum value observed at Orgari village (AQQ3) as 18.6 $\mu g/m^3$ during the study period.

3] **$SO_2$:** The maximum value for $SO_2$ is observed to be 10.4 $\mu g/m^3$ at Dharsara village (AAQ7) and the minimum concentration of $SO_2$ was observed at Gidher Village (AAQ2) as 6.1 $\mu g/m^3$ during the study period.

4] **NOx:** The concentrations for NOx were ranged in 6.1 - 10.4 $\mu g/m^3$ in the study area with the maximum concentration of 10.4 $\mu g/m^3$ at Dharsara Village (AAQ7) and the minimum value (6.1 $\mu g/m^3$) were observed at Gidher (AAQ2)

5] **CO:** The maximum and minimum values of CO was observed 410 $\mu g/m^3$ and 258 $\mu g/m^3$ at Gidher village (AAQ2).

6] **Fluorides:** At all the location the fluoride concentrations were observed to be below the detectable limits of 0.1 $\mu g/m^3$.

7] **PAH:** The concentrations of PAH were observed less than 0.01 $\mu g/m^3$ in all locations during study period.

- ***Conclusions***

From the above analysis of the data, it infers that the air quality levels in the study area are of good quality and devoid of any pollution.

## TABLE-3.5.2
## SUMMARY OF AMBIENT AIR QUALITY RESULTS (WINTER SEASON, 2007-08)

| Station Code | Name of the Location | TSPM (µg/m³) | | | | RPM (µg/m³) | | | | $SO_2$ (µg/m³) | | | | NOx (µg/m³) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Max | Min | Avg | 98th %ile | Max | Min | Avg | 98th %ile | Max | Min | Avg | 98th %ile | Max | Min | Avg | 98th %ile |
| AAQ1 | Bargawan Village | 143.7 | 114.5 | 128.7 | 142.8 | 44.8 | 29.7 | 37.9 | 44.5 | 9.6 | 7.4 | 8.6 | 9.6 | 9.9 | 8.1 | 8.8 | 9.8 |
| AAQ2 | Gidher Village | 111.3 | 88.7 | 99.6 | 110.6 | 31.9 | 20.7 | 27.0 | 31.6 | 9.2 | 7.6 | 8.6 | 9.2 | 9.8 | 8.3 | 9.0 | 9.7 |
| AAQ3 | Orgari Village | 93.4 | 72.9 | 84.1 | 93.3 | 31.4 | 21.4 | 26.7 | 31.3 | 9.5 | 7.1 | 8.6 | 9.5 | 9.7 | 7.9 | 8.9 | 9.7 |
| AAQ4 | Barauniya Village | 103.6 | 69.8 | 91.0 | 103.4 | 31.4 | 21.2 | 27.2 | 31.3 | 9.2 | 7.1 | 8.0 | 9.2 | 9.6 | 8.4 | 9.0 | 9.6 |
| AAQ5 | Barokhar Village | 101.8 | 67.7 | 86.4 | 101.3 | 32.1 | 22.1 | 27.1 | 32.1 | 9.5 | 6.9 | 7.9 | 9.3 | 9.9 | 7.9 | 9.1 | 9.9 |
| AAQ6 | Waghadih Village | 100.5 | 62.4 | 83.8 | 99.1 | 32.1 | 21.2 | 25.5 | 30.5 | 8.2 | 6.1 | 7.3 | 8.2 | 9.5 | 7.3 | 8.7 | 9.5 |
| AAQ7 | Dharsara Village | 104.2 | 59.4 | 83.8 | 103.3 | 34.5 | 21.4 | 27.8 | 34.4 | 9.1 | 6.8 | 7.9 | 9.1 | 9.6 | 7.2 | 8.5 | 9.6 |
| AAQ8 | Biradar Village | 136.4 | 115.9 | 127.0 | 136.1 | 47.5 | 33.9 | 42.6 | 47.2 | 10.2 | 8.7 | 9.4 | 10.2 | 10.8 | 8.6 | 9.5 | 10.7 |
| **Study Area Range** | | **59.4 - 143.7** | | | | **20.7 - 47.5** | | | | **6.1 - 10.2** | | | | **7.2 - 10.8** | | | |

| Station Code | Name of the Location | CO (µg/m³) | | | | Fluoride (µg/m³) | PAH (µg/m³) |
|---|---|---|---|---|---|---|---|
| | | Max | Min | Avg | 98th %ile | | |
| AAQ1 | Bargawan Village | 398.0 | 359.0 | 379.8 | 397.6 | < 0.1 | <0.01 |
| AAQ2 | Gidher Village | 286.0 | 247.0 | 265.9 | 284.7 | < 0.1 | <0.01 |
| AAQ3 | Orgari Village | 300.0 | 260.0 | 278.1 | 298.7 | < 0.1 | <0.01 |
| AAQ4 | Barauniya Village | 320.0 | 275.0 | 297.6 | 319.2 | < 0.1 | <0.01 |
| AAQ5 | Barokhar Village | 325.0 | 290.0 | 308.0 | 324.2 | < 0.1 | <0.01 |
| AAQ6 | Waghadih Village | 300.0 | 261.0 | 276.6 | 298.7 | < 0.1 | <0.01 |
| AAQ7 | Dharsara Village | 307.0 | 258.0 | 278.4 | 305.7 | < 0.1 | <0.01 |
| AAQ8 | Biradar Village | 399.0 | 361.0 | 379.5 | 398.6 | < 0.1 | <0.01 |
| **Study Area Range** | | **247 - 399** | | | | **< 0.1** | **<0.01** |

| CPCB/ NAAQ Standards | TSPM | RPM | $SO_2$ | NOX | CO | $F^-$ | PAH |
|---|---|---|---|---|---|---|---|
| for Industrial Area | 500 | 150 | 120 | 120 | 5000 | No Standards | No Standards |
| For Rural/Residential Area | 200 | 100 | 80 | 80 | 2000 | | |
| For Sensitive Area | 100 | 75 | 30 | 30 | 1000 | | |

## TABLE-3.5.3
## SUMMARY OF AMBIENT AIR QUALITY RESULTS (PRE-MONSOON SEASON, 2008)

| Station Code | Name of the Location | TSPM (µg/m³) | | | | RPM (µg/m³) | | | | $SO_2$ (µg/m³) | | | | NOx (µg/m³) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Max | Min | Avg | 98th %ile | Max | Min | Avg | 98th %ile | Max | Min | Avg | 98th %ile | Max | Min | Avg | 98th %ile |
| AAQ1 | Bargawan Village | 160.1 | 120.6 | 148.3 | 159.6 | 49.6 | 37.2 | 45.5 | 49.5 | 6.7 | 5.7 | 6.2 | 6.7 | 9.2 | 7.9 | 8.4 | 9.1 |
| AAQ2 | Gidher Village | 120.9 | 98.6 | 98.6 | 119.9 | 41.4 | 30.6 | 30.6 | 41.3 | 7.4 | 5.8 | 6.5 | 7.2 | 9.6 | 7.4 | 8.6 | 9.6 |
| AAQ3 | Orgari Village | 102.9 | 83.3 | 93.8 | 102.9 | 33.4 | 21.3 | 27.8 | 33.3 | 7.3 | 5.2 | 6.4 | 7.3 | 8.8 | 7.3 | 8.3 | 8.8 |
| AAQ4 | Barauniya Village | 113.7 | 79.4 | 100.6 | 113.6 | 36.7 | 26.0 | 31.9 | 36.6 | 6.9 | 5.1 | 5.9 | 6.9 | 8.6 | 7.6 | 8.2 | 8.6 |
| AAQ5 | Barokhar Village | 111.3 | 77.2 | 96.1 | 110.6 | 35.7 | 25.7 | 30.8 | 35.5 | 7.2 | 4.7 | 5.8 | 7.1 | 8.7 | 7.1 | 8.2 | 8.7 |
| AAQ6 | Waghadih Village | 110.3 | 71.9 | 93.5 | 109.2 | 35.5 | 24.2 | 28.4 | 33.8 | 6.2 | 4.0 | 5.2 | 6.2 | 8.5 | 6.8 | 7.7 | 8.5 |
| AAQ7 | Dharsara Village | 113.3 | 70.4 | 93.5 | 112.1 | 43.1 | 30.4 | 36.5 | 42.5 | 7.1 | 4.8 | 5.8 | 7.1 | 8.9 | 6.3 | 8.0 | 8.9 |
| AAQ8 | Biradar Village | 145.8 | 125.4 | 136.7 | 145.5 | 58.6 | 44.9 | 53.4 | 58.2 | 8.2 | 5.6 | 7.4 | 8.2 | 10.7 | 8.2 | 9.7 | 10.7 |
| **Study Area Range** | | **70.4 – 160.1** | | | | **21.3 – 58.6** | | | | **4.0 – 8.2** | | | | **6.3– 10.7** | | | |

| Station Code | Name of the Location | CO (µg/m³) | | | | Fluoride (µg/m³) | PAH (µg/m³) |
|---|---|---|---|---|---|---|---|
| | | Max | Min | Avg | 98th %ile | | |
| AAQ1 | Bargawan Village | 404 | 369 | 386 | 402 | < 0.1 | <0.01 |
| AAQ2 | Gidher Village | 299 | 257 | 278 | 296 | < 0.1 | <0.01 |
| AAQ3 | Orgari Village | 314 | 273 | 290 | 310 | < 0.1 | <0.01 |
| AAQ4 | Barauniya Village | 330 | 285 | 309 | 329 | < 0.1 | <0.01 |
| AAQ5 | Barokhar Village | 338 | 300 | 319 | 336 | < 0.1 | <0.01 |
| AAQ6 | Waghadih Village | 313 | 272 | 289 | 310 | < 0.1 | <0.01 |
| AAQ7 | Dharsara Village | 317 | 269 | 289 | 315 | < 0.1 | <0.01 |
| AAQ8 | Biradar Village | 409 | 371 | 390 | 408 | < 0.1 | <0.01 |
| **Study Area Range** | | **257 – 409** | | | | **< 0.1** | **<0.01** |

| CPCB/ NAAQ Standards | TSPM | RPM | $SO_2$ | NOX | CO | $F^-$ | PAH |
|---|---|---|---|---|---|---|---|
| for Industrial Area | 500 | 150 | 120 | 120 | 5000 | No Standards | No Standards |
| For Rural/Residential Area | 200 | 100 | 80 | 80 | 2000 | | |
| For Sensitive Area | 100 | 75 | 30 | 30 | 1000 | | |

## TABLE-3.5.4
## SUMMARY OF AMBIENT AIR QUALITY RESULTS (POST-MONSOON SEASON, 2008)

| Station Code | Name of the Location | TSPM ($\mu g/m^3$) | | | | RPM ($\mu g/m^3$) | | | | $SO_2$ ($\mu g/m^3$) | | | | NOx ($\mu g/m^3$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Max | Min | Avg | 98th %le | Max | Min | Avg | 98th %le | Max | Min | Avg | 98th %le | Max | Min | Avg | 98th %le |
| AAQ1 | Bargawan Village | 139.0 | 99.2 | 116.8 | 136.3 | 45.6 | 28.6 | 36.9 | 45.2 | 8.1 | 5.2 | 6.5 | 7.9 | 10.0 | 6.6 | 8.1 | 9.8 |
| AAQ2 | Gidher Village | 111.4 | 89.1 | 89.1 | 110.8 | 37.1 | 26.3 | 26.3 | 37.0 | 8.2 | 5.1 | 6.5 | 8.1 | 10.4 | 6.1 | 8.5 | 10.4 |
| AAQ3 | Orgari Village | 93.4 | 73.8 | 85.0 | 93.4 | 31.2 | 18.6 | 25.9 | 30.6 | 8.4 | 5.3 | 6.6 | 7.6 | 10.1 | 6.8 | 8.4 | 10.0 |
| AAQ4 | Barauniya Village | 104.2 | 69.9 | 89.4 | 104.1 | 32.6 | 21.4 | 27.5 | 32.0 | 8.4 | 5.1 | 6.6 | 7.7 | 10.4 | 6.6 | 8.5 | 10.3 |
| AAQ5 | Barokhar Village | 101.8 | 67.7 | 85.3 | 101.1 | 32.6 | 20.1 | 26.1 | 29.9 | 9.4 | 5.3 | 6.6 | 7.9 | 9.8 | 6.8 | 8.2 | 9.8 |
| AAQ6 | Waghadih Village | 100.8 | 62.4 | 83.4 | 99.7 | 32.9 | 21.6 | 26.3 | 31.2 | 7.9 | 5.2 | 6.3 | 7.8 | 10.3 | 6.7 | 8.5 | 10.0 |
| AAQ7 | Dharsara Village | 103.8 | 60.9 | 82.4 | 102.6 | 33.7 | 21.0 | 26.8 | 33.1 | 8.2 | 5.2 | 6.7 | 7.9 | 10.4 | 6.5 | 8.4 | 10.2 |
| AAQ8 | Biradar Village | 136.5 | 115.9 | 126.2 | 136.0 | 46.0 | 32.3 | 40.0 | 45.6 | 7.8 | 5.1 | 6.6 | 7.6 | 10.1 | 6.7 | 8.6 | 10.1 |
| **Study Area Range** | | **60.9 - 139** | | | | **18.6 - 46** | | | | **6.1 - 10.4** | | | | **6.1- 10.4** | | | |

| Station Code | Name of the Location | CO ($\mu g/m^3$) | | | | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) |
|---|---|---|---|---|---|---|---|
| | | Max | Min | Avg | 98th %le | | |
| AAQ1 | Bargawan Village | 399 | 264 | 334 | 399 | < 0.1 | <0.01 |
| AAQ2 | Gidher Village | 410 | 258 | 318 | 407 | < 0.1 | <0.01 |
| AAQ3 | Orgari Village | 406 | 261 | 315 | 400 | < 0.1 | <0.01 |
| AAQ4 | Barauniya Village | 405 | 263 | 319 | 404 | < 0.1 | <0.01 |
| AAQ5 | Barokhar Village | 408 | 274 | 323 | 405 | < 0.1 | <0.01 |
| AAQ6 | Waghadih Village | 410 | 266 | 318 | 405 | < 0.1 | <0.01 |
| AAQ7 | Dharsara Village | 403 | 263 | 313 | 402 | < 0.1 | <0.01 |
| AAQ8 | Biradar Village | 408 | 263 | 313 | 402 | < 0.1 | <0.01 |
| **Study Area Range** | | **258- 410** | | | | **< 0.1** | **<0.01** |

| CPCB/ NAAQ Standards | TSPM | RPM | $SO_2$ | NOX | CO | $F^-$ | PAH |
|---|---|---|---|---|---|---|---|
| for Industrial Area | 500 | 150 | 120 | 120 | 5000 | No Standards | No Standards |
| For Rural/Residential Area | 200 | 100 | 80 | 80 | 2000 | | |
| For Sensitive Area | 100 | 75 | 30 | 30 | 1000 | | |

## 3.6 Water Quality

Selected water quality parameters of ground and surface water resources within 10-km radius of the study area has been studied for assessing the water environment and evaluate anticipated impact of the proposed project. Understanding the water quality is essential in preparation of Environmental Impact Assessment and to identify critical issues with a view to suggest appropriate mitigation measures for implementation. The purpose of this study is to:

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

The information required has been collected through primary surveys and secondary sources.

### 3.6.1 Methodology

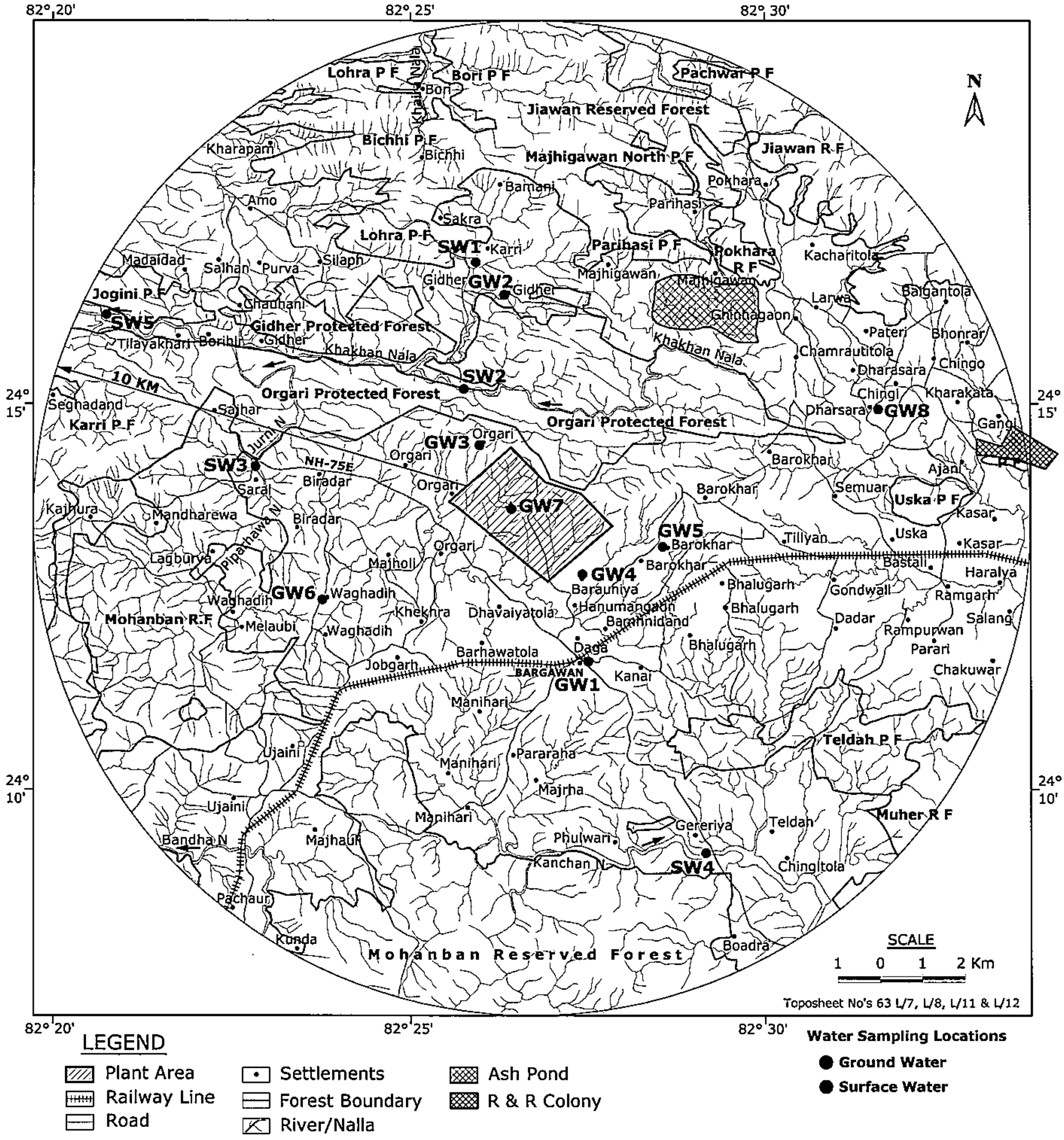
Reconnaissance survey was undertaken and monitoring locations were finalized based on:

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

Water sources covering 10-km radial distance from proposed project site were examined for physico-chemical, heavy metals and bacteriological parameters in order to assess the effect of industrial and other activities on water. The samples were collected and analyzed as per the procedures specified in 'Standard Methods for the Examination of Water and Wastewater' published by American Public Health Association (APHA).

### 3.6.2 Water Sampling Locations

Water samples were collected from ***thirteen*** sampling locations consisting of **eight** ground and **five** surface water samples. These samples were analyzed for various parameters to compare with the standards for drinking water as per IS: 10500 for ground water sources and standard for inland waters as per IS: 2296 for surface water sources. The details of water sampling locations are given in **Table-3.6.1** and shown in **Figure-3.6.1**.




## FIGURE-3.6.1
## WATER SAMPLING LOCATIONS

## TABLE-3.6.1
## DETAILS OF WATER SAMPLING LOCATIONS

| Code | Location | Distance from Proposed Site (Km) | Direction w.r.t Proposed site | Source of Water |
|---|---|---|---|---|
| *Ground Water* | | | | |
| GW1 | Bargawan Village | 3.5 | S | Bore well |
| GW2 | Gidher Village | 5.0 | N | Bore well |
| GW3 | Orgari Village | 1.9 | NW | Bore well |
| GW4 | Barauniya Village | 1.2 | SE | Bore well |
| GW5 | Barokhar Village | 3.3 | ESE | Bore well |
| GW6 | Waghadih Village | 4.8 | WSW | Bore well |
| GW7 | Plant site | - | - | Bore well |
| GW8 | Dharsara Village | 6.7 | NE | Bore well |
| *Surface Water* | | | | |
| SW1 | Gidher Village | 5.0 | NNW | Nala Near Gidher village |
| SW2 | Khakhan Nala | 2.0 | N | Khakhan Nala |
| SW3 | Saral Village | 4.8 | S | Jurni Nala |
| SW4 | Gereriya Village | 6.7 | SE | Kanchan Nala |
| SW5 | Tilayakhari Village | 7.5 | WNW | Confluence of Khakhan nala and Jurni nala |

### 3.6.3 Presentation of Results

The results of the parameters analyzed for the eight ground water and five surface water samples are presented in **Table-3.6.2 and Table-3.6.7** respectively and are compared with the standards for drinking water as per IS: 10500-2001 "Specifications for Drinking Water" and standard for inland waters as per IS: 2296 for surface water sources.

**Winter Season (2007-2008)**

- ***Ground Water***

As seen from the **Table-3.6.2**, the pH and conductivity varies from 7.4 - 8.0 and 582-900 µs/cm. The maximum pH of 8.0 was observed at Orgari (GW3) and the maximum conductivity was observed at Barokhar village (GW5).

Sodium and potassium content is found to be in the range of 22.0-90.2 mg/l and 1.1-5.3 mg/l. Calcium and magnesium content varies between 52.0-98.4 mg/l and 9.7-25.3 mg/l respectively. Total hardness and alkalinity expressed as $CaCO_3$ ranges between 170-332 mg/l and 168-360 mg/l respectively. Chlorides and sulphates are found to be in the range of 22.7-73.8 mg/l and 9.7-80.4 mg/l respectively. Nitrates and fluorides are found to be in the range of 7.5-9.9 mg/l and 0.1-0.7 mg/l respectively. The maximum TDS of 549 mg/l was observed at Borakhar (GW5) which is exceeding the limits. This is due to local geological conditions only. The heavy metal contents are found to be well within the limit. Insecticides and pesticides were found to be absent. The physico-chemical and biological analysis revealed that most of the parameters are well within the permissible limits when there is no alternative choice as per IS:10500.

- ***Surface Water***

The analysis results presented in the **Table-3.6.3** indicate that the pH ranges in between 7.6 and 8.2, which is well with in the specified standard of 6.5 to 8.5. TDS concentration was observed in the range of 148 – 221 mg/l. The TDS concentration has been observed to be below the permissible limit of 1500 mg/l at all the locations. DO was observed in the range of 5.4 – 5.9 mg/l. BOD values were observed to be ≤ 3 mg/l.

The chlorides and sulphates were found to be in the range of 8.7 to 13.4 mg/l, 16.2 – 21.4 mg/l respectively. It is observed that chlorides and sulphates were well with in the permissible limits of 600 mg/l and 400 mg/l. Bacteriological studies revels the presence of bacteria within the limits. Based on the results, the surface water has been found suitable for drinking after the conventional treatment followed by disinfection (IS: 2296).

Bacteriological examination of samples revealed the presence of coliforms. The total coliform count in the samples ranged from 134 – 529 MPN/100 ml which are with in limit of 5000 MPN/100 ml. The physico-chemical and biological analysis revealed that all the parameters are well within the prescribed limits of IS: 2296 Class 'C' limits.

**Pre-Monsoon Season (2008)**

- ***Ground Water***

As seen from the **Table-3.6.4**, the pH and conductivity varies from 6.9 - 8.1 and 245-1370 μs/cm. The maximum pH of 8.1 was observed at Plant site (GW7) and the maximum conductivity was observed at Bargwan village (GW1).

Sodium and potassium content is found to be in the range of 22.8-53.7 mg/l and 0.9-6.1 mg/l. Calcium and magnesium content varies between 24.3-145.2 mg/l and 5.6-65.3 mg/l respectively. Total hardness and alkalinity expressed as $CaCO_3$ ranges between 86-646 mg/l and 95-265 mg/l respectively. Chlorides and sulphates are found to be in the range of 17.73-244.61 mg/l and 3.87-46.39 mg/l respectively. Nitrates and fluorides are found to be in the range of 0.76-61.09 mg/l and 0.26-0.64 mg/l respectively. The maximum TDS of 1162 mg/l was observed at Bargwan (GW1) which is exceeding the limits. This is due to local geological conditions only. The heavy metal contents are found to be well within the limit. Insecticides and pesticides were found to be absent. The physico-chemical and biological analysis revealed that most of the parameters are well within the permissible limits when there is no alternative choice as per IS:10500.

- ***Surface Water***

The analysis results presented in the **Table-3.6.5** indicate that the pH ranges in between 7.1 and 7.8, which is well with in the specified standard of 6.5 to 8.5. TDS concentration was observed in the range of 148 - 221 mg/l. The TDS concentration has been observed to be below the permissible limit of 1500 mg/l at all the locations. DO was observed in the range of 5.8 - 6.2 mg/l. BOD values were observed to be ≤ 3 mg/l.

The chlorides and sulphates were found to be in the range of 7.09 to 14.8 mg/l, 3.68 - 19.35 mg/l respectively. It is observed that chlorides and sulphates were well with in the permissible limits of 600 mg/l and 400 mg/l. Bacteriological studies revels the presence of bacteria within the limits. Based on the results, the surface water has been found suitable for drinking after the conventional treatment followed by disinfection (IS: 2296).

Bacteriological examination of samples revealed the presence of coliforms. The total coliform count in the samples ranged from 134 - 529 MPN/100 ml which are with in limit of 5000 MPN/100 ml. The physico-chemical and biological analysis revealed that all the parameters are well within the prescribed limits of IS: 2296 Class 'C' limits.

**Post-Monsoon (2008)**

- ***Ground Water***

As seen from the **Table-3.6.6**, the pH and conductivity varies from 6.9 - 8.1 and 245-1370 µs/cm. The maximum pH of 8.1 was observed at Plant site (GW7) and the maximum conductivity was observed at Bargwan village (GW1).

Sodium and potassium content is found to be in the range of 16.5-53.7 mg/l and 0.9-6.1 mg/l. Calcium and magnesium content varies between 24.3-154.2 mg/l and 5.6-65.3 mg/l respectively. Total hardness and alkalinity expressed as $CaCO_3$ ranges between 85.1-646.9 mg/l and 95-305 mg/l respectively. Chlorides and sulphates are found to be in the range of 14.2-244.6 mg/l and 3.9-46.4 mg/l respectively. Nitrates and fluorides are found to be in the range of 0.8-61.1 mg/l and 0.3-0.8 mg/l respectively. The maximum TDS of 1210 mg/l was observed at Bargwan (GW1) which is exceeding the limits. This is due to local geological conditions only. The heavy metal contents are found to be well within the limit. Insecticides and pesticides were found to be absent. The physico-chemical and biological analysis revealed that most of the parameters are well within the permissible limits when there is no alternative choice as per IS:10500.

- ***Surface Water***

The analysis results presented in the **Table-3.6.7** indicate that the pH ranges in between 6.7 and 7.8, which is well with in the specified standard of 6.5 to 8.5. TDS concentration was observed in the range of 78 - 186 mg/l. The TDS concentration has been observed to be below the permissible limit of 1500 mg/l at all the locations. DO was observed in the range of 4.8 - 6.1 mg/l. BOD values were observed to be ≤ 3 mg/l.

The chlorides and sulphates were found to be in the range of 7.1 to 14.2 mg/l, 3.7 - 20.7 mg/l respectively. It is observed that chlorides and sulphates were well with in the permissible limits of 600 mg/l and 400 mg/l. Bacteriological studies revels the presence of bacteria within the limits. Based on the results, the surface water has been found suitable for drinking after the conventional treatment followed by disinfection (IS: 2296).

Bacteriological examination of samples revealed the presence of coliforms. The total coliform count in the samples ranged from 134 - 529 MPN/100 ml which are with in limit of 5000 MPN/100 ml. The physico-chemical and biological analysis revealed that all the parameters are well within the prescribed limits of IS: 2296 Class 'C' limits.

## TABLE 3.6.2
## GROUND WATER QUALITY (winter)

| Sr. No | Parameter | UOM | IS:10500 | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | GW7 | GW8 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 – 8.5 (NR) | 7.4 | 7.6 | 8.0 | 7.8 | 7.5 | 7.9 | 7.5 | 7.4 |
| 2 | Colour | Hazen | 5(25) | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 1 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | UO | UO | UO | UO | UO | UO | UO | UO | UO |
| 5 | Conductivity | µS/cm | $ | 748 | 860 | 677 | 740 | 900 | 582 | 770 | 840 |
| 6 | Turbidity | NTU | 5(10) | 3 | 2 | 2 | 3 | 2 | 3 | 2 | 2 |
| 7 | TDS | mg/l | 500(2000) | 487 | 462 | 379 | 425 | 549 | 332 | 405 | 456 |
| 8 | Total Hardness as $CaCo_3$ | mg/l | 300(600) | 312 | 282 | 222 | 230 | 332 | 170 | 244 | 321 |
| 9 | Total Alkalinity | mg/l | 200(600) | 236 | 222 | 250 | 360 | 352 | 168 | 284 | 345 |
| 10 | Calcium as Ca | mg/l | 75(200) | 98.4 | 71.2 | 56.0 | 73.6 | 94.4 | 52.0 | 74.4 | 94.2 |
| 11 | Magnesium as Mg | mg/l | 30(100) | 16.0 | 25.3 | 19.9 | 11.2 | 23.3 | 9.7 | 14.1 | 21.7 |
| 12 | Residual Chlorine | mg/l | 0.2 Min | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| 13 | Boron | mg/l | 1.0 | 0.04 | 0.04 | 0.03 | 0.03 | 0.04 | 0.01 | 0.03 | 0.02 |
| 14 | Chlorides as Cl | mg/l | 250(1000) | 68.1 | 63.8 | 39.7 | 22.7 | 72.3 | 61.0 | 49.6 | 73.8 |
| 15 | Sulphates as $So_4$ | mg/l | 200(400) | 74.1 | 80.4 | 29.5 | 9.7 | 54.7 | 37.5 | 22.6 | 52.8 |
| 16 | Fluorides as F | mg/l | 1.0(1.5) | 0.4 | 0.1 | 0.1 | 0.7 | 0.6 | 0.2 | 0.3 | 0.5 |
| 17 | Nitrates as $NO_3$ | mg/l | 45(NR) | 9.6 | 8.8 | 9.6 | 9.2 | 9.9 | 7.5 | 8.2 | 9.7 |
| 18 | Sodium as Na | mg/l | $ | 22.0 | 50.7 | 40.5 | 81.6 | 90.2 | 56.2 | 69.5 | 89.2 |
| 19 | Potassium as K | mg/l | $ | 1.1 | 4.2 | 5.1 | 1.9 | 3.6 | 5.3 | 5.0 | 3.9 |
| 20 | Phenolic Compounds | mg/l | 0.001(0.002) | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 21 | Cyanides | mg/l | 0.05(NR) | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| 22 | AnionicDetergents | mg/l | 0.2(1.0) | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| 23 | Mineral Oil | mg/l | 0.01(0.03) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 24 | Cadmium as Cd | mg/l | 0.01(NR) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 25 | Arsenic as As | mg/l | 0.01(NR) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 26 | Copper as Cu | mg/l | 0.05(1.5) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 27 | Lead as Pb | mg/l | 0.05(NR) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 28 | Manganese as Mn | mg/l | 0.1(0.3) | 0.01 | 0.03 | 0.08 | < 0.01 | 0.05 | 0.006 | 0.07 | 0.04 |
| 29 | Iron as Fe | mg/l | 0.3(1.0) | 0.3 | 0.05 | 0.03 | 0.01 | 0.2 | 0.06 | 0.05 | 0.2 |
| 30 | Chromium as $Cr^{+6}$ | mg/l | 0.05(NR) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 31 | Selenium as Se | mg/l | 0.01(NR) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 32 | Zinc as Zn | mg/l | 5(15) | 0.1 | 2.04 | 0.18 | 0.02 | 0.64 | 0.1 | 0.03 | 0.60 |
| 33 | Aluminium as Al | mg/l | 0.03(0.2) | 0.06 | 0.07 | 0.05 | 0.1 | 0.07 | 0.07 | 0.08 | 0.07 |
| 34 | Mercury as Hg | mg/l | 0.001(NR) | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100ml | 10 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 |

$: Limits not specified, UO: Un-Objectionable, Ag-Agreeable, NR-No Relaxation

## TABLE 3.6.3
## SURFACE WATER QUALITY( WINTER)

| Sr. No. | Parameter | Unit | IS:2296 Class 'C' Limits | SW1 | SW2 | SW3 | SW4 | SW5 |
|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 to 8.5 | 7.6 | 7.7 | 7.9 | 8.0 | 8.2 |
| 2 | Colour | Hazen | 300 | 3 | 4 | 6 | 5 | 5 |
| 3 | Conductivity | µS/cm | $ | 324 | 295 | 287 | 306 | 318 |
| 4 | Dissolved Oxyzen | mg/l | 4 Min. | 5.8 | 5.9 | 5.6 | 5.8 | 5.4 |
| 5 | BOD 5 day at 20 $^0$ C | mg/l | 3 | <3 | 3 | 3 | 3 | <3 |
| 6 | Total Dissolved Oxyzen (TDS) | mg/l | 1500 | 148 | 172 | 213 | 205 | 221 |
| 7 | Total Hardness as $CaCO_3$ | mg/l | $ | 88 | 118 | 107 | 115 | 124 |
| 8 | Chlorides as Cl | mg/l | 600 | 8.7 | 9.9 | 9.5 | 32.7 | 50.3 |
| 9 | Fluorides as F | mg/l | 1.5 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 |
| 10 | Sulphates as $SO_4$ | mg/l | 400 | 18.6 | 20.0 | 21.4 | 16.2 | 17.5 |
| 11 | Alkalinity as $CaCO_3$ | mg/l | $ | 114 | 128 | 129 | 134 | 138 |
| 12 | Nitrates as $NO_3$ | mg/l | 50 | 3.2 | 4.6 | 7.4 | 6.8 | 8.2 |
| 13 | Cyanides | mg/l | 0.05 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 14 | Calcium as Ca | mg/l | $ | 33.1 | 37.6 | 45.2 | 38.9 | 28.4 |
| 15 | Magnesium as Mg | mg/l | $ | 3.8 | 5.8 | 5.4 | 3.9 | 2.5 |
| 16 | Sodium as Na | mg/l | $ | 13.7 | 15.6 | 16.2 | 18.7 | 14.5 |
| 17 | Potassium as K | mg/l | $ | 1.1 | 1.4 | 1.5 | 1.3 | 1.7 |
| 18 | Iron as $F_e$ | mg/l | 50 | 0.03 | 0.02 | 0.05 | 0.02 | <0.01 |
| 19 | Chromium as $Cr^{+6}$ | mg/l | 0.05 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | <0.05 |
| 20 | Cadmium as Cd | mg/l | 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | <0.01 |
| 21 | Lead as Pb | mg/l | 0.1 | 0.01 | 0.07 | 0.03 | 0.02 | 0.02 |
| 22 | Copper as Cu | mg/l | 1.5 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 23 | Arsenic as As | mg/l | 0.2 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 24 | Selenium as Se | mg/l | 0.05 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 25 | Phenolics as $C_6H_5OH$ | mg/l | 0.005 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 26 | Zinc as Zn | mg/l | 15 | < 0.001 | 0.03 | 0.01 | 0.01 | <0.001 |
| 27 | Mercury as Hg | mg/l | $ | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 28 | Anionic detergents as MBAS | mg/l | 1 | < 0.1 | < 0.1 | < 0.1 | <0.2 | <0.2 |
| 29 | Oil and grease | mg/l | 0.1 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 30 | Total Coliforms | MPN/100 ml | 5000 | 134 | 496 | 146 | 183 | 529 |

*$: Limits not specified, UO: Un-Objectionable, Ag-Agreeable*

**TABLE 3.6.4**
**GROUND WATER QUALITY (PRE MONSOON)**

| Sr. No | Parameter | UOM | IS:10500 | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | GW7 | GW8 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 – 8.5 (NR) | 7.3 | 6.9 | 7.5 | 7.9 | 7.8 | 7.8 | 8.1 | 7.8 |
| 2 | Colour | Hazen | 5(25) | 12 | 8 | 4 | 8 | 6 | 9 | 5 | 4 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | UO | UO | UO | UO | UO | UO | UO | UO | UO |
| 5 | Conductivity | µS/cm | $ | 1370 | 333 | 657 | 624 | 677 | 245 | 719 | 724 |
| 6 | Turbidity | NTU | 5(10) | 4 | 3 | 6 | 2 | <1 | 2 | 3 | 2 |
| 7 | TDS | mg/l | 500(2000) | 1162 | 242 | 518 | 562 | 512 | 182 | 608 | 612 |
| 8 | Total Hardness as $CaCo_3$ | mg/l | 300(600) | 646 | 126 | 278 | 262 | 218 | 86 | 268 | 215 |
| 9 | Total Alkalinity | mg/l | 200(600) | 255 | 125 | 235 | 250 | 255 | 95 | 305 | 265 |
| 10 | Calcium as Ca | mg/l | 75(200) | 145.2 | 36.2 | 65.2 | 70.2 | 60.1 | 24.3 | 73.2 | 92.3 |
| 11 | Magnesium as Mg | mg/l | 30(100) | 65.3 | 8.2 | 26.3 | 19.8 | 15.6 | 5.6 | 19.5 | 19.3 |
| 12 | Residual Chlorine | mg/l | 0.2 Min | < 0.1 | <0.1 | < 0.1 | <0.1 | < 0.1 | <0.1 | < 0.1 | <0.1 |
| 13 | Boron | mg/l | 1.0 | 0.18 | 0.16 | 0.04 | 0.09 | 0.12 | 0.06 | 0.09 | 0.08 |
| 14 | Chlorides as Cl | mg/l | 250(1000) | 244.61 | 17.73 | 46.09 | 28.36 | 35.45 | 14.48 | 21.27 | 63.81 |
| 15 | Sulphates as $So_4$ | mg/l | 200(400) | 46.39 | 5.87 | 14.9 | 7.55 | 19.74 | 5.81 | 12.71 | 3.87 |
| 16 | Fluorides as F | mg/l | 1.0(1.5) | 0.26 | 0.64 | 0.35 | 0.8 | 0.3 | 0.41 | 0.54 | 0.47 |
| 17 | Nitrates as $NO_3$ | mg/l | 45(NR) | 61.09 | 10.26 | 10.6 | 18.49 | 16.1 | 0.76 | 17.97 | 4.43 |
| 18 | Sodium as Na | mg/l | $ | 20.8 | 18.5 | 25.2 | 30.3 | 53.7 | 16.5 | 39.8 | 22.4 |
| 19 | Potassium as K | mg/l | $ | 3.1 | 2.4 | 6.1 | 3.9 | 3.7 | 0.9 | 5.4 | 1.7 |
| 20 | Phenolic Compounds | mg/l | 0.001(0.002) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 21 | Cyanides | mg/l | 0.05(NR) | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 22 | AnionicDetergents | mg/l | 0.2(1.0) | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 23 | Mineral Oil | mg/l | 0.01(0.03) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Cadmium as Cd | mg/l | 0.01(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 25 | Arsenic as As | mg/l | 0.01(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Copper as Cu | mg/l | 0.05(1.5) | 0.12 | 0.03 | 0.03 | 0.01 | 0.08 | 0.02 | 0.09 | 0.02 |
| 27 | Lead as Pb | mg/l | 0.05(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 28 | Manganese as Mn | mg/l | 0.1(0.3) | 0.03 | 0.06 | 0.02 | 0.13 | 0.1 | 0.06 | 0.05 | 0.09 |
| 29 | Iron as Fe | mg/l | 0.3(1.0) | 0.12 | 0.08 | 0.15 | 0.06 | 0.09 | 0.18 | 0.06 | 0.02 |
| 30 | Chromium as $Cr^{+6}$ | mg/l | 0.05(NR) | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 31 | Selenium as Se | mg/l | 0.01(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 5(15) | 0.08 | 0.06 | 0.11 | 0.06 | 0.16 | 0.08 | 0.14 | 0.12 |
| 33 | Aluminium as Al | mg/l | 0.03(0.2) | 0.02 | 0.02 | <0.01 | 0.04 | <0.01 | 0.03 | 0.02 | 0.02 |
| 34 | Mercury as Hg | mg/l | 0.001(NR) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100ml | 10 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 |

$: Limits not specified, UO: Un-Objectionable, Ag-Agreeable, NR-No Relaxation

## TABLE-3.6.5
## SURFACE WATER QUALITY (PRE MONSOON)

| Sr. No. | Parameter | Unit | IS:2296 Class 'C' Limits | SW1 | SW2 | SW3 | SW4 | SW5 |
|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 to 8.5 | 7.8 | 7.2 | 7.1 | 7.5 | 7.3 |
| 2 | Colour | Hazen | 300 | 6 | 11 | 12 | 8 | 7 |
| 3 | Conductivity | µS/cm | $ | 266 | 108 | 165 | 184 | 142 |
| 4 | Dissolved Oxyzen | mg/l | 4 Min. | 5.8 | 6.1 | 5.9 | 6.2 | 5.6 |
| 5 | BOD 5 day at 20 $^0$ C | mg/l | 3 | <3 | <3 | <3 | <3 | <3 |
| 6 | Total Dissolved solids (TDS) | mg/l | 1500 | 172.6 | 59 | 96.4 | 106.2 | 92 |
| 7 | Total Hardness as $CaCO_3$ | mg/l | $ | 94 | 37 | 53 | 62 | 72 |
| 8 | Chlorides as Cl | mg/l | 600 | 7.09 | 7.09 | 14.18 | 10.64 | 8.6 |
| 9 | Residual chloride | mg/l | < 0.1 | <0.1 | < 0.1 | <0.1 | < 0.1 | <0.1 |
| 10 | Boran | mg/l | 0.03 | 0.02 | 0.01 | 0.03 | 0.03 | 0.02 |
| 11 | Fluorides as F | mg/l | 1.5 | 0.41 | 0.42 | 0.25 | 0.51 | 0.22 |
| 12 | Sulphates as $SO_4$ | mg/l | 400 | 6.52 | 16.97 | 19.35 | 3.68 | 12.5 |
| 13 | Total Alkalinity | mg/l | $ | 110 | 25 | 40 | 65 | 35 |
| 14 | Nitrates as $NO_3$ | mg/l | 50 | 2.2 | 3.59 | 0.51 | 1.21 | 2.69 |
| 15 | Cyanides | mg/l | 0.05 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 16 | Calcium as Ca | mg/l | $ | 25.3 | 8.9 | 13.8 | 16.2 | 9.3 |
| 17 | Magnesium as Mg | mg/l | $ | 7.1 | 3.4 | 4.4 | 4.9 | 3.9 |
| 18 | Sodium as Na | mg/l | $ | 13.2 | 5.1 | 9.4 | 9.1 | 6.2 |
| 19 | Potassium as K | mg/l | $ | 4.1 | 6.1 | 6.7 | 4.5 | 5.2 |
| 20 | Phenolic Compounds | mg/l | 0.01 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 21 | Iron as $F_e$ | mg/l | 50 | 0.08 | 0.02 | 0.01 | 0.04 | 0.03 |
| 22 | Chromium as $Cr^{+6}$ | mg/l | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 23 | Cadmium as Cd | mg/l | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Lead as Pb | mg/l | 0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 25 | Copper as Cu | mg/l | 1.5 | 0.07 | 0.08 | 0.12 | 0.02 | 0.09 |
| 26 | Arsenic as As | mg/l | 0.2 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 27 | Selenium as Se | mg/l | 0.05 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 28 | Phenolics as $C_6H_5OH$ | mg/l | 0.005 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 29 | Zinc as Zn | mg/l | 15 | 0.06 | 0.02 | 0.04 | 0.02 | 0.02 |
| 30 | Aluminium as Al | mg/l | - | 0.06 | 0.05 | <0.01 | 0.02 | 0.01 |
| 31 | Mercury as Hg | mg/l | - | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 32 | Anionic detergents as MBAS | mg/l | 1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 33 | Oil and grease | mg/l | 0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 34 | *Total Coliforms* | *MPN/100 ml* | *5000* | <2 | <2 | <2 | <2 | <2 |

**TABLE 3.6.6**
**GROUND WATER QUALITY (POST-MONSOON)**

| Sr. No | Parameter | UOM | IS:10500 | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | GW7 | GW8 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 – 8.5 (NR) | 7.3 | 6.9 | 7.5 | 7.9 | 7.8 | 7.8 | 8.1 | 7.8 |
| 2 | Colour | Hazen | 5(25) | 3 | 2 | 3 | 4 | 2 | 4 | 3 | 2 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | UO | UO | UO | UO | UO | UO | UO | UO | UO |
| 5 | Conductivity | µS/cm | $ | 1370 | 333 | 657 | 624 | 677 | 245 | 719 | 724 |
| 6 | Turbidity | NTU | 5(10) | 2 | 3 | 1 | 2 | 1 | 3 | 2 | 1 |
| 7 | TDS | mg/l | 500(2000) | 1210 | 286 | 525 | 506 | 592 | 178 | 602 | 625 |
| 8 | Total Hardness as $CaCo_3$ | mg/l | 300(600) | 646.9 | 126.2 | 277.4 | 261.6 | 218.1 | 85.1 | 267.8 | 314.7 |
| 9 | Total Alkalinity | mg/l | 200(600) | 255 | 125 | 235 | 250 | 255 | 95 | 305 | 265 |
| 10 | Calcium as Ca | mg/l | 75(200) | 145.2 | 36.2 | 65.2 | 70.2 | 60.1 | 24.3 | 73.2 | 92.3 |
| 11 | Magnesium as Mg | mg/l | 30(100) | 65.3 | 8.2 | 26.3 | 19.8 | 15.6 | 5.6 | 19.5 | 19.3 |
| 12 | Residual Chlorine | mg/l | 0.2 Min | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| 13 | Boron | mg/l | 1.0 | 0.02 | 0.01 | 0.03 | 0.04 | 0.01 | 0.04 | 0.03 | 0.02 |
| 14 | Chlorides as Cl | mg/l | 250(1000) | 244.6 | 17.7 | 46.1 | 28.4 | 35.5 | 14.2 | 21.3 | 63.8 |
| 15 | Sulphates as $So_4$ | mg/l | 200(400) | 46.4 | 5.9 | 14.9 | 7.5 | 19.7 | 5.8 | 12.7 | 3.9 |
| 16 | Fluorides as F | mg/l | 1.0(1.5) | 0.3 | 0.6 | 0.4 | 0.8 | 0.3 | 0.4 | 0.5 | 0.5 |
| 17 | Nitrates as $NO_3$ | mg/l | 45(NR) | 61.1 | 10.3 | 10.6 | 18.5 | 16.1 | 0.8 | 18.0 | 4.4 |
| 18 | Sodium as Na | mg/l | $ | 20.8 | 18.5 | 25.2 | 30.3 | 53.7 | 16.5 | 39.8 | 22.4 |
| 19 | Potassium as K | mg/l | $ | 3.1 | 2.4 | 6.1 | 3.9 | 3.7 | 0.9 | 5.4 | 1.7 |
| 20 | Phenolic Compounds | mg/l | 0.001(0.002) | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 21 | Cyanides | mg/l | 0.05(NR) | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 | < 0.02 |
| 22 | Anionic Detergents | mg/l | 0.2(1.0) | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| 23 | Mineral Oil | mg/l | 0.01(0.03) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 24 | Cadmium as Cd | mg/l | 0.01(NR) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 25 | Arsenic as As | mg/l | 0.01(NR) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 26 | Copper as Cu | mg/l | 0.05(1.5) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 27 | Lead as Pb | mg/l | 0.05(NR) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 28 | Manganese as Mn | mg/l | 0.1(0.3) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 29 | Iron as Fe | mg/l | 0.3(1.0) | 0.03 | 0.04 | 0.11 | 0.05 | 0.02 | 0.02 | 0.01 | 0.04 |
| 30 | Chromium as $Cr^{+6}$ | mg/l | 0.05(NR) | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 | < 0.05 |
| 31 | Selenium as Se | mg/l | 0.01(NR) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 32 | Zinc as Zn | mg/l | 5(15) | 0.01 | 0.03 | 0.04 | 0.05 | 0.02 | 0.04 | 0.03 | 0.06 |
| 33 | Aluminium as Al | mg/l | 0.03(0.2) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| 34 | Mercury as Hg | mg/l | 0.001(NR) | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100ml | 10 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 |

$: Limits not specified, UO: Un-Objectionable, Ag-Agreeable, NR-No Relaxation

**TABLE 3.6.7**
**SURFACE WATER QUALITY (POST-MONSOON)**

| Sr. No. | Parameter | Unit | IS:2296 Class 'C' Limits | SW1 | SW2 | SW3 | SW4 | SW5 |
|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 to 8.5 | 7.8 | 7.2 | 7.1 | 7.5 | 6.7 |
| 2 | Colour | Hazen | 300 | 12 | 8 | 11 | 13 | 11 |
| 3 | Conductivity | µS/cm | $ | 266 | 108 | 165 | 184 | 121 |
| 4 | TDS | | 1500 | 186 | 88 | 98 | 86 | 75 |
| 5 | Dissolved Oxyzen | mg/l | 4 Min. | 5.8 | 5.6 | 5.9 | 6.1 | 4.8 |
| 6 | BOD 5 day at 20 $^0$ C | mg/l | 3 | <3 | <3 | <3 | <3 | 10 |
| 7 | COD | | $ | 5 | 10 | 10 | 5 | 45 |
| 8 | Total Hardness as $CaCO_3$ | mg/l | $ | 94.1 | 37 | 53.6 | 61.8 | 42.8 |
| 9 | Alkalinity as $CaCO_3$ | mg/l | $ | 110 | 25 | 40 | 65 | 25 |
| 10 | Calcium as Ca | mg/l | $ | 25.3 | 8.9 | 13.8 | 16.2 | 11.2 |
| 11 | Magnesium as Mg | mg/l | $ | 7.1 | 3.4 | 4.4 | 4.9 | 3.4 |
| 12 | Chlorides as Cl | mg/l | 600 | 7.1 | 7.1 | 14.2 | 10.6 | 7.1 |
| 13 | Residual free chlorine | mg/l | $ | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 14 | Phosphates as PO4 | mg/l | $ | 0.02 | 0.01 | 0.03 | 0.02 | 0.02 |
| 15 | Sulphates as $SO_4$ | mg/l | 400 | 6.5 | 17.0 | 19.4 | 3.7 | 20.7 |
| 16 | Fluorides as F | mg/l | 1.5 | 0.4 | 0.4 | 0.3 | 0.5 | 0.3 |
| 17 | Nitrates as $NO_3$ | mg/l | $ | 2.2 | 3.6 | 0.5 | 1.2 | 7.2 |
| 18 | Sodium as Na | mg/l | $ | 13.2 | 5.1 | 9.4 | 9.1 | 5.9 |
| 19 | Potassium as K | mg/l | $ | 4.1 | 6.1 | 6.7 | 4.5 | 5.4 |
| 20 | Total Boron as B | mg/l | $ | 0.02 | 0.06 | 0.03 | 0.01 | 0.02 |
| 21 | Cyanides | mg/l | 0.05 | <0.02 | < 0.02 | <0.02 | <0.02 | <0.02 |
| 22 | Phenolic Compounds | mg/l | 0.005 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 23 | Oil and grease | mg/l | 0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Cadmium as Cd | mg/l | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 25 | Arsenic as As | mg/l | 0.2 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Copper as Cu | mg/l | 1.5 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 27 | Lead as Pb | mg/l | 0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 28 | Iron as $F_e$ | mg/l | 50 | 0.04 | 0.03 | 0.02 | 0.01 | 0.04 |
| 29 | Chromium as $Cr^{+6}$ | mg/l | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 30 | Selenium as Se | mg/l | 0.05 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 31 | Zinc as Zn | mg/l | 15 | 0.02 | 0.03 | 0.01 | 0.04 | 0.02 |
| 32 | Aluminium as Al | mg/l | $ | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 33 | Mercury as Hg | mg/l | $ | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 34 | SAR | - | - | 0.6 | 0.37 | 0.56 | 0.51 | 0.4 |
| 35 | Insecticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | Anionic detergents as MBAS | mg/l | 1 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 37 | Total Coliforms | MPN/100 ml | 5000 | <2 | <2 | <2 | <2 | <2 |

*$: Limits not specified, UO: Un-Objectionable, Ag-Agreeable*

### 3.7 Noise Level Survey

The physical description of sound concerns its loudness as a function of frequency. Noise in general is sound which is composed of many frequency components of various loudness are distributed over the audible frequency range. Various noise scales have been introduced to describe, in a single number, the response of an average human to a complex sound made up of various frequencies at different loudness levels. The most common and universally accepted scale is the A weighted scale which is measured as dB (A). This is more suitable for audible range of 20 to 20,000 Hz. The scale has been designed to weigh various components of noise according to the response of a human ear. The impact of noise sources on surrounding community depends on:

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

The environmental impact of noise can have several effects varying from Noise Induced Hearing Loss (NIHL) to annoyance depending on loudness of noise. The environmental impact assessment of noise due to construction activity, and vehicular traffic can be undertaken by taking into consideration various factors like potential damage to hearing, physiological responses, and annoyance and general community responses.

Noise monitoring has been undertaken for 24-hr duration at each location.

### 3.7.1 Identification of Sampling Locations

A preliminary reconnaissance survey has been undertaken to identify the major noise generating sources in the area. Noise at different noise generating sources has been identified based on the activities in the village area, ambient noise due to industries and traffic and the noise at sensitive areas like hospitals and schools. The noise monitoring has been conducted for determination of noise levels at **eight** locations in the study area.

The environment setting of each noise monitoring location is given in **Table-3.7.1** and depicted in **Figure-3.7.1**.

### 3.7.2 Method of Monitoring

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

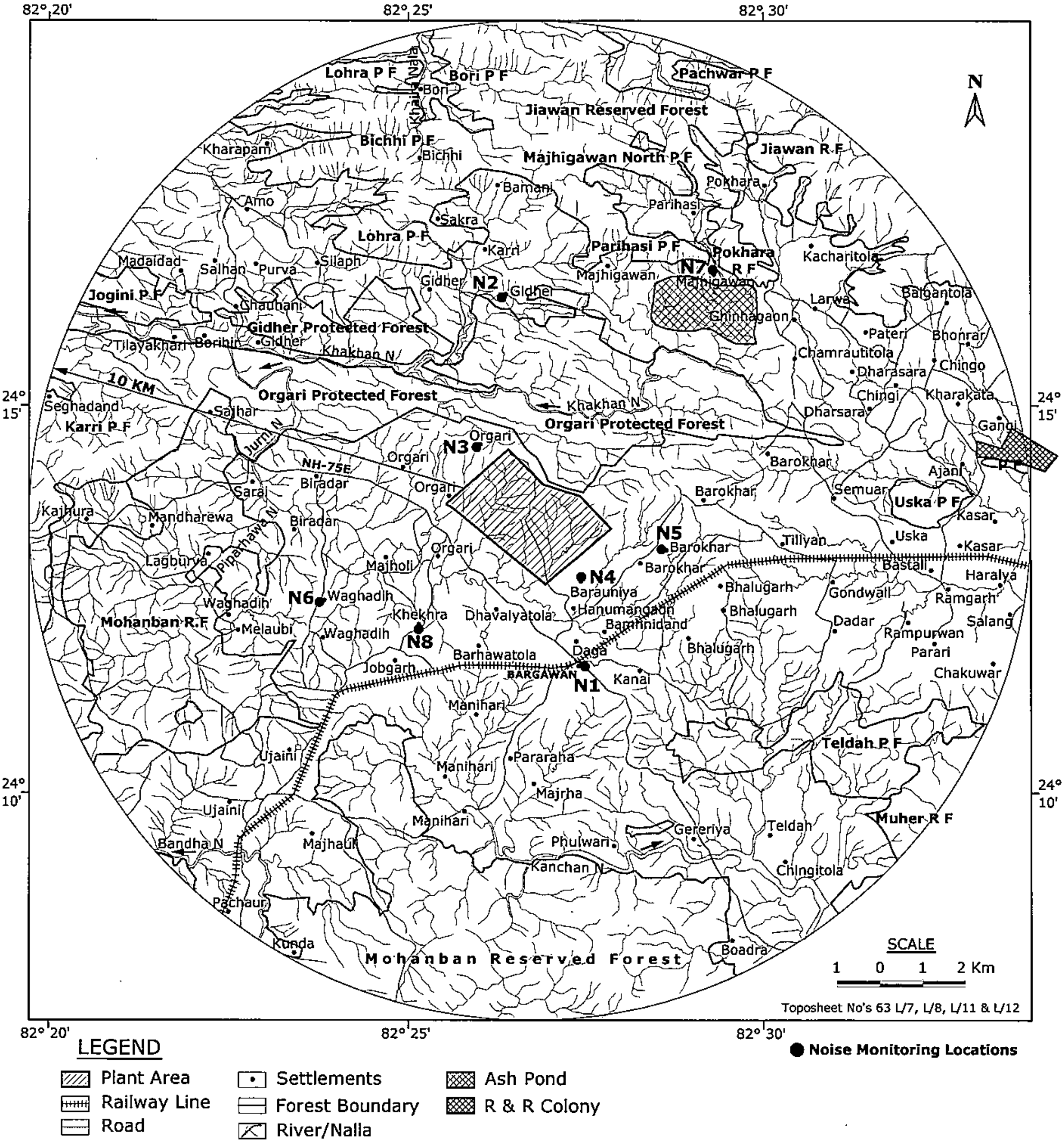



**FIGURE- 3.7.1**
**NOISE MONITORING LOCATIONS**

**TABLE-3.7.1**
**DETAILS OF NOISE MONITORING LOCATIONS**

| Location Code | Location | Distance from Proposed Site (km) | Direction w.r.t. Proposed Site |
|---|---|---|---|
| N1 | Bargawan village | 3.5 | S |
| N2 | Gidher village | 5.0 | N |
| N3 | Orgari village | 1.9 | NW |
| N4 | Barauniya village | 1.2 | SE |
| N5 | Borakhar village | 3.3 | ESE |
| N6 | Wagadih village | 4.8 | WSW |
| N7 | Majhigawan village | 5.0 | NE |
| N8 | Khekhra village | 3.1 | SW |

3.7.3 Parameters Measured During Monitoring

For noise levels measured over a given period of time interval, it is possible to describe important features of noise using statistical quantities. This is calculated using the percent of the time certain noise levels are exceeding the time interval. The notation for the statistical quantities of noise levels are described below:

- $L_{10}$ is the noise level exceeded 10 per cent of the time;
- $L_{50}$ is the noise level exceeded 50 per cent of the time ; and
- $L_{90}$ is the noise level exceeded 90 per cent of the time.

**Equivalent Sound Pressure Level ($L_{eq}$):**

The Leq is the equivalent continuous sound level which is equivalent to the same sound energy as the actual fluctuating sound measured in the same period. This is necessary because sound from noise source often fluctuates widely during a given period of time. This is calculated from the following equation:

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

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

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

A noise rating developed by **E P A** for specification of community noise from all the sources is the Day-Night Sound Level, ($L_{dn}$).

**Day-Night Sound Level ($L_{dn}$):**

The noise rating developed for community noise from all sources is the Day-Night Sound Level ($L_{dn}$). It is similar to a 24 hr equivalent sound level except that during night time period (10 pm to 6 am) a 10 dB (A) weighting penalty is added to the instantaneous sound level before computing the 24 hr average.

This night time penalty is added to account for the fact that noise during night when people usually sleep is judged as more annoying than the same noise during the day time.

The $L_{dn}$ for a given location in a community may be calculated from the hourly $L_{eq}$'s, by the following equation.

$$L_{dn} = 10 \log \{1/24[16(10^{Ld/10}) + 8 (10^{(Ln+10)/10})]\}$$

Where $L_d$ is the equivalent sound level during the day time (6 am to 10 pm) and $L_n$ is the equivalent sound level during the night time (10 pm to 6 am).

3.7.4 Presentation of Results

The statistical analysis is done for measured noise levels at eight locations during study period representing three seasons – Winter, Pre-monsoon and Post-monsoon seasons. The parameters are analyzed for $L_{day}$, $L_{night}$, and $L_{dn}$. These results are tabulated in **Table-3.7.2A to Table-3.7.2C.**

**TABLE-3.7.2A**
**NOISE LEVELS IN THE STUDY AREA- WINTER SEASON**

| Location Code | Location | Winter 2007 | | | |
|---|---|---|---|---|---|
| | | Leq | Ld | Ln | Ldn |
| N1 | Bargawan village | 58.3 | 59.2 | 48.1 | 58.8 |
| N2 | Gidher village | 48.3 | 48.9 | 40.5 | 49.6 |
| N3 | Orgari village | 50.2 | 51.3 | 43.2 | 51.1 |
| N4 | Bareniya village | 52.0 | 51.1 | 43.3 | 52.6 |
| N5 | Borakhar village | 54.0 | 54.6 | 45.6 | 55.0 |
| N6 | Wagadih village | 51.5 | 50.3 | 43.1 | 51.6 |
| N7 | Majhigawan village | 51.2 | 51.8 | 42.7 | 52.2 |
| N8 | Khekhra village | 53.7 | 52.2 | 44.3 | 53.9 |

**TABLE-3.7.2B**
**NOISE LEVELS IN THE STUDY AREA- PRE-MONSOON SEASON**

| Location Code | Location | Pre-Monsoon 2008 | | | |
|---|---|---|---|---|---|
| | | Leq | Ld | Ln | Ldn |
| N1 | Bargawan village | 56.9 | 57.8 | 54.0 | 61.2 |
| N2 | Gidher village | 46.8 | 48.8 | 43.9 | 51.4 |
| N3 | Orgari village | 51.4 | 52.2 | 48.6 | 55.7 |
| N4 | Bareniya village | 52.3 | 53.5 | 49.6 | 56.8 |
| N5 | Borakhar village | 54.1 | 55.1 | 50.7 | 58.1 |
| N6 | Wagadih village | 53.8 | 55.4 | 51.1 | 58.4 |
| N7 | Majhigawan village | 49.0 | 51.1 | 45.3 | 53.2 |
| N8 | Khekhra village | 51.3 | 52.2 | 47.6 | 55.0 |

**TABLE-3.7.2C**
**NOISE LEVELS IN THE STUDY AREA- POST-MONSOON SEASON**

| Location Code | Location | Post-Monsoon 2008 | | | |
|---|---|---|---|---|---|
| | | Leq | Ld | Ln | Ldn |
| N1 | Bargawan village | 46.9 | 47.8 | 44.0 | 51.2 |
| N2 | Gidher village | 43.0 | 45.0 | 40.1 | 47.6 |
| N3 | Orgari village | 42.4 | 43.2 | 39.6 | 46.7 |
| N4 | Bareniya village | 45.0 | 46.2 | 42.3 | 49.5 |
| N5 | Borakhar village | 45.1 | 46.1 | 41.7 | 49.1 |
| N6 | Wagadih village | 44.7 | 46.3 | 42.0 | 49.3 |
| N7 | Majhigawan village | 44.3 | 46.4 | 40.6 | 48.5 |
| N8 | Khekhra village | 45.4 | 46.3 | 41.7 | 49.1 |

3.7.5 Observations - Winter season

**a) Day time Noise Levels ($L_{day}$)**

The daytime ($L_{day}$) noise levels at all the residential locations were observed to be in the range of 59.2 dB(A) to 48.9 dB(A). The maximum noise level of 59.2 dB(A) was observed at Bargawan (N1) and the minimum noise level of 48.9 dB(A) was observed at Gidher (N2). It is observed that the day time noise levels at maximum residential locations are within the prescribed limit of 55 dB(A). The noise levels at Bargawan (N1) were observed exceeding the limits due to the commercial activities & traffic movement on National Highway NH 75 E.

**b) Night time Noise Levels ($L_{night}$)**

The night time ($L_{night}$) noise levels at all the residential locations were observed to be in the range of 48.1 dB(A) to 40.5 dB(A). The maximum noise level of 48.1 dB(A) was observed at Bargawan (N1) and the minimum noise level of 40.5 dB(A) was observed at Gidher (N2). It is also observed that the night time noise levels at all the residential locations are within the prescribed limit of 45 dB(A). The noise levels at Bargawan (N1) and Barokhar (N5) were observed exceeding the limits due to the commercial activities & traffic movement on National Highway NH 75 E.

Observations - Pre-Monsoon season

**a) Day time Noise Levels ($L_{day}$)**

The daytime ($L_{day}$) noise levels at all the locations were observed to be in the range of 48.8 dB(A) to 57.8 dB(A). The maximum noise level of 57.8 dB(A) was observed at Bargawan (N1) and the minimum noise level of 48.8 dB(A) was observed at Gidher (N2). It is observed that the day time noise levels at maximum residential locations are within the prescribed limit of 55 dB(A). The noise levels at Bargawan (N1) were observed exceeding the limits due to the commercial activities & traffic movement on National Highway NH 75 E.

**b) Night time Noise Levels ($L_{night}$)**

The night time ($L_{night}$) noise levels at all the locations were observed to be in the range of 43.9 dB(A) to 54.0 dB(A). The maximum noise level of 54.0 dB(A) was observed at Bargawan (N1) and the minimum noise level of 43.9 dB(A) was observed at Gidher (N2). It is also observed that the night time noise levels at all the residential locations are within the prescribed limit of 45 dB(A). The noise levels at Bargawan (N1) were observed exceeding the limits due to the commercial activities & traffic movement on National Highway NH 75 E.

Observations – Post-Monsoon season

**a) Day time Noise Levels ($L_{day}$)**

The daytime ($L_{day}$) noise levels at all the residential locations were observed to be in the range of 47.8 dB(A) to 43.2 dB(A). The maximum noise level of 47.8 dB(A) was observed at Bargawan (N1) and the minimum noise level of 43.2 dB(A) was observed at Gidher (N2). It is observed that the day time noise levels at maximum residential locations are within the prescribed limit of 55 dB(A). The noise levels at Bargawan (N1) were observed exceeding the limits due to the commercial activities & traffic movement on National Highway NH 75 E.

**b) Night time Noise Levels ($L_{night}$)**

The night time ($L_{night}$) noise levels at all the residential locations were observed to be in the range of 44.0 dB(A) to 39.6 dB(A). The maximum noise level of 48.1 dB(A) was observed at Bargawan (N1) and the minimum noise level of 40.5 dB(A) was observed at Gidher (N2). It is also observed that the night time noise levels at all the residential locations are within the prescribed limit of 45 dB(A).

## 3.8 Flora and Fauna Studies

### 3.8.1 Introduction

An ecological survey of the study area was conducted particularly with reference to listing of species and assessment of the existing ecological conditions (Terrestrial and Aquatic ecosystem) conditions in the study area.

### 3.8.2 Objectives of Ecological Studies

The present study was undertaken with the following objectives:

- To assess the nature and distribution of vegetation in and around the project site;
- To assess the distribution of animal life spectra;
- To understand the productivity of the water bodies; and
- To ascertain migratory routes of fauna and possibility of breeding grounds.

### 3.8.3 Methodology Adopted for the Survey

To achieve the above objectives a detailed study of the area was undertaken in 10-km radius area with the proposed smelter complex. The different methods adopted were as follows:

- Compilation of secondary data with respect to the study area from published literature and Government agencies;

- Generation of primary data by undertaking systematic ecological studies in the area;
- Discussion with local people so as to elicit information about local plants, animals and their uses; and
- Gathering data for ethnobiology.

The present report gives the review of published secondary data and the results of field sampling conducted during winter season- 2006-07.

### 3.8.4 Review of Secondary Published Data

The study area falls under East Sidhi Forest division. The area of the division includes Deosar, Chitrangi and Singruali tehsils of Sidhi districts. Geographical area is 5672.83 Sq.km which R.F is 1303.15 Sq.Km and P.F is 916.50 Sq.Km. The total forest area is 2219.65 Sq.Km.

The main species of the forests of the region is Sal. Natural teak is not present though quite a few successful teak plantations are observed. Bamboo in Sal as well as in mixed forests forms the understorey over quite a large area but it is in a degraded condition.

**Types of Forests**

The forests have been classified into following sub-groups as per revised classification of Champion and Seth (1967).

- Northern Tropical Dry deciduous forests, Sub-groups 5B, Dry peninsular sal 5B/C1c;
- Northern Tropical Deciduous forests, Sub-group 5B, Northern Dry Deciduous Mixed Deciduous forest: 5B/C2; and
- In addition, following two edaphic sub-Types area also found:

  1. Salai forest- 5B/E2
  2. Dry Bamboo area- 5B/E9

### 3.8.5 Terrestrial Ecological Status: Primary Survey

A preliminary survey was made and six locations were selected for detailed study within 10-km radius of the proposed project site. The selected locations are given in **Table-3.8.1** and shown in **Figure-3.8.1.**

**TABLE-3.8.1**
**DETAILS OF TERRESTRIAL ECOLOGICAL SAMPLING LOCATIONS**

| Code | Name of the Area | Direction | Distance From Project Site (km) |
|---|---|---|---|
| TE-1 | Near Village Bargawan | S | 3.5 |
| TE-2 | Near Village Gidher | N | 5.0 |
| TE-3 | Near Village Orgari | W | 1.9 |
| TE-4 | Near Village Barariya | SE | 1.2 |
| TE-5 | Near Village Brokhar | E | 3.3 |
| TE-6 | Near Village Wagadhi | W | 4.8 |

The primary data was generated through:

1. Preparing a general checklist of all plants encountered in the study area. This would indicate the biodiversity for wild and cultivated plants. The plants so encountered were classified into life form spectrum according to the classification of Raunkiaer's classification of life form spectrum.

2. Phytosociological studies by using list count quadrate method for woody and herbaceous flora in forest areas and only herbaceous flora in ambient air quality monitoring locations. Sufficient number of quadrates of 100-$m^2$ size was adopted for study, which is based on the area species curve. The number of quadrates depended on actual field requirements.

3. Estimating basal areas of trees and shrubs at breast height [132 cm from ground or above buttresses];

4. Herbaceous and woody flora was studied by taking 10 and 20 quadrates at each location having 100 $m^2$;

5. Determining frequency, abundance, relative frequency, relative density, relative dominance and importance value indices using Mueller-Dombois-Ellenberge theory [1974];

6. Determining the bird population of migratory and local birds by taking 10 random readings at every location;

7. Observing mammals, amphibians and reptiles, noting their calls, droppings, burrows, pugmarks and other signs;and

8. Physical observations were also carried out from the Machans for two-twelve hour periods, one during day time and the other during night time for terrestrial fauna;

9. Local inhabitants were interviewed for uses of plants and animals and to get ethnobiological data.

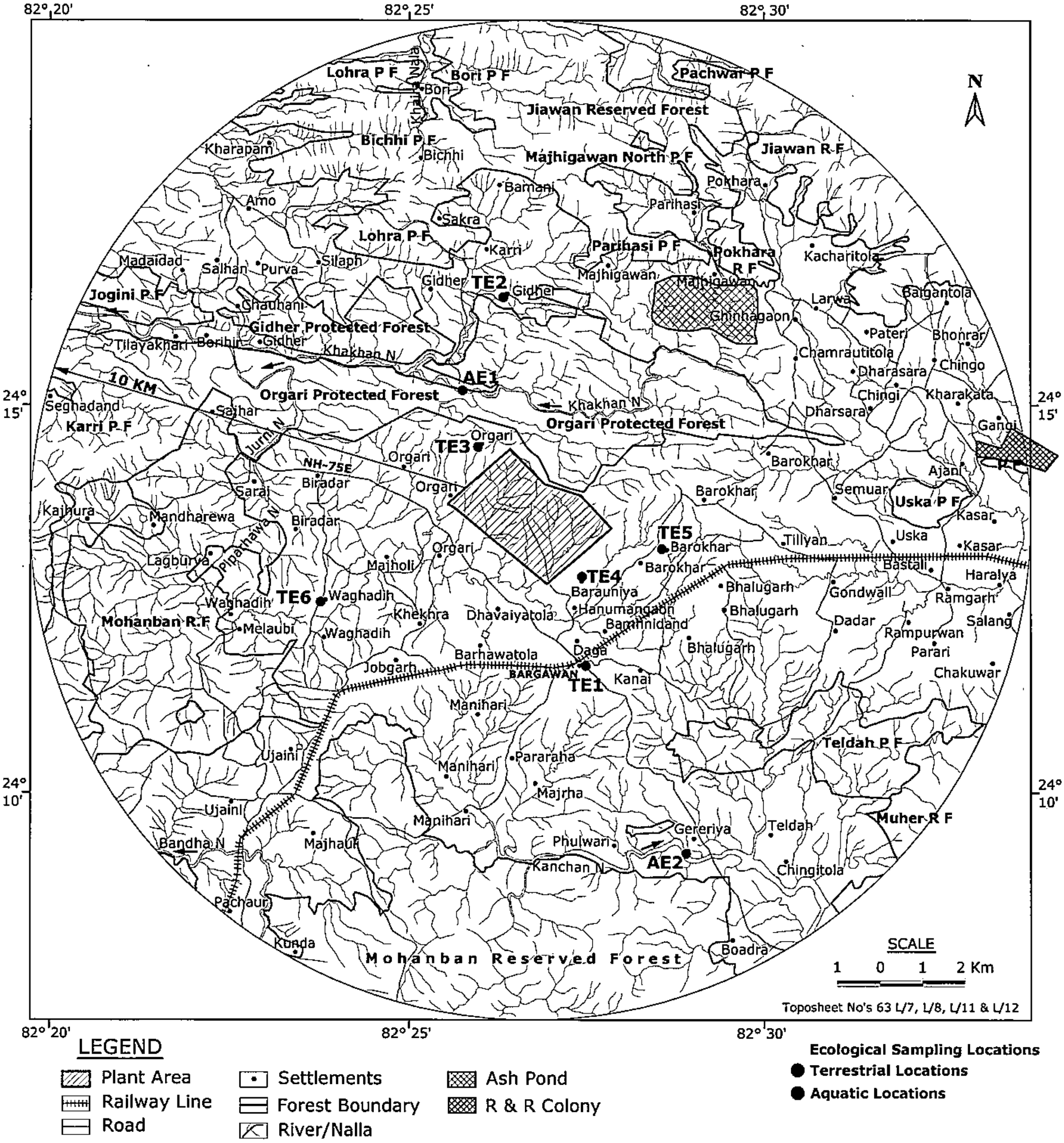



**FIGURE-3.8.1**
**TERRESTRIAL AND AQUATIC ECOLOGICAL SAMPLING LOCATIONS**

### 3.8.5.1 Floristic Composition- Primary Survey

**Floristic Richness**

- ***Cryptogamic Vegetation***

The area shows many algae, fungi, bryophytes and ferns. Algae are present in aquatic bodies or in marshy places. Fungi, particularly from ascomycetes and basidiomycetes are located on ground or epiphytically. Lichens of crustose, foliose and fruticose types are present on different substrates (Lichens, Ascomycetes and Basidiomycetes could be observed near hilly terrain). Bryophytes occur in wet areas and occasionally on barks of trees and old walls of houses. The commonly observed bryophites in this area are *Funaria sp* and *Polypodium sp* Fern flora of the study area is insignificant. The aquatic weeds *Hydrilla sp, Chara sp,* and *Salvinia* were observed in small ponds in agricultural fields.

- ***Life Form Spectrum***

Raunkiaer defined life forms as the sum of adaptations of plants to climate. Braun-Blanquet (1951), whose system is adapted in this study, modified the Raunkiaer's system. Following five of the ten classes created by Braun-Blanquet is present in the study area.

- Phanerophytes : Shrubs and trees
- Therophytes : Annuals including ferns
- Hydrophytes : Water plants except plankton
- Hemicryptophytes : Plants with perennial shoots and buds close to surface.
- Geophytes : Plants, with perennating parts buried in substratum.

During field survey, maximum 355 number of plant species (except algae, fungi and bryophytes) were recorded from the study area. **Table-1 of Annexure-VII** lists all species recorded in the study area. Their analysis revealed the following;

**TABLE-3.8.2**
**CLASS WISE DISTRIBUTION OF PLANT SPECIES IN THE STUDY AREA**

| Type of Species | Winter Season | |
|---|---|---|
| | No. | % |
| Phanerophytes (P) | 165 | 46.48 |
| Therophytes (T) | 139 | 39.16 |
| Hydrophytes (H) | 08 | 2.25 |
| Hemicryptophytes (He) | 35 | 9.86 |
| Geophytes (G) | 08 | 2.25 |
| **Total** | **355** | **100** |

- ***Comments on the Life Form Spectrum***

Life form spectrum is a reflection of plant community. A plant community is governed by several factors like climatic, edaphic, topographic and biotic. Even local variations in environment affect components of plant community.

In the study area, maximum numbers of species are phanerophytes (46.48%) followed by therophytes (39.16%). These classes are followed by hemicryptophytes (9.86%) and hydrophytes (2.25%). Geophytes were found in very few numbers.

Presence of large number of phanerophytes (shrubs and trees) and therophytes (annuals or herbaceous vegetation) indicates semiarid to tropical vegetation structure.

Hemicryptophytes (predominantly grasses and sedges) were found to be significant in the area. These indicate fertile and wet soil in upper layer of soil profile. Hydrophytes were present in both the seasonal and perennial water bodies.

Fluoride Concentrations in Leaf and Grass Samples

5 grass and 5 leaf samples were collected from variety of plants and crops in and around proposed plant site. All the samples were collected from agricultural fields near to village areas. The results are presented in the **Table-3.8.3** . It can be observed that the leaf and grass samples are very low in fluoride concentrations as the area is not affected by any industrial activity.

**TABLE-3.8.3**
**FLUROIDE CONCENTRATIO IN LEAF AND GRASS SAMPLES**

| Sr. No. | Species | Name of village | Distance / Direction | Fluoride concentration (mg/kg) | Fluoride concentration (mg/kg) |
|---|---|---|---|---|---|
| | | | | Winter 2007 | Pre-monsoon 2008 |
| 1 | Grass | Near Bargawan | 3.5 (S) | 2.1 | 1.9 |
| 2 | Grass | Near Gidher | 5.0 (N) | 0.9 | 0.7 |
| 3 | Dalbergia Sisoo | Near Orgari | 1.9 (NW) | 1.7 | 1.4 |
| 4 | Shorea rubusta | Barauniya (close to plant boundary) | 1.2 (SE) | 1.5 | 1.1 |
| 5 | Delonix regia | Near Barokhar | 3.3 (E) | 2.0 | 1.7 |
| 6 | Grass | Near Waghadih | 4.8 (W) | 0.9 | 0.8 |
| 7 | Grass | Near Dharsara | 7.5 (NE) | 0.8 | 0.6 |
| 8 | Butea Serpuria | Near Biradar | 3.4 (W) | 1.2 | 0.8 |

*3.8.5.2 Forest Blocks in Study Area*

The major forest blocks in 10 km radius from project boundary are presented in **Table-3.8.4.** The forests are manily composed of Sal, Kasi, Kendu, Char, Harda, Bahedi, Dhaura, Asan, Bija, Kusumbi, Kalam, Aam, Mahua, Kasam and Amla. The major contribution is only from this region is Sal and Tendu.

**TABLE-3.8.4**
**FOREST BLOCKS IN STUDY AREA**

| Sr. No. | Name of the Forest Block | Direction | Distance (km) |
|---|---|---|---|
| 1 | Gidher Protected Forest | NW | 2.7 |
| 2 | Lohra Protected Forest | NNW | 4.5 |
| 3 | Bichhi Protected Forest | N | 6.6 |
| 4 | Bori Protected Forest | N | 7.8 |
| 5 | Jiawan Protected Forest | NNE | 5.5 |
| 6 | Majhigawan north Protected Forest | NNE | 7.0 |
| 7 | Pachwar Protected Forest | NNE | 9.9 |
| 8 | Uska Protected Forest | E | 6.3 |
| 9 | Muher Protected Forest | SE | 9.2 |
| 10 | Parihari Protected Forest | NNE | 4.6 |
| 11 | Pokhara Resrve Forest | NE | 6.3 |
| 12 | Oragari Protected Forest | N | 0.2 |
| 13 | Teldah Protected Forest | SE | 7.0 |
| 14 | Mahanban Resreve Forest | S | 6.8 |
| 15 | Mahanban Resreve Forest | SE | 5.0 |
| 16 | Jogin Protected Forest | NW | 7.0 |

The forests mentioned above are 'low' to 'medium' dense forests. The nearest forests to the proposed smelter, CPP complex (Orgari PF and Gidher PF) are 'low' dense forests with a forest density of 0.1.

***Conclusions***

Phytosociological studies were conducted during winter season at various locations such as forest areas and near villages areas to assess phytosociological structure in the study. Dominance of *Shorea robusta, Terminalia tomentosa, Adina cordifolia, Ceiba pentandra, Cassia tora, Eupatorium odarattum* and *Androgarphis panicula* for woody and herbal populations in plant site and surrounding villages Field survey and records from forest pertaining study area indicates that the floral structure in the study area is uniform in nature. The wide variety of herbaceous members and presence of wide variety of woody members reflects that the study area is a un-disturbed ecosystem. Marginal differences were observed in the dominant species in the forest and in non-forest areas. The dominance of herbaceous flora is due to southwest monsoon rains and fertility of soil.

### 3.8.6 Terrestrial Fauna and Ornithology

#### *3.8.6.1 Review of Secondary Published Data*

As per MoEF Notifications and local forest notifications, no Wildlife sanctuaries, National parks/biospheres in 25-km radius from smelter plant boundary.

#### *3.8.6.2 Primary Survey*

A comprehensive Central Legislation namely Wild Life (Protection) Act was enforced in 1972. This law is to provide protection to wild animals and for matters related to their ancillary or incidental death. Schedule-I of this act included the list of rare and endangered species, which are completely protected throughout the country. The detailed list of wild animals and their conservation status as per Wild Life Act (1972) are presented in **Table-3.8.5.**

**TABLE-3.8.5**
**FAUNA AND THEIR CONSERVATION STATUS FROM STUDY AREA**

| Technical Name | English Name/ Local Name | Wild Life Protection Act (1972) |
|---|---|---|
| **Butterflies** | | |
| *Acrae violae* | Tawny coster | Sch-IV |
| *Tirumala liminae* | Blue tiger | Sch-IV |
| *Euploe corecor* | Common crow | Sch-IV |
| *Danaus Melissa* | Dark blue tiger | Sch-IV |
| *Danaus aglea* | Glassy blue tiger | Sch-IV |
| *Precis orthya* | Blue pancy | Sch-IV |
| *Hypolimmansa misipur* | Dannaid eggfly | Sch-IV |
| *Pachliopta hector* | Crimson rose | Sch-IV |
| *Papilo demoleus* | Lime butterfly | Sch-IV |
| *Graphium agamemnos* | Tailed jay | Sch-IV |
| *Neptis hylas* | Common sailor | Sch-IV |
| *Triodes minos* | Southern Birdwing | Sch-IV |
| *Pachliopta hector* | Crimson rose | Sch-IV |
| *Papilo demoleus* | Lime butterfly | Sch-IV |
| *Graphium agamemnos* | Tailed jay | |
| ***spiders*** | | |
| *Pisarua mirabilis* | Hunting spider | - |
| *Tagenaria domestica* | House spider | - |
| ***Insects*** | | |
| *Brachytron pratens* | Hairy dragonfly | - |
| *Anax imperator* | Emperor dragonfly | - |
| *Tettigonia viridisima* | Common green grasshopper | - |
| *Heiroglyphus banian* | Rice grasshopper | - |
| *Nephotettix apicalis* | Common painted grasshopper | - |
| *Spodoptera mauritia* | Swarming caterpillar | - |
| **Aves** | | |
| *Milyus migrans* | Common Kite | Sch-IV |
| *Quills contronix* | Grey quail | Sch-IV |
| *Corvus corvus* | Jungle crow | Sch-IV |
| *Corvus splendens* | House crow | Sch-IV |
| *Turdoides striatus* | White headed babler | Sch-IV |
| *Aegithina tiphia* | Iora | Sch-IV |
| *Pycnonotus cafer* | Red vented bulbul | Sch-IV |
| *Pycnonotus jokokus* | White browed Bulbul | Sch-IV |
| *Saxicoloides fulicata* | Indian robin | Sch-IV |
| *Gallus gallus* | Red Jungle fowl | Sch-IV |
| *Columbus livibus* | Rock Pigeon | Sch-IV |
| *Bubo bubo* | Indian great horned Owl | Sch-IV |
| *Copsychus saularis* | Magpie Robin | Sch-IV |
| *Tchitrea paradisi* | Paradise Fl ycatcher | Sch-IV |
| *Tephrodornis pondiceraianus* | Common Wood shrike | Sch-IV |
| *Lalage sykesi* | Black headed cochoo Shrike | Sch-IV |
| *Artamus fuscus* | Ashy Swallow Shrike | Sch-IV |
| *Dicrurus macrocerus* | Black Drongo | Sch-IV |
| *Dicrurus longicaudatus* | Grey Drongo | Sch-IV |
| *Oriolus oriolus* | Indian Oriole | Sch-IV |

| Technical Name | English Name/ Local Name | Wild Life Protection Act (1972) |
|---|---|---|
| *Temenuchus pagodarum* | Brahmny Myna | Sch-IV |
| *Acridotheres tristicus* | Common myna | Sch-IV |
| *Ploceus philippines* | Weaver bird | Sch-IV |
| *Uroloncha striata* | Spotted munia | Sch-IV |
| *Passer domisticus* | House Sparrow | Sch-IV |
| *Motacilla cinerea* | Grey wagtail | Sch-IV |
| *Motacilla maderaspatensis* | Large pied wagtail | Sch-IV |
| *Cinnyris lotensis* | Loten's sunbird | Sch-IV |
| *Cinnyris asiatica* | Purple Sunbird | Sch-IV |
| *Brachypternus bengalensis* | Malabar Golden backed wood | Sch-IV |
| *Megalaima merulinus* | Indian Cuckoo | Sch-IV |
| *Hierococys varius* | Common Hawk Cuckoo | Sch-IV |
| *Eudynamis scolopaceus* | Koel | Sch-IV |
| *Centropus sinensis* | Crow Pheasant | Sch-IV |
| *Psittacula Krammeri* | Rose ringed parakeet | Sch-IV |
| *Coryllis vaeralis* | Lorikeet | Sch-IV |
| *Coracias benghalensis* | Indian Roller | Sch-IV |
| *Merops orinetalis* | Common Bee Eater | Sch-IV |
| *Merops leschenaulti* | Chestnut headed Bee Eater | Sch-IV |
| *Alcedo atthis* | Common Kingfisher | Sch-IV |
| *Halcyon smyrensis* | White breasted kingfisher | Sch-IV |
| *Microfus affinis* | House swift | Sch-IV |
| *Cyprirus parvus* | Palm swift | Sch-IV |
| *Caprimulgus asiaticus* | Common Indian jar | Sch-IV |
| *Tylo alba* | Barn Owl | Sch-IV |
| *Haliastur indus* | Brahmny kite | Sch-IV |
| *Milvus migrans* | Pariah kite | Sch-IV |
| *Circus aeruginosus* | Marsh harrier | Sch-IV |
| *Astur badius* | Shikra | Sch-IV |
| *Chalcophaps indica* | Emerald Dove | Sch-IV |
| *Lobvanella indicus* | Redwattled Lapwing | Sch-IV |
| *Lobpluvia malabaraica* | Yellow wattled lapwing | Sch-IV |
| *Anhinga melanogaster* | Darter | Sch-IV |
| *Egretta garzetta* | Little Egret | Sch-IV |
| *Bubulcus ibis* | Cattle Egret | Sch-IV |
| *Ardeola grayii* | Pond Heron | Sch-IV |
| *Anas acuta* | Common Teal | Sch-IV |
| *Gallinula chlorpus* | Moore hen | Sch-IV |
| *Sterna albifrons* | Indian River Tern | Sch-IV |
| *Galerida malabarica* | Malabar Crested Lark | Sch-IV |
| *Pavo cristatus* | Peacock | Part-III of sch-I |
| **Reptiles** | | |
| *Hemidactylus sp* | House Lizard | Sch-IV |
| *Calotes versicolor* | Garden Lizard | Sch-IV |
| *Chameleon zeylanicus* | Lizard | Sch-IV |
| *Varanus benghalensis* | Monitor Lizard | Part-II Sch-II |
| *Ptyas mucosus* | Rat snake | Sch-III |
| *Naja naja* | Cobra | Sch-IV |
| *Hemibungarus sps* | Indian coral snake | Sch-IV |
| *Bungarus candidus* | Krait | Sch-IV |
| *Vipera russeli* | Viper | Part-II Sch-II |
| **Amphibia** | | |
| *Rana hexadactyla* | Frog | Sch-IV |
| *Rana tigrina* | Bull frog | Sch-IV |
| *Cocopus sps* | Burrowing frog | Sch-IV |
| **Mammals** | | |

| Technical Name | English Name/ Local Name | Wild Life Protection Act (1972) |
|---|---|---|
| *Lepus nigricollis* | Hare | Sch-IV |
| *Hyaena hyaena* | Hyaena | Sch-III |
| *Canis auries* | Jackal | Part—II of Sch-II |
| *Presbytis entellus* | Black faced monkey | Part-I of Sch-II |
| *Macaca mulata* | Rhesus monkey | Part-I of Sch-II |
| *Funambulus spp.* | Squirrel | Sch-IV |
| *Sus sucrofa* | Wild pig | Sch-III |
| *Rattus norvegicus* | Field mouse | Sch-V |
| *Herpestes edwardii* | Common mongoose | Part-II of Sch-II |
| *Bandicota bengalensis* | Bandicoot | Sch-V |
| *Melursus ursinus** | Sloth Bear | Part-I of Sch-I |
| *Muntiacus muntjak** | Muntiacus | Sch-III |
| *Boselaphus tragocamelus** | Neelgai | Sch-III |
| *Gazelle gazelle** | Chinkara | Part-I of Sch-I |
| *Panthera pardus** | Panther | Part-I of Sch-I |
| *Vulpus benghalensis* | Wild fox | Part-II of Sch-II |
| Fishes | | |
| *Anabas testudino* | Keu | - |
| *Clarias batrachus* | Catfish | - |
| *Wallugo attu* | Mully | - |
| *Puntius sophore* | - | - |
| *Channa punctatus* | - | - |
| *Penecus indicus* | White prawn | - |

- ***Not observed during study period***

It can be concluded that 4 species of Schedule-I, 7 species of Schedule-II, 4 species of Schedule-III and rest belong to Schedule-IV of Wildlife Protection Act, 1972 are recorded/reported during study period from study area. *Panthera pardus (*Panther*), Gazella gazelle (*Chinkara*), Melursus ursinus*are (Sloth Bear) and *Pavo cristatus* (Peacock) are the endangered species reported from the study area.

### 3.8.6.3 Wild Life Conservation

Flora and faunal data was collected from Forest Working Plans (1994-1999 and 2005) of East Sidhi district. Detailed field observations and interactions with local villagers and local tribal hamlet heads reveals that Bears are observed within 10 km of the study area. As per the Wild Life Act (1972), those animals which have been enlisted in the schedules of the Wildlife Act have been presented in the above table. The schedules are based on the species namely, rare, endangered, threatened, vulnerable etc. According to threat of extinction Schedule-I contains those species which need topmost priority, while II, III, IV and V have lesser degree of threat. Most of the avi-fauna are listed in Schedule–IV. As per the list of avi-faunal species, these are mostly local migrant species only. As per recent forest working plans and discussion with local forest officials, there are no migratory paths reported from the study area. In consultation with forest department the wildlife conservation shall be prepared and implemented under guidance of forest department. In addition to that the following mitigation measures will be taken for protection of fauna in the study area:

- Educate the local people to develop awareness to protect the animals;
- Formulations of wild life protection committees in near by villages to check the poaching and hunting;

- Wild life patrolling committee would be formed to monitor the wild animals movement; and
- Develop thick green belt around the plant site with fruit bearing tree which will attract the avi-fauna in the study area and increase the aesthetic value of the area.

A detailed Wild Life Conservation Plan for Schedule-I species is given in **Chapter-5.**

### 3.8.7 Aquatic Ecosystems

Protecting the environment and making efficient use of natural resources are two of the most pressing demands in the present stage of social development. The task of preserving the purity of the atmosphere and water basins is of both national and global significance since there are no boundaries to the propagation of anthropogenic contaminants in the water. An essential pre requisite for the successful solution to these problems is to evaluate ecological impacts from the baseline information and undertake effective management plan. So the objective of aquatic ecological study may be outlined as follows:

- To characterize water bodies like fresh waters;
- To understand their present biological status;
- To understand the impact of proposed industrial and urbanization activities; and
- To suggest recommendations to counter adverse impacts, if any on the ecosystem.

To meet these objectives following methods were followed:

- Generating data by actual field sampling and analysis in these areas through field visits during study period;

To fulfill these objectives and to understand the present status of aquatic ecosystem, samples were collected from different fresh water system (Nallahs) under investigation.

In order to get a clear picture and to assess the various parameters of water, two sampling locations were identified for sampling. Samples were collected during the winter and summer seasons. The sampling locations are presented in **Table-3.8.6** and shown in **Figure-3.8.1.**

**TABLE-3.8.6**
**DETAILS OF AQUATIC SAMPLING LOCATIONS**

| Sr. No. | Code | Locations | Remarks |
|---|---|---|---|
| 1 | AE-1 | Khakher river near village | Fresh water |
| 2 | AE-2 | Khakher nalla | Fresh water |

#### *3.8.7.1 Methodology Adopted for Aquatic Studies*

Aquatic ecosystem close to the project area under investigation was considered for a detailed study. Water samples were considered for their physico-chemical characteristics. Plankton, aquatic plants, fish fauna of water bodies, and their associated fauna were collected, identified and estimated. The following methodology has been adopted for sampling.

*3.8.7.2 Aquatic Fauna*

The field studies indicate that the aquatic fauna consisting of crustaceans, aquatic insects, fishes amphibia, reptiles, birds are listed in **Table-3.8.7.** The fresh water turtle, water snakes and others were found to be present in the nallahs due to its vastness in area and presence of a variety of forage fauna.

**TABLE-3.8.7**
**AQUATIC FAUNA FROM STUDY AREA**

| Sr. No. | Name of the Species | Lentic Water Bodies | Lotic Water Bodies |
|---|---|---|---|
| **Insect** | | | |
| 1 | *Dytiscus sp* | - | Observed |
| 2 | *Nepa sp* | - | Observed |
| 3 | *Ranatra sp* | - | Observed |
| **Amphibians and Aves** | | | |
| 4 | *Rana cynophyctis* | Observed | Observed |
| 5 | *Phalacrocorax carbo* | Observed | Observed |
| 6 | *Bubulcus ibis* | Observed | Observed |
| 7 | *Egretta garzetta* | Observed | Observed |
| 8 | *Ardea cinerea* | Observed | Observed |
| 9 | *Alcedo athinis* | Observed | Observed |
| 10 | *Dendrocygna javanica* | Observed | Observed |

*3.8.7.3 Conclusions on Aquatic Ecology*

Surface water samples were collected for biological analysis from nalahs near Khakher River and Burkhu nala during study period. Biological samples were analysed and estimated diversity index. Plankton diversity Index for phytoplankton and zooplankton varies from 2.56 to 3.11 and 2.22 to 2.79. Physico-chemical, biological parameters and diversity index reveals that the studied water bodies are slightly mesotrophic in nature.

## 3.9 Demography and Socio-Economic Profile

### 3.9.1 Methodology adopted for the Study

The methodology adopted for the study is based on the review of secondary data, which mainly comprises 2001 Census records, as these are more comprehensive and authentic. The sociological aspects studied include human settlements, demographic and other socio-economic aspects and the infrastructural facilities available in the study area. The economic aspects include agriculture, industry and occupational structure of workers.

### 3.9.2 Review of Demographic and Socio-Economic Profiles - 2001

The information on socio-economic aspects of the study area has been compiled from secondary sources, which mainly include census data of 2001. The sociological aspects of this study include human settlements, demographic and other socio-economic aspects and infrastructure facilities available in the study area. The economic aspects include agriculture and occupational structure of workers. The village wise demographic details of the study area are presented in **Annexure–VIII.**

The salient features of the demographic and socio-economic details are described in the following sections.

### 3.9.3 Settlement Pattern and Demography

The socio-economic condition was studied over an area falling within 10-km radius around the proposed site area.

#### *3.9.3.1 Distribution of Population*

As per 2001 census, the study area consists of a total population of 60653 souls residing in 10557 residential households. This indicates an average household size of 5.7 persons per household. The distribution of settlements and population in the study area is shown in **Table-3.9.1.**

**TABLE-3.9.1**
**DISTRIBUTION OF POPULATION**

| Particulars | Study Area |
|---|---|
| No. of Households | 10557 |
| Male Population | 31186 |
| Female Population | 29467 |
| Total Population | 60653 |
| Average Household Size | 5.7 |
| Sex ratio | 945 |
| Density of population/km$^2$ | 241 |

*Source: District Census Hand Book*

#### *3.9.3.2 Population Density*

The density of population reveals that the study area has an overall density of 241 persons per square kilometer.

#### *3.9.3.3 Sex Ratio*

The configuration of male and female indicates that the males constitute about 51.42 % and females 48.58 % of the total population. The sex ratio i.e. the number of females per 1000 males indirectly reveals certain sociological aspects in relation to female births, infant mortality among female children and single person family structure, a result of migration of industrial workers. The study area on an average has 945 females per 1000 males as per 2001 census.

### 3.9.4 Social Structure

As per 2001 census, 19.6 % of the population in the study area belongs to Scheduled Castes (SC) and 30.0 % to Scheduled Tribes (ST). The distribution of population by social structure is shown in **Table-3.9.2.**

**TABLE- 3.9.2**
**DISTRIBUTION OF POPULATION BY SOCIAL STRUCTURE**

| Sr. No. | Particulars | Study Area |
|---|---|---|
| 1 | Scheduled Castes | 11873 |
| 2 | % to total population | 19.6 |
| 3 | Scheduled Tribes | 18834 |
| 4 | % to total population | 31.0 |
| 5 | Total SC and ST | 30707 |
| 6 | % to total population | 50.6 |

*Source: District Census Hand Book*

3.9.5 Literacy Levels

The analysis of the literacy levels reveals a medium literacy rate in the study area. The study area experienced a literacy rate of 34.9 % in 2001. If this is computed only for the people of above the age group of 6 years, i.e. the school going age people, this slightly increases the literacy rate. The distribution of literates and literacy rates in the study area is given in **Table-3.9.3.**

**TABLE-3.9.3**
**DISTRIBUTION OF LITERATE AND LITERACY RATES**

| Sr. No. | Particulars | Study Area |
|---|---|---|
| 1 | Total literates | 21220 |
| 2 | Average literacy (%) | 34.9 |
| 3 | Male literacy rate (%) | 48.6 |
| 4 | Female literacy rate (%) | 20.6 |
| 5 | Male literates | 15145 |
| 6 | % to study area literates | 71.4 |
| 7 | Female literates | 6075 |
| 8 | % to study area literates | 28.6 |

*Source: District Census Hand Book*

The male literacy i.e. the percentage of literate males to the total males of the study area works out to be 48.6 %. The female literacy rate, which is an important indicator for social change, is observed to be 20.6 % in the study area as per 2001 census. This indicates that there is a need for sociological development in the region.

3.9.6 Occupational Structure

The occupational structure of residents in the study area is studied with reference to main workers, marginal workers and non-workers. The main workers include cultivators, agricultural laborers, those engaged in household industry and other services workers.

The marginal workers are those workers engaged in some work for a period of less than six months during the reference year prior to the census survey. The non-workers include those engaged in unpaid household duties, students, retired persons, dependents, beggars, vagrants etc. besides institutional inmates or all other non-workers who do not fall under the above categories.

As per the 2001 census records, altogether the main workers work out to be 30.65 % of the total population. The marginal workers constitute 14.36 % of the total population. The non-workers constitute 54.99 % of the total population. The occupational structure of the study area is shown in **Table-3.9.4.**

**TABLE-3.9.4**
**OCCUPATIONAL STRUCTURE**

| Sr. No. | Occupation | Study Area | |
|---|---|---|---|
| | | No. | % to Population |
| 1 | Total main workers | 18588 | 30.65 |
| | Male | 13015 | 21.46 |
| | Female | 5573 | 9.19 |
| 2 | Marginal workers | 8712 | 14.36 |
| | Male | 2401 | 3.95 |
| | Female | 6311 | 10.41 |
| 3 | Non-workers | 33353 | 54.99 |
| | Male | 15770 | 26.00 |
| | Female | 17583 | 28.99 |

*Source: District Census Hand Book*

# 4.0 IMPACT ASSESSMENT

## 4.1 Introduction

This chapter presents identification and appraisal of various impacts from the proposed aluminium smelter and captive power plant.

The environmental impacts are categorized as primary or secondary. Primary impacts are attributed directly to the project and secondary impacts are indirectly induced and typically include the associated investment and changed pattern of social and economic activities by the proposed action.

The impacts have been assessed for the smelter plant and captive power plant assuming that the pollution due to the existing activities has already been covered under baseline environmental monitoring and continue to remain same till the operation of the project.

The construction and operational phase of the proposed project comprises various activities each of which may have an impact on some or other environmental parameters. Various impacts during the construction and operation phases on the environment have been studied to estimate the impacts on the environmental attributes and are discussed in the subsequent sections.

## 4.2 Impacts during Construction Phase

This includes the following activities related to land acquisition if any, levelling of site, construction of related structures and installation of related equipment.

### 4.2.1 Impact on Land Use

Present land use of the selected site is barren and agricultural land. There will be change in land use of the area and the selected site will be categorized as industrial area.

### 4.2.2 Impact on Soil

The construction activities will result in loss of vegetation cover and topsoil to some extent in the plant area. It is envisaged that about 300-mm of topsoil will be removed from the plant area. The project area consists of agricultural and barren lands. Therefore, a total of about 22-Lakh cum of topsoil is estimated to be removed from the project area. This shall be stacked separately and to be used for plantation purposes and filling up of low lying area.

Apart from localized construction impacts at the plant site, no adverse impacts on soil in the buffer area are anticipated.

### 4.2.3 Impact on Air Quality

The main sources of emission during the construction period are the movement of equipment at site and dust emitted during the levelling, grading, earthwork, foundation works and exhaust emissions from vehicles and equipment deployed during the construction phase is also likely to result in marginal increase in the levels of $SO_2$, NOx, SPM and CO. The impact will be for short duration and confined within the project boundary and is expected to be negligible outside the plant boundaries. The impact will, however, be reversible, marginal and temporary in nature. Proper upkeep and maintenance of vehicles, sprinkling of water on roads and construction site, providing sufficient vegetation etc are some of the measures that would greatly reduce the impacts during the construction phase.

### 4.2.4 Impact on Water Resources and Quality

Water demand for various activities during the construction phase will be met by sourcing from rainwater collected in specially created surface water ponds. As no labour camps are envisaged in the project area, no major sanitation water requirement is envisaged during construction phase. Water for drinking and sanitation for construction labour will be sourced from the ground water. However, water demand for construction is temporary and widely variable in nature and is expected to last for about 40 months.

The wastewater from vehicle and construction equipment maintenance centre will contribute to oil and grease concentration. The wastewater from sanitation of labours will contribute to higher BOD concentrations.

Impact on water quality during construction phase may be due to non-point discharges of solids from soil loss and sewage generated from the construction workforce stationed at the site. However, due to the construction being carried out on the flat terrain, the soil losses will be negligible. Further, the construction of the plant will be more related to mechanical fabrication, assembly and erection; hence the water requirements would be small. Temporary sanitation facilities (septic tanks and soak pits) will be set-up for disposal of sanitary sewage generated by the workforce. Since, most of the construction workforce will constitute of floating population, the demand for water and sanitation facilities will be small and temporary and it will be managed by providing drinking water facility and sanitation facilities at the site during construction phase.

The overall impact on Water Environment during construction phase due to proposed project is likely to be short term and insignificant.

### 4.2.5 Impact on Noise Levels

Heavy construction traffic for loading and unloading, fabrication and handling of equipment and materials are likely to cause an increase in the ambient noise levels. However, the noise will be temporary and will be restricted mostly to daytime.

The noise control measures during construction phase include provision of caps on the equipment and regular maintenance of the equipment.

Overall, the impact of generated noise on the environment is likely to be insignificant, reversible and localized in nature and mainly confined to the day hours.

### 4.2.6 Impact on Terrestrial Ecology

The initial construction works at the project site involves land clearance. During construction vegetation may be disturbed including tree cutting. However, tree cutting will be kept at bare minimum. Greenbelt will be developed during construction to improve the aesthetic value in the area and to screen out the fugitive dust generated during construction.

The removal of vegetation from the soil and loosening of the topsoil generally causes soil erosion. However, such impacts will be primarily confined to the project site during initial periods of the construction phase and will be minimized through adoption of mitigative measures like paving and surface treatment, water sprinkling and appropriate plantation program. The project site will be extensively landscaped with the development of green belt consisting of a variety of taxa, which would enrich the ecology of the area and add to the aesthetics.

The sanitary wastewater will be sent to septic tanks. The wastewater coming from heavy machinery will be treated to remove oil and grease and suspended solids in the detention tank before utilizing for greenbelt and sprinkling to suppress the dust.

### 4.2.7 Demography and Socio-Economics

The non-workers in the study area constitute about 55.1%. This indicates the availability of sizeable manpower required for the construction activity. The project will provide either direct or indirect job opportunities to the local population as far as possible. There will be some migration of labour force from outside the study area during construction phase, which may put some pressure on the local settlements and resources. However, this impact is envisaged to be marginal and temporary in nature.

## 4.3 Impacts during Operational Phase

The proposed project operation will involve production of 3,25,000 TPA of aluminium metal and 750 MW power generation. The following environmental attributes will be affected to varying degree due to activities related to the operational phase and are considered for impact assessment:

- Topography and Climate;
- Landuse pattern;
- Soil quality;
- Air quality;
- Water resources and quality;
- Solid waste;
- Noise levels;
- Terrestrial and aquatic ecology;
- Demography and socio-economics; and
- Infrastructural facilities.

### 4.3.1 Impact Topography and Climate

The major envisaged topographical changes would be due to the manmade structures like civil structures and industrial complex. The impact would be minimal. However, it will invite positive benefits in the form of land levelling and tree plantations in the project vicinity.

Heat loss through stack will be 6 to 7% of the total heat in the furnace. The quantum of heat so lost to the atmosphere is not significant. The moderate wind speed and rainfall in the region will mitigate the adverse impacts. The vegetation in the region will help to manage the thermal balance.

### 4.3.2 Impact on Land Use

The present land use of the area falls under barren and agricultural land use category. After commissioning of proposed plant, this land use will change to industrial category. Along with the development of plant activities, greenbelt will also be developed along the plant boundary, which will be a beneficial impact.

### 4.3.3 Impact on Soil

The air borne fugitive dust from the plant is likely to be deposited on the topsoil in the immediate vicinity of the plant boundary. However, the fugitive emissions are likely to be controlled to a great extent through proposed control measures like pot hooding, gas collection efficiency and highly efficient electrostatic precipitators. Further, proper arrangement and vacuum will be maintained in the fume collection hood to prevent any fugitive emissions from the pot to ensure maximum fume collection efficiency.

The emissions of fluorides from the stacks are also likely to be controlled to a great extent through proposed control measures. Hence, the impact on the soil is likely to be insignificant due to fugitive dust.

### 4.3.4 Impact on Air Quality

The impact on air quality is assessed based on combined emissions of the proposed smelter and CPP. Suspended Particulate Matter (SPM) and Sulphur dioxide ($SO_2$) and Oxides of Nitrogen (NOx), Fluoride (F) and PAH will be the important pollutants emitting from smelter and CPP. There are no existing other industries in 10-km radius and hence, no cumulative impact with other industries on the regional air quality is envisaged.

Prediction of impacts on air environment has been carried out employing mathematical model based on a steady state Gaussian plume dispersion model designed for multiple point sources for short term. In the present case, **Industrial Source Complex [ISC3]** 1993 dispersion model based on steady state Gaussian plume dispersion, designed for multiple point sources for short term and developed by United States Environmental Protection Agency [USEPA] has been used for simulations from point sources.

#### *4.3.4.1 Impacts due to Coal Handling and Storage*

It is envisaged to store coal in an area of about 100-acre in the plant area. Fugitive emissions are envisaged from the coal stack piles. FDM modeling techniques are used for assessing the impacts of coal stack piles.

Fugitive Dust Model (FDM) is a computerized air quality model specifically designed for computing concentration and analysis of the dispersion of fugitive dust. The sources may be point, line or area sources. The model is generally based on the well-known Gaussian Plume formulation for computing concentrations, but the model has been specifically adapted to incorporate an improved gradient-transfer deposition algorithm. Gravitational setting velocity and a deposition velocity are calculated by FDM for each class. Concentration and deposition are computed at all user-selectable receptor locations.

For the short-term simulations, the concentrations were estimated around 445 receptor points including village receptors are chosen to obtain an optimum description of variations in concentrations over the site in 10-km radius and AAQ locations covering 16 directions. SPM concentration of 15.2 $\mu g/m^3$ resulted at about 500-m distance from the stock pile during winter season.

#### *4.3.4.2 Impacts due to Point Emission Sources*

The details of stack emissions envisaged from the project are given in **Table-4.1.** For the modeling purpose pollutants namely, Suspended Particulate Matter, Sulphur dioxide, Oxides of Nitrogen, PAH and Fluoride are considered. The details of emission calculations and isopleths are given in Annexure-V.

**TABLE-4.1**
**STACK AND EMISSION DETAILS (PROPOSED ALUMINIUM SMELTER & CPP)**

| Sr. No. | Stacks Attached | Dia (m) | H (m) | Exit Vel (m/s) | Exit Temp (°C) | Flow ($Nm^3$/sec) | Emission Rate (g/s) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $SO_2$ | $NO_X$ | SPM | F | PAH |
| **Captive Power Plant** | | | | | | | | | | | |
| 1 | CPP-1 | 3.5 | 120 | 23.6 | 140 | 164 | 215.6 | 194.0 | 16.4 | -- | -- |
| 2 | CPP-2 | 3.5 | 120 | 23.6 | 140 | 164 | 215.6 | 194.0 | 16.4 | -- | -- |
| 3 | CPP-3 | 3.5 | 120 | 23.6 | 140 | 164 | 215.6 | 194.0 | 16.4 | -- | -- |
| 4 | CPP-4 | 3.5 | 120 | 23.6 | 140 | 164 | 215.6 | 194.0 | 16.4 | -- | -- |
| 5 | CPP-5 | 3.5 | 120 | 23.6 | 140 | 164 | 215.6 | 194.0 | 16.4 | -- | -- |
| **Aluminium Smelter** | | | | | | | | | | | |
| 6 | Gas Treatment Plant | 4.3 | 80 | 20.0 | 90 | 238.4 | 55.4 | - | 23.8 | 0.4 | -- |
| 7 | Gas Treatment Plant | 4.3 | 80 | 20.0 | 90 | 238.4 | 55.4 | - | 23.8 | 0.4 | -- |
| 8 | Baking Furnace | 1.9 | 50 | 20.0 | 250 | 32.3 | 20.6 | - | 1.6 | 0.1 | 0.1 |

- ***Meteorological Data***

The hourly meteorological data recorded at site is converted to the mean meteorological hourly data as specified by CPCB and the same has been used in the model. In absence of site specific mixing heights, mixing heights published in

'Spatial Distribution of Hourly Mixing Depths over Indian Region' by Dr. R.N.Gupta have been used.

*4.3.4.3 Presentation of Results*

In the present case, model simulations have been carried out for winter season. For the short-term simulations, the concentrations have been estimated around 1200 receptors to obtain an optimum description of variations in concentrations over the site in 10-km radius covering 16 directions.

The incremental ground level concentrations for SPM, $SO_2$, NOx, PAH and F are given in **Table-4.2**.

**TABLE-4.2**
**PREDICTED 24-HOURLY SHORT TERM INCREMENTAL CONCENTRATIONS(WINTER)**

| Pollutant | Incremental Concentration ($\mu g/m^3$) | Distance (km) | Direction |
|---|---|---|---|
| **Cumulative Incremental Concentration (Aluminium Smelter + CPP)** | | | |
| SPM | 3.8 | 1.0 | East |
| $SO_2$ | 42.5 | 1.0 | East |
| NOx | 38.9 | 1.0 | East |
| F | 1.5 | 1.0 | East |
| PAH | 0.05 | 1.0 | East |

- ***Comments on Predicted Concentrations***

A perusal of **Table-4.2** reveals that the maximum incremental short term 24 hourly ground level concentrations for SPM, $SO_2$, NOx, PAH and F likely to be encountered during winter season are 3.8, 42.5, 38.9, 1.5 and 0.05 $\mu g/m^3$ respectively occurring at a distance of about 1.0-km in east direction.

- ***Resultant Concentrations after Implementation of the Project***

The maximum incremental GLCs due to the proposed project for SPM, $SO_2$, NOx, PAH and F are superimposed on the maximum baseline concentrations recorded during the study period in the downwind direction to arrive at the likely resultant concentrations during the same period after implementation of the proposed project. The cumulative concentrations (baseline + incremental) after implementation of the project are tabulated in **Table-4.3**.

**TABLE-4.3**
**RESULTANT CONCENTRATIONS DUE TO INCREMENTAL GLC's (Proposed Aluminium Smelter + CPP)**

| Pollutant | Concentration ($\mu g/m^3$) | | |
|---|---|---|---|
| | Baseline | Incremental | Resultant |
| SPM | 143.7 | 3.8 | 147.5 |
| $SO_2$ | 10.2 | 42.5 | 52.7 |
| NOX | 10.8 | 38.9 | 49.7 |
| F | <0.1 | 1.5 | 1.5 |
| PAH | <0.01 | 0.05 | 0.05 |

The predictions indicate that the SPM, $SO_2$, NOx concentrations are likely to be within the prescribed limit of 200, 80 and 80 µg/m³ respectively for residential and rural zone. Similarly, the resultant concentrations of Fluorides and PAH are negligible.

**TABLE-4.4**
**PREDICTED 24-HOURLY SHORT TERM INCREMENTAL CONCENTRATIONS (PRE-MONSOON)**

| Pollutant | Incremental Concentration (µg/m³) | Distance (km) | Direction |
|---|---|---|---|
| **Cumulative Incremental Concentration (Aluminium Smelter + CPP)** | | | |
| SPM | 3.6 | 1.4 | East |
| $SO_2$ | 41.2 | 1.4 | East |
| NOx | 40 | 1.4 | East |
| F | 1.5 | 1.4 | East |
| PAH | 0.05 | 1.4 | East |

- ***Comments on Predicted Concentrations***

A perusal of **Table-4.2** reveals that the maximum incremental short term 24 hourly ground level concentrations for SPM, $SO_2$, NOx, PAH and F likely to be encountered during winter season are 3.6, 41.2, 40, 1.5 and 0.05 µg/m³ respectively occurring at a distance of about 1.4-km in east direction.

- ***Resultant Concentrations after Implementation of the Project***

The maximum incremental GLCs due to the proposed project for SPM, $SO_2$, NOx, PAH and F are superimposed on the maximum baseline concentrations recorded during the study period in the downwind direction to arrive at the likely resultant concentrations during the same period after implementation of the proposed project. The cumulative concentrations (baseline + incremental) after implementation of the project are tabulated in **Table-4.5**.

**TABLE-4.5**
**RESULTANT CONCENTRATIONS DUE TO INCREMENTAL GLC's (Proposed Aluminium Smelter + CPP)**

| Pollutant | Concentration (µg/m³) | | |
|---|---|---|---|
| | Baseline | Incremental | Resultant |
| SPM | 160.1 | 3.6 | 163.7 |
| $SO_2$ | 8.2 | 41.2 | 49.4 |
| NOX | 10.7 | 40 | 50.7 |
| F | <0.1 | 1.5 | 1.5 |
| PAH | <0.01 | 0.05 | 0.05 |

The predictions indicate that the SPM, $SO_2$, NOx concentrations are likely to be within the prescribed limit of 200, 80 and 80 µg/m³ respectively for residential and rural zone. Similarly, the resultant concentrations of Fluorides and PAH are negligible.

**TABLE-4.6**
**PREDICTED 24-HOURLY SHORT TERM INCREMENTAL CONCENTRATIONS (POST-MONSOON)**

| Pollutant | Incremental Concentration (μg/m³) | Distance (km) | Direction |
|---|---|---|---|
| **Cumulative Incremental Concentration (Aluminium Smelter + CPP)** | | | |
| SPM | 3.9 | 1.0 | south |
| $SO_2$ | 40.6 | 1.0 | south |
| NOx | 39.5 | 1.0 | south |
| F | 1.5 | 1.0 | south |
| PAH | 0.05 | 1.0 | south |

- ***Comments on Predicted Concentrations***

A perusal of **Table-4.6** reveals that the maximum incremental short term 24 hourly ground level concentrations for SPM, $SO_2$, NOx, PAH and F likely to be encountered during winter season are 3.9, 40.6, 39.5, 1.5 and 0.05 μg/m³ respectively occurring at a distance of about 1.0-km in south direction.

- ***Resultant Concentrations after Implementation of the Project***

The maximum incremental GLCs due to the proposed project for SPM, $SO_2$, NOx, PAH and F are superimposed on the maximum baseline concentrations recorded during the study period in the downwind direction to arrive at the likely resultant concentrations during the same period after implementation of the proposed project. The cumulative concentrations (baseline + incremental) after implementation of the project are tabulated in **Table-4.7.**

**TABLE-4.3**
**RESULTANT CONCENTRATIONS DUE TO INCREMENTAL GLC's (Proposed Aluminium Smelter + CPP)**

| Pollutant | Concentration (μg/m³) | | |
|---|---|---|---|
| | Baseline | Incremental | Resultant |
| SPM | 139.0 | 3.9 | 142.9 |
| $SO_2$ | 10.4 | 40.6 | 51 |
| NOX | 10.4 | 39.5 | 49.9 |
| F | <0.1 | 1.5 | 1.5 |
| PAH | <0.01 | 0.05 | 0.05 |

The predictions indicate that the SPM, $SO_2$, NOx concentrations are likely to be within the prescribed limit of 200, 80 and 80 μg/m³ respectively for residential and rural zone. Similarly, the resultant concentrations of Fluorides and PAH are negligible.

Hence, it can be concluded that the impacts due to the proposed smelter plant complex are marginal and insignificant.

## 4.3.5 Impact on Water Resources and Water Quality

### 4.3.5.1 Impact on Water Resources

The total area for plant site is about 1500-ha. A few first and second order streams are passing though the plant site. As far as possible, these streams will not be disturbed and their natural course is maintained. A water pond will be developed in the southern corner of the plant site and the rainwater will be stored in the pond and reused for plant operations.

The total requirement of water for domestic, industrial and allied activities including water requirement for greenbelt development during operation phase is about 4600 $m^3$/hr.

No ground water source will be tapped for meeting the water requirements during operation of proposed smelter and CPP. The raw water requirement of 4600 $m^3$/hr during operation phase shall be met from Gopad river which is at a distance of about 35-km by laying pipeline. Energy Department of Madhya Pradesh has indicated availability of sufficient water in Gopad river and already allocated 45.12 cusecs of water from Gopad river for the project.

Hence, no impact on the water resources is envisaged.

### 4.3.5.2 Impact on Water Quality

The water balance and wastewater generation details have been described in Chapter-2.

The wastewater generation in the smelter complex along with CPP will be 935 $m^3$/hr. The complete wastewater generated will be treated and utilised within the plant.

The domestic wastewater generated from canteen and toilets of smelter plant will be treated and used in greenbelt development. Thus, wastewater generated in smelter project will not be discharged out side the premises.

Under normal operation of the plant, no wastewater will be discharged out side plant premises. However, in rainy days the treated domestic wastewater used in greenbelt will not be required. The same will be discharged in the seasonal nalla flowing adjacent to plant boundary.

The storm water in the project area will be collected through storm water drains and collected in the storm water tank, which will be lined to prevent any contamination of ground water. The stored storm water will be utilized in the smelter operation resulting in conservation of fresh water. In case the storm water tank starts overflowing, the water will be treated in de-fluoridation plant before discharging into nalla.

The guard pond will be provided with proper lining to prevent seepage and avoid contamination of groundwater. Hence, the impact on the groundwater bodies is not envisaged. Hence, impact on the water quality is not envisaged.

### 4.3.6 Impact of Solid Wastes

#### *4.3.6.1 Aluminium Smelter*

The details of the solid wastes from the proposed project are described in Chapter-2. The details of the solid waste generated in the plant are given in **Table-4.8.**

**TABLE-4.8**
**EXPECTED SOLID WASTE FROM SMELTER**

| Sr. No. | Type of Waste | Unit | Quantity | Mode of Disposal |
|---|---|---|---|---|
| 1 | Spent Pot Lining (from 5th year onwards) | TPA | 5800 | Will be disposed-off in secured landfill as per CPCB guidelines. |
| 2 | Used Oil | KLPA | 7.0 | Will be sent to authorized recyclers |
| 3 | Dross | TPA | 1400 | Will be supplied to authorized secondary metal processing industries |
| 4 | Scrap cast iron | TPA | 850 | Will be sent to authorized recyclers |
| 5 | Scrap collector bars (from 5th year onwards) | TPA | 1700 | Will be re-used |

The solid waste will be disposed in the following manner:

- The Spent Pot Lining (SPL) waste will be stored in secured land fill as discussed in Chapter-2 or disposed in accordance with CPCB guidelines;
- The burnt coke fines from bake oven will be recycled in green anode plant. The refractory from the bake oven from ladle cleaning and cast house, the sundry waste and sweeping dust from the plant will be utilized or stored along with SPL;
- The aluminum dross and cast iron scraps will be supplied to authorized secondary metal processing industries; and
- Sludge from sewage treatment plant will be dried and used as manure for greenbelt maintenance. Canteen/sanitary waste will be composted and used as manure for greenbelt development.

With the implementation of above precautionary measures, the impacts due to solid waste disposal will be insignificant.

- ***Secured Land Filling***

Around 5800 tonnes of Spent Pot Lining (SPL) will be generated annually, which will be put into secure land fill area as per the CPCB guidelines. Trenches will be constructed along the sides of the secured land fill facility to collect the run-off water and prevent the water from entering the pit. This will prevent the contamination of rain water.

A secured land filling area has been earmarked for SPL storage, which will be sufficient to store SPL for a period of 15 years. However, possibility of SPL utilization will be continuously explored on high priority.

Thereby, there will not be any impact either on groundwater/storm water or on soil due to the SPL solid waste.

#### *4.3.6.2 Captive Power Plant*

The details of the solid waste generated in the plant are given in **Table-4.9.**

**TABLE-4.9**
**EXPECTED SOLID WASTE FROM CPP PROJECT**

| Sr. No. | Plant | Quantity | Mode of Disposal |
|---|---|---|---|
| 1 | Used Oil | 7.0 KLPA | Will be supplied to authorized recyclers |
| 2 | Ash from CPP | 3170 TPD (Fly ash - 2535 TPD; Bottom ash - 635 TPD) | Ash will be disposed off in ash disposal area using High Concentrated Slurry Disposal method and will be supplied to potential users at free of cost. |

The ash generated in the plant will be utilized to maximum extent possible and balance will be stored in the ash pond using High Concentrate Slurry Disposal method along with the ash generated in the CPP under implementation. The ash will be transported in the form of high concentrate slurry to ash pond through dedicated pipeline.

The water required in ash handling unit will be met from cooling tower blowdown, which will result in substantial reduction in fresh water requirement.
With the implementation of above precautionary measures, the impacts due to solid waste disposal will have insignificant impacts on environment.

- ***Impact of Ash Pond on Surface Water***

In ash disposal, High Concentration Slurry Disposal method will be adopted, which uses very less water to form the slurry. The slurry will be self settling and also self-limiting so that in the ash pond ash will deposit and dry by itself to form a hard surface. Hence, there will not be any discharge from the ash pond.

The ash pond will be provided with peripheral drains to collect run-off water during rainy season. The run-off water will be treated in clariflocculators before discharging into nalla. Hence, the impact of the ash pond on the surface water will be insignificant.

- ***Impact of Ash Pond on Ground Water***

The possibility of groundwater contamination due to the leaching of metals from the ash pond was examined based on soil investigation study and hydrogeological conditions in the region. The study indicates the co-efficient of permeability in the area is in the range of $10^{-7}$ to $10^{-6}$ cm per second, which indicates very poor drainability. The same will be reduced further to $10^{-9}$ cm per second, if required, by compaction and by provision of clay lining.

The dykes around the pond shall be constructed with proper compaction at maximum dry density. The co-efficient of permeability shall be much less than the natural deposits to further reduce the drainability.

Thus, the impact of the ash pond on the ground water will be insignificant. Further, the existing infiltration rates may reduce further due to the disposal of ash in the ash pond, which is likely to be caused due to the result of deposition of fly ash in the pore space of the topsoil, which will decrease its permeability. With the passage of time, more and more fly ash particles will get deposited in the pore spaces of the top soil making it essentially non-porous and impervious and in view of the above, contamination through leaching is not envisaged.

Moreover, in high concentrate slurry, water content will be very less and there will not be pounding of the water in ash pond. There will not be any water left for leaching into ground water. Hence, the impact on the ground water will be insignificant.

4.3.7 Impact on Noise Levels

The main noise generating sources from the smelter plant will be pumps, compressors along with cooling tower and boiler at paste plant. The noise levels at the source for these units will be in the range of 80-90 dB(A). The major noise generating sources from the proposed plant are listed in **Table-4.10.** These are considered as input to the noise model.

**TABLE-4.10**
**ESTIMATED NOISE LEVELS FROM THE PLANT**

| Sr. No. | Sources | Noise Level in dB(A) |
|---|---|---|
| 1 | Compressor house | 90 |
| 2 | Pot lines-1 | 80 |
| 3 | Pot lines-2 | 80 |
| 4 | Casting plant | 85 |
| 5 | Paste plant | 85 |
| 6 | Cooling tower | 90 |
| 7 | CPP | 80-90 |

*4.3.7.1 Presentation of Results*

The model results are discussed below and are represented through contours in **Figure-4.1.** The incremental and resultant noise levels at the plant boundaries are given in **Table-4.11.**

**TABLE-4.11**
**PREDICTED NOISE LEVELS AT PLANT BOUNDARIES**

| Sr. No. | Direction | Incremental Noise Level in dB(A) | Resultant Noise Level in dB(A) |
|---|---|---|---|
| 1 | N | 36.0 | 51.2 |
| 2 | NE | 38.0 | 51.3 |
| 3 | E | 31.5 | 51.1 |
| 4 | SE | 32.5 | 51.2 |
| 5 | S | 31.0 | 51.1 |
| 6 | SW | 33.5 | 51.2 |
| 7 | W | 30.0 | 51.1 |
| 8 | NW | 31.1 | 51.1 |

The predicted noise levels at the boundary due to various plant activities will be ranging in between 30 to 38 dB(A). The increment noise levels will be less than 40 dB(A) at all of the surrounding habitations. It is seen from the simulation results that the resultant noise levels will be well within the CPCB standards.

*4.3.7.2 Impact on Work Zone*

There are no high noise equipments in the proposed smelter project. However, impacts on the working personnel are not expected to be significant on account of the high level of automation of the plant, which means that workers will be exposed for short duration only that too intermittently.

4.3.8 Impact of Air Quality on Reserve Forest

The air quality impacts on surrounding reserved forest have been computed based on SPM, $SO_2$ and NOx incremental concentration over the Reserve Forests. The incremental concentration over protected forests and reserve forests are given in **Table-4.12.**

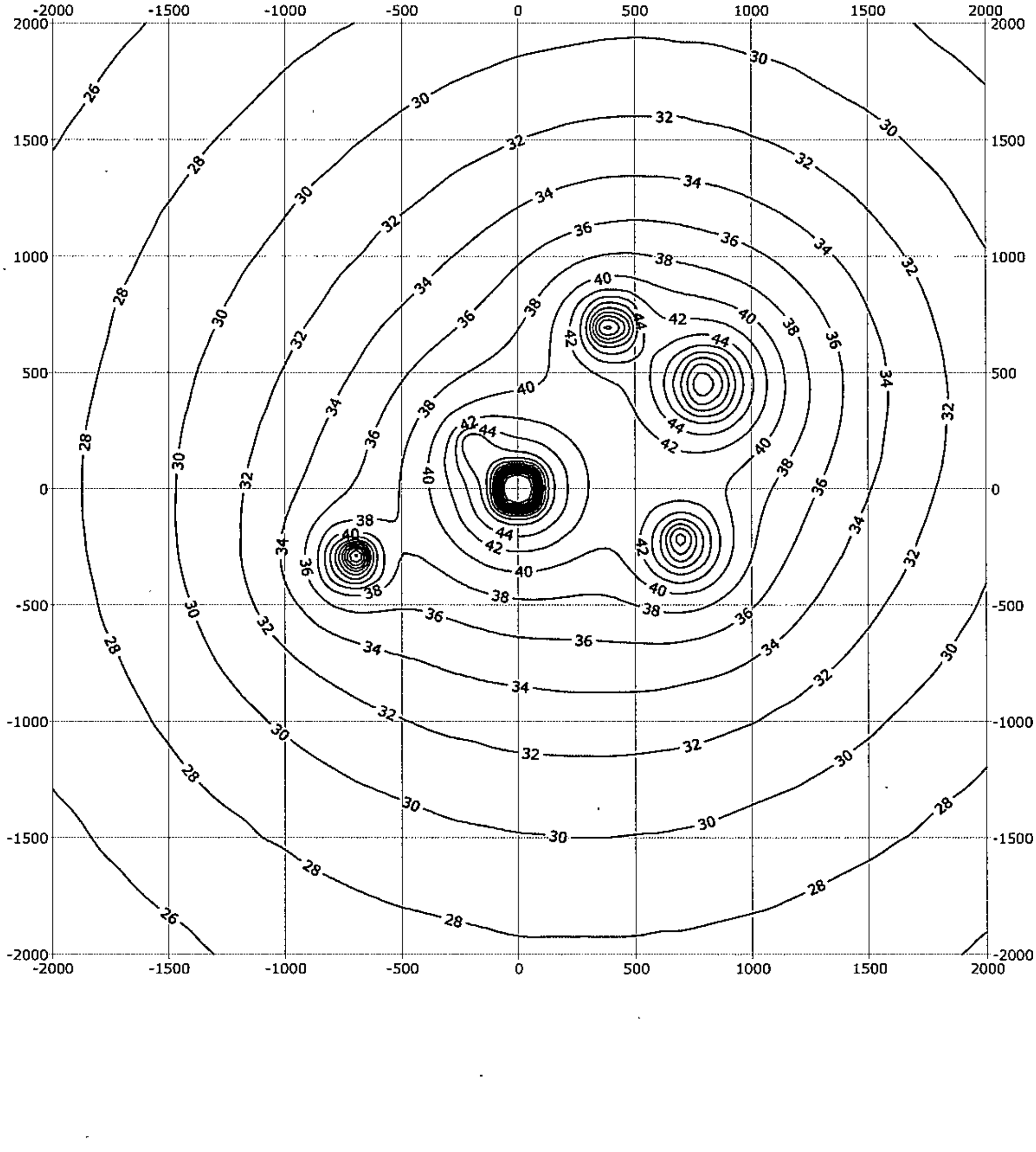



**FIGURE-4.1**
**NOISE DISPERSION CONTOURS**

**TABLE-4.12**
**INCREMENTAL CONCENTRATIONS DUE TO CPP + SMELTER AT RESERVE FORESTS**

*All the values are given μg/m³*

| Forests | Distance (km) | Direction | Incremental Concentrations | | |
|---|---|---|---|---|---|
| | | | SPM | $SO_2$ | $NO_x$ |
| Orgari PF | 0.2 | N | 0.2 | 2.1 | 2.0 |
| Gidhar PF | 2.7 | NW | <0.1 | <0.1 | <0.1 |
| Mahanban RF | 4.0 | WSW | <0.1 | <0.1 | <0.1 |
| Lohra PF | 4.5 | NNW | <0.1 | <0.1 | <0.1 |
| Teldah PF | 4.6 | SE | <0.1 | <0.1 | <0.1 |
| Parihasi PF | 4.6 | NNE | 0.8 | 6.1 | 4.1 |
| Jiwan RF | 5.5 | NNE | 0.6 | 12.0 | 10.0 |
| Uska PF | 6.3 | E | 1.4 | 4.0 | 2.0 |
| Pokhara RF | 6.3 | NE | 0.2 | 10.2 | 8.1 |
| Bichhi PF | 6.6 | N | <0.1 | <0.1 | <0.1 |
| Majaghavan PF | 7.0 | NNE | 0.8 | 2.1 | 1.0 |
| Bori PF | 7.8 | N | <0.1 | <0.1 | <0.1 |
| Muher RF | 9.2 | SE | <0.1 | <0.1 | <0.1 |
| Pachwar PF | 9.9 | NNE | <0.1 | <0.1 | <0.1 |

### 4.3.9 Impact on Flora and Fauna

The baseline flora and fauna has been depicted in Section-3.8 of Chapter-3. As per forest working plans and records from MoEF, there are no protected areas as per Wildlife Protection Act, 1972 (Wildlife sanctuaries, National parks, Tiger reserves, Biospheres, Elephant reserves, Community reserves and Conservation reserves) in 25-km radius from plant boundary. Plant species observed are common in nature and there are no endangered threatened or protected or rare plant species recorded during field surveys and also from forest department records and also records of Red data plants in India by Botanical Survey of India.

Orgari PF is the nearest forest to the plant site. Project area shares a common boundary with Orgari PF. Mohanban Reserve Forest exists at 4.0-km from plant boundary on WSW direction. In addition, about 10 protected / reserved forests also exist in 10-km radius. The forest is classified as Northern dry deciduous Sal forest and mainly composed of Sal, Bija, Haldu, Tendu, Mundi, Kasai, Aonla, Salai, Dhawda, Palas, Harra, Saja and Mahua. The predominant tree species in 10-km area are presented in **Table-4.13** and the Sch-I and Sch-II animals which are observed in study area are presented in **Table-4.14.**

**TABLE-4.3**
**PLANT SPECIES OBSERVED IN STUDY AREA (10-KM RADIUS)**

| Sr. No. | Technical Name | Local Name |
|---|---|---|
| 1 | *Adina cordifolia* | Haldu |
| 2 | *Buchanania lanzan* | Char |
| 3 | *Anogeissus latifolia* | Dhaura |
| 4 | *Boswellia serrata* | Salai |
| 5 | *Bridelia retusa* | Bridelia |
| 6 | *Diospyros melanoxylon* | Tendu |

| Sr. No. | Technical Name | Local Name |
|---|---|---|
| 7 | *Soymida febrifuga* | Rohan |
| 8 | *Emblica officinale* | Aonola |
| 9 | *Ficus hispida* | Bad |
| 10 | *Lagestromia parviflora* | Moyen |
| 11 | *Lannea coramandalica* | Jingan |
| 12 | *Madhuca latifolia* | Mahua |
| 13 | *Shorea robusta* | Sal |
| 14 | *Sygygium cumini* | Jamun |
| 15 | *Terminalia bellarica* | Bellerica |
| 16 | *Terminalia tomentosa* | Saja |
| | **Shrubs and under shrubs** | |
| 17 | *Grewia hirsute* | Gudsakri |
| 18 | *Desmodium gyrans* | Roilei |
| | **Bamboos** | |
| 19 | *Dendrocalamus stricuts* | Bans |
| 20 | *Bmbusa vulgaris* | Bamboo |
| | **Grasses** | |
| 21 | *Cyanodactylon sp* | Doob |
| 22 | *Eragrostis tenella* | Bhurbhusi |
| 23 | *Aristida sp* | Shukla |
| | **Climbers** | |
| 24 | *Bauhinia vahlii* | Mahui patta |

***Source: Forest Department, Sidhi & Vimta Labs Limited, Hyderabad***

## TABLE-4.14
## LIST OF SCHEDULE-I AND II ANIMALS IN STUDY AREA (10-KM RADIUS)

| Sr. No. | Technical Name | English Name | Local Name | Conservation Status as per Wildlife Protection Act (1972) |
|---|---|---|---|---|
| 1 | *Naja naja* | Cobra | Nag | Part-II of Sch-II |
| 2 | *Canis auries* | Jackal | Siyar | Part-II of Sch-II |
| 3 | *Presbytis entellus* | Black faced monkey | Langur | Part-I of Sch-II |
| 4 | *Macaca mulata* | Rhesus monkey | Monkey | Part-I of Sch-II |
| 5 | *Herpestes edwardii* | Common mongoose | Neola | Part-II of Sch-II |
| 6 | *Vulpus benghalensis* | Wild fox | Lomdi | Part-II of Sch-II |
| 7 | *Pavo cristatus* | Peacock | Mor | Part-III of Sch-I |
| 8 | *Melursus ursinus* | Sloth Bear | Bhalu | Part-I of Sch-I |
| 9 | *Gazelle gazelle** | Chinkara | Chinkara | Part-I of Sch-I |
| 10 | *Panthera pardus** | Panther | Panther | Part-I of Sch-I |

***Source: Forest Department, Sidhi & Vimta Labs Limited, Hyderabad***

The forests in 10-km radius area are 'low' to 'medium' dense forests. The nearest forests to the proposed smelter, CPP complex (Orgari PF and Gidher PF) are 'low' dense forests with a forest density of 0.1. It is proposed to develop a comprehensive greenbelt with a density of 2000 trees per hectare in the project area. With the proposed plantations, the tree density of the area will increase significantly, which is a positive impact on the environment.

However, the detailed Forest Conservation Plan and Wildlife Conservation Plan are given in Chapter-5. It is envisaged that with proper implementation of EMP given in Chapter-5 along with Forest Conservation Plan and Wildlife Conservation Plan, no impact is envisaged on ecological environment.

### 4.3.10 Impact on Socio - Economic Aspects

It is obvious to assume that the activities of the project operations will improve the socio-economic levels in the study area. The anticipated impact of this project on various aspects is described in the following sections:

- ***Impact on Human Settlement***

There are some human settlements in the proposed project area, which needs to be relocated. The rehabilitation and resettlement issues involved in the project, is landoutsees, which will be sorted out in consultation with the district authorities as per the Land Acquisition Act and also through private purchase agreements.

The land covered under the proposed project site is mostly agricultural (41.42%) and waste land (55.8%). The land will be acquired as per Land Acquisition Act after the payment of the prescribed compensation to the land holders. Direct employment if feasible will be provided to the rehabilitated persons depending upon their skills and the project requirements.

Adequate facilities like sanitation, drinking water etc will be provided in the rehabilitated area. Educational and medical facilities of the Hindalco township at project site will be extended to the local people.

- ***Impact on Population Growth***

This project will have an impact on the population growth, as it will provide some employment to the families in the nearby villages. It is assumed that half of the employees will be from the study area itself. About 50% employees from outside will take up jobs in the proposed plant and with migration of their families, an increase in the population is anticipated.

- ***Impact on Literacy and Educational Facilities***

The literacy rate of the study area is very poor. The literacy level of the project area is likely to increase as there will be sudden influx of many educated people taking up jobs in the plant, which is likely to result in establishment of better educational facilities. Better literacy rates are possible due to assumed better economic conditions of the people. Better literacy means better social status and will improve the life style in the region. This will be a positive impact due to the proposed project.

- ***Impact on Civic Amenities***

The impact of the project on the civic amenities will be substantial after the commencement of project activities. As per the census 2001, the area has a good network of roads, educational facilities, post & telegraph facilities and health care facilities. The construction of new roads in the project area will enhance the transportation facilities. With improved transportation facilities there is always a scope for development.

- ***Impact on Health Care Facilities***

Industrial activities involve accidents during operation phase. Thus, it is imperative to have proper health care facilities at the project site. Health care center will be developed at proposed Hindalco residential colony which will also extending the medical facilities in the surrounding villages through its rural welfare schemes.

- ***Impact on Economic Aspects***

The impact of plant on the economic aspects can be clearly observed. The proposed project activities will provide employment to persons of different skills and trades. The local population will have preference to get an employment. The employment potential will ameliorate economic conditions of these families directly and provide employment to many other families indirectly who are involved in business and service oriented activities. This will in-turn improve the socio-economic conditions of the area.

### 4.3.11 Impacts on Public Health and Safety

The discharge of waste materials (stack emission, wastewater and solid wastes) from process operations can have potential impact on public safety and health. The impact from the discharge of waste products is not expected to be significant. Since, the adverse impacts on ambient air and soil quality are predicted to be low. And there will not be any process wastewater generation from the plant. The public health and safety is dependent on the effective implementation of control measures suggested for pollution control.

# 5.0 ENVIRONMENTAL MANAGEMENT PLAN

## 5.1 Introduction

The Environment Management Plan (EMP) is necessary to ensure sustainable development in the area of the proposed project of aluminium smelter complex. Hence, it needs to be an a comprehensive plan for which the proposed industry, Government and Regulating agencies like Pollution Control Board working in the region and more importantly the affected population of the study area need to extend their cooperation and contribution. The identification and quantification of impacts based on scientific and mathematical modelling has been presented in Chapter-4.0. The Management Action Plan aims at controlling pollution at the source level to the possible extent with the best available and state of the art technology.

Environment Management Plan (EMP) is developed to minimize adverse impacts and to ensure that the environment in and around the project site is well protected. The EMP is prepared for both construction and operation phases of the proposed facilities.

## 5.2 Environment Management Plan during Construction Phase

During construction phase, the construction activities like site levelling, grading, and transportation of the construction material cause various impacts on the surroundings.

### 5.2.1 Air Quality Management

The activities like site development, grading and vehicular traffic contribute to increase in SPM and NOx concentration. The mitigation measures recommended to minimize the impacts are:

- Water sprinkling in construction area;
- Asphalting the main approach road;
- Proper maintenance of vehicles and construction equipment; and
- Tree plantation in the area earmarked for greenbelt development.

### 5.2.2 Water Quality Management

The soil erosion at site during heavy precipitation contributes to the increase in suspended solids. The wastewater from vehicle and construction equipment maintenance centre will contribute to oil and grease concentration. The wastewater from labour colony will contribute to higher BOD concentration. The mitigation measures recommended to minimize the impacts are:

- Sedimentation tank to retain the solids from run-off water;
- Oil and grease trap at equipment maintenance centre;
- Septic tanks to treat sanitary waste at labour colony; and
- Utilizing the wastewater in greenbelt development.

### 5.2.3 Noise Level Management

Operation of construction equipment and vehicular traffic contribute to the increased noise level. Recommended mitigation measures are:

- Good maintenance of vehicles and construction equipment;
- Restriction of construction activities to day time only;
- Plantation of trees around the plant boundary to attenuate the noise; and
- Provision of earplugs and earmuffs to workers.

### 5.2.4 Ecological Management

During construction, vegetation in the plant premises is required to be cleared. The measures required to minimise the impact on the ecology are:

- The felling of trees will be kept at minimum;
- The possibility of transplantation of existing matured trees will be explored and implemented to the maximum extent possible; and
- The greenbelt having tree density of 2000 - 2500 trees/ha will be developed.

## 5.3 Environment Management Plan during Operation Phase

During operation phase, the impacts on the various environmental attributes should be mitigated using appropriate pollution control equipment. The Environment Management Plan prepared for the proposed aluminium smelter and CPP project aims at minimizing the pollution at source.

### 5.3.1 Air Pollution Management

Fugitive and stack emissions from the aluminium smelter and CPP will contribute to increase in concentrations of SPM, $SO_2$ and NOx pollutants along with fluoride concentration. The mitigative measures recommended in the plant are:

- Installation of Bag filters to limit the SPM concentrations to below 100 mg/Nm$^3$;

- Installation of dry scrubbers with standby exhaust fans to control the fluoride emissions from FTP;

- Complete hood coverage of cells and highly efficient extraction system to achieve lower emissions of fluoride;

- Adoption of latest generation Pre bake technology to minimise the emissions of Coal tar pitch, volatiles and Greenhouse gases like $C_2F_6$;

- Controlled firing in the anode baking furnaces to optimize the energy usage and to reduce PAH and $NO_x$ emissions;

- Provision of stacks with adequate height for wider dispersion of gaseous emissions;

- Providing highly efficient ESPs to CPP to restrict particulate matter emissions below 100 mg/$Nm^3$ as per CREP guidelines;
- Providing low NOx burners to reduce the NOx emissions in CPP;
- Provision of water sprinkling system at coal storage yard;
- Asphalting of the roads within the plant area;
- Developing of greenbelt around the plant to arrest the fugitive emissions; and
- Design of control equipment to meet the standards stipulated by CREP.

**PAH Emission Control Measures**

PAH emissions from pot room are practically nil as the anodes that will be used are pre-bake. Emissions from the pot room will be much below the emissions that is being experienced by other smelters in India.

Further, suitable technology to incinerate the material thereby detoxifying the same will be explored in consultation with technology suppliers.

### 5.3.2 Water Pollution Management

The wastewater will be generated from cooling towers in the smelter plant and CPP. Besides, domestic wastewater from canteen and employees wash area will also be generated. The recommended measures to minimise the impacts and conservation of fresh water are:

- Recycling of complete wastewater generated in cooling tower.
- Treatment of wastewater for recycling in areas of use;
- Provision of sewage treatment plant to treat domestic sewage from plant;
- Utilization of treated domestic wastewater in greenbelt development and dust suppression;
- Provision of separate storm water system to collect and store run-off water during rainy season and utilization of the same in the process to reduce the fresh water requirement; and
- Treatment of storm water to remove fluoride concentration by following suitable de-flouridation techniques, if present, before discharging into water streams.

### 5.3.3 Noise Pollution Management

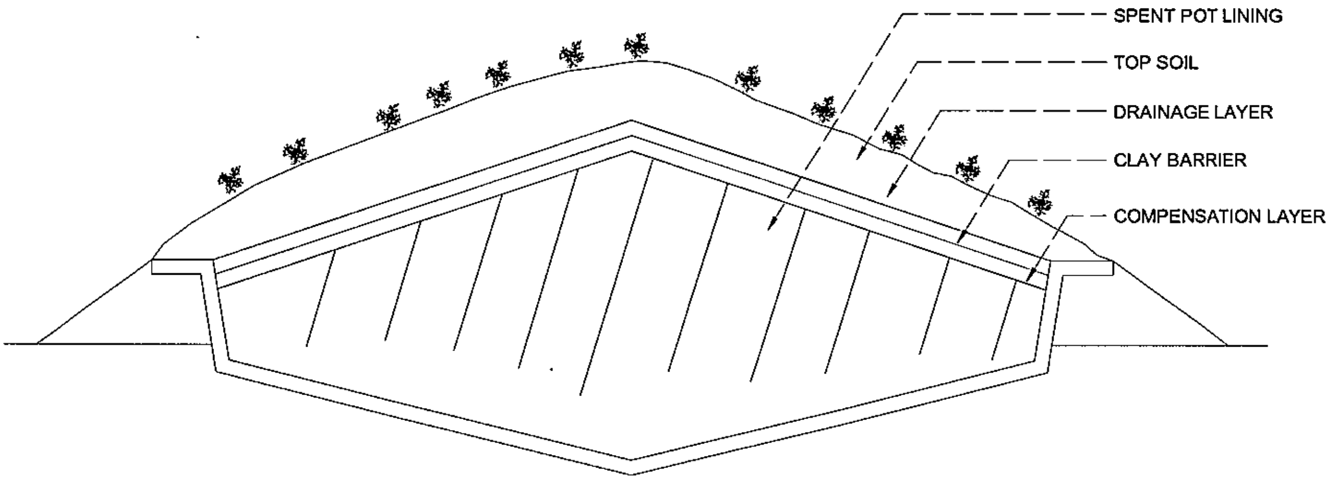
In the process, various equipment like pumps, cooling tower, compressors etc generate the noise. The recommendations to mitigate higher noise levels are:

- Equipment will be designed to conform to noise levels prescribed by regulatory authorities;
- Provision of acoustic enclosures for noise generating equipments like pumps;
- Provision of thick greenbelt to attenuate the noise levels; and
- Provision of earplugs to the workers working in high noise level area.

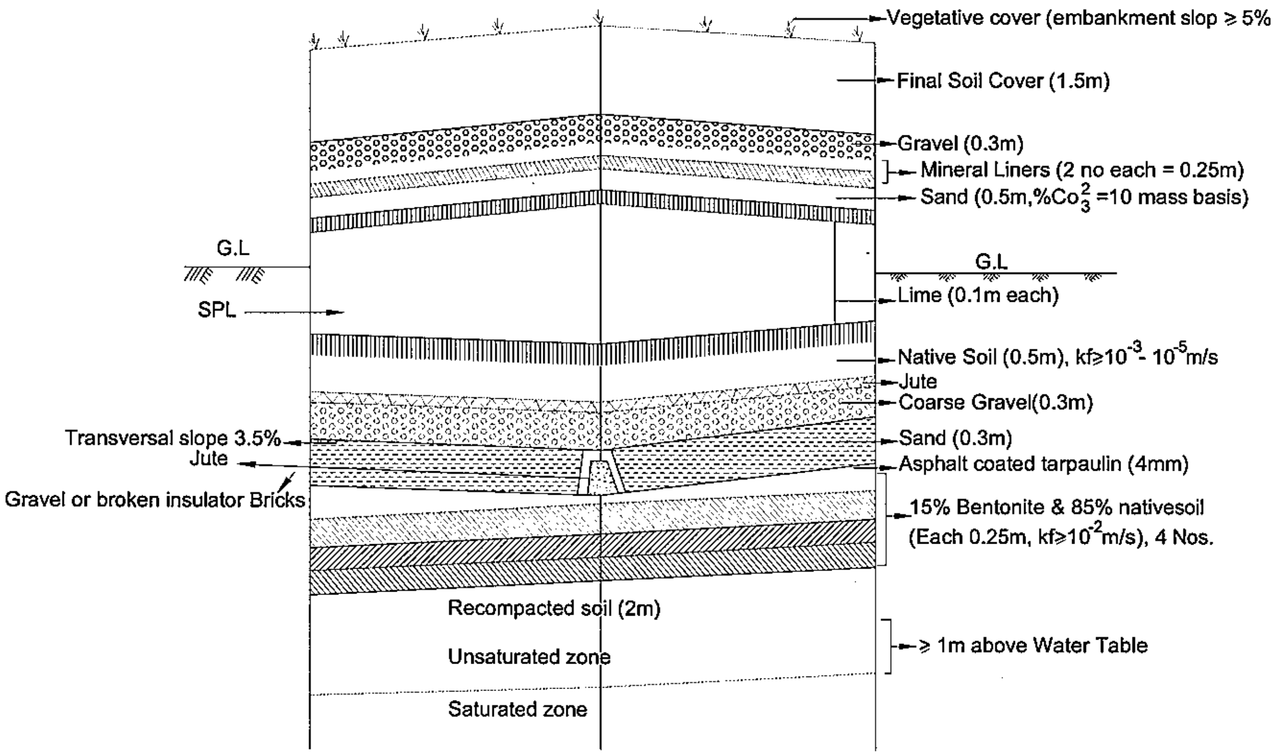
5.3.4 Solid Waste Management in Aluminium Smelter

Solid waste like Spent Pot Lining (SPL), used oil, used batteries and dross will be generated in the proposed smelter. These are categorized as hazardous waste and need to be disposed off in proper manner with great care to prevent contamination of the surrounding areas. The recommended measures to mitigate the impacts due to disposal of solid waste are:

- Waste will be segregated onsite and managed in accordance with the CPCB Guidelines;
- Spent Pot Lining waste which is categorized under hazardous waste will be reused in areas of steel making, cement and alternatively will be disposed-off in secured land fill. The design of the secured landfill will be based on CPCB design. The typical section of the secured landfill design is shown in **Figure-5.1**. The storm water drainage will be carefully designed to collect the run-off water and prevent it from getting it in contact with the waste.
- Improving the life of the pot cells to reduce the SPL waste generation;
- Observatory wells around the SPL storage area to monitor the quality of groundwater and assess the efficacy of the impervious material;
- The anode butts generated from the pots will be cleaned and recycled in the green anode plant;
- The waste batteries will be returned back to the supplier;
- The used oil will be given to authorized recyclers;
- The dross will be treated and disposed to authorised recyclers;
- The organic portion of solid waste generated in the Sewage Treatment Plant (STP) will be used as manure in greenbelt development after composting; and
- Maintain the database on solid waste generation.




**CROSS SECTION CONCEPTUAL DESIGN OF BOX SYSTEM**




**DESIGN OF SECURED LANDFILL FOR SPL DISPOSAL**

**FIGURE-5.1**
**DESIGN OF SECURED LANDFILL FOR HAZARDOUS WASTE DISPOSAL**

### 5.3.5 Solid Waste Management in Captive Power Plant

The main solid waste from the CPP will be the ash (fly ash and bottom ash). The average coal consumption rate will be 35,00,000 TPA. The total ash generation will be about 3835 TPD. Out of this, the bottom ash will be about 20% of the total ash generated i.e. 767 TPD and the balance 3068 TPD will be fly ash.

As per fly ash Notification, Hindalco will put all efforts to utilize 100% of the ash generated within the nine years from the commissioning of the plant. Some of the ash utilization options being contemplated by Hindalco are detailed in subsequent sections. Used oil is the other solid waste generated, which is categorized as hazardous waste and need to be disposed off in proper manner with great care to prevent contamination of the surrounding areas.

The major recommended measures to mitigate the impacts due to disposal of solid waste are:

- Ash will be disposed off by using high concentration slurry disposal system;
- The used oil will be given to authorized recyclers;
- The organic portion of solid waste generated in the Sewage Treatment Plant (STP) will be used as manure in greenbelt development after composting and
- Maintaining the database on solid waste generation.

#### *5.3.5.1 Policy on Fly Ash Utilization*

Utilization of ash produced by coal based power stations as a thrust area of its activities and all possible actions will be taken to enhance level of ash utilization. In the proposed power plant, various avenues for ash utilization will be explored as delineated in the above sections. In particular, supply of quality ash for manufacture of cement will be taken, as there are some cement units. Some of the actions planned for the project are as given below:

- Hindalco will make efforts to motivate and encourage entrepreneurs to set up units for manufacture of ash-based products such as fly ash bricks, lightweight aggregates, cellular concrete products etc as ancillary industries in the region. HINDALCO would be providing all possible infrastructure facilities to these entrepreneurs in accordance with its policy;

- Hindalco would request State Government to make mandatory to utilize ash/ash based products in Works Department and other Government/State sponsored projects to enhance ash utilization;

- Hindalco would also continue to encourage utilization of available ash based products in all its construction activities; and

- Hindalco will encourage the use of water treated fly ash as a soil ameliorator and as a source of micro-nutrients and secondary nutrients for improving agricultural productivity.

## 5.4 Greenbelt Development

With rapid industrialization and consequent deleterious impact of pollutants on environment, values of environmental protection offered by trees are becoming clear. Trees are very suitable for detecting, recognizing and monitoring air pollution effects. Monitoring of biological effects of air pollutant by the use of plants as indicators has been applied on local, regional and national scale. Trees function as sinks of air pollutants, besides their bio-esthetical values, owing to its large surface area.

The greenbelt development not only functions as foreground and background landscape features resulting in harmonizing and amalgamating the physical structures of the plant with surrounding environment, but also acts as pollution sink.

Thus, implementation of afforestation program is of paramount importance. It will also check soil erosion, make the ecosystem more complex and functionally more stable and make the climate more conducive.

Total greenbelt in the project complex will spread over an area of 602 ha including area around ash pond. The greenbelt width of 50-m will be maintained around the plant site.

In the proposed greenbelt, about 12,00,000 number of trees will be planted with a density of 2000 trees/ha. Every year around 2,40,000 of trees will be planted and complete greenbelt will be developed over a period of five years. Annual budget of Rs. 4 crores will be earmarked for social afforestation and related works. The layout plan of the greenbelt and tree cover in plant area is shown in **Figure-5.2.**

### 5.4.1 Species for Plantation

The species proposed will have broad leaves. Trees will be selected based on the type of pollutants, their intensity, location, easy availability and suitability to the local climate. They will have different morphological, physiological and bio-chemical mechanism/ characters like branching habits, leaf arrangement, size, shape, surface (smooth/hairy), presence or absence of trichomes, stomatal conductivity proline content, ascorbic acid content and cationic peroxides activities etc to trap or reduce the pollutants. Species to be selected will fulfill the following specific requirements of the area.

- Tolerance to specific conditions or alternatively wide adaptability to eco-physiological conditions;
- Rapid growth;
- Capacity to endure water stress and climate extremes after initial establishment;
- Differences in height and growth habits;
- Pleasing appearances; and
- Providing shade.

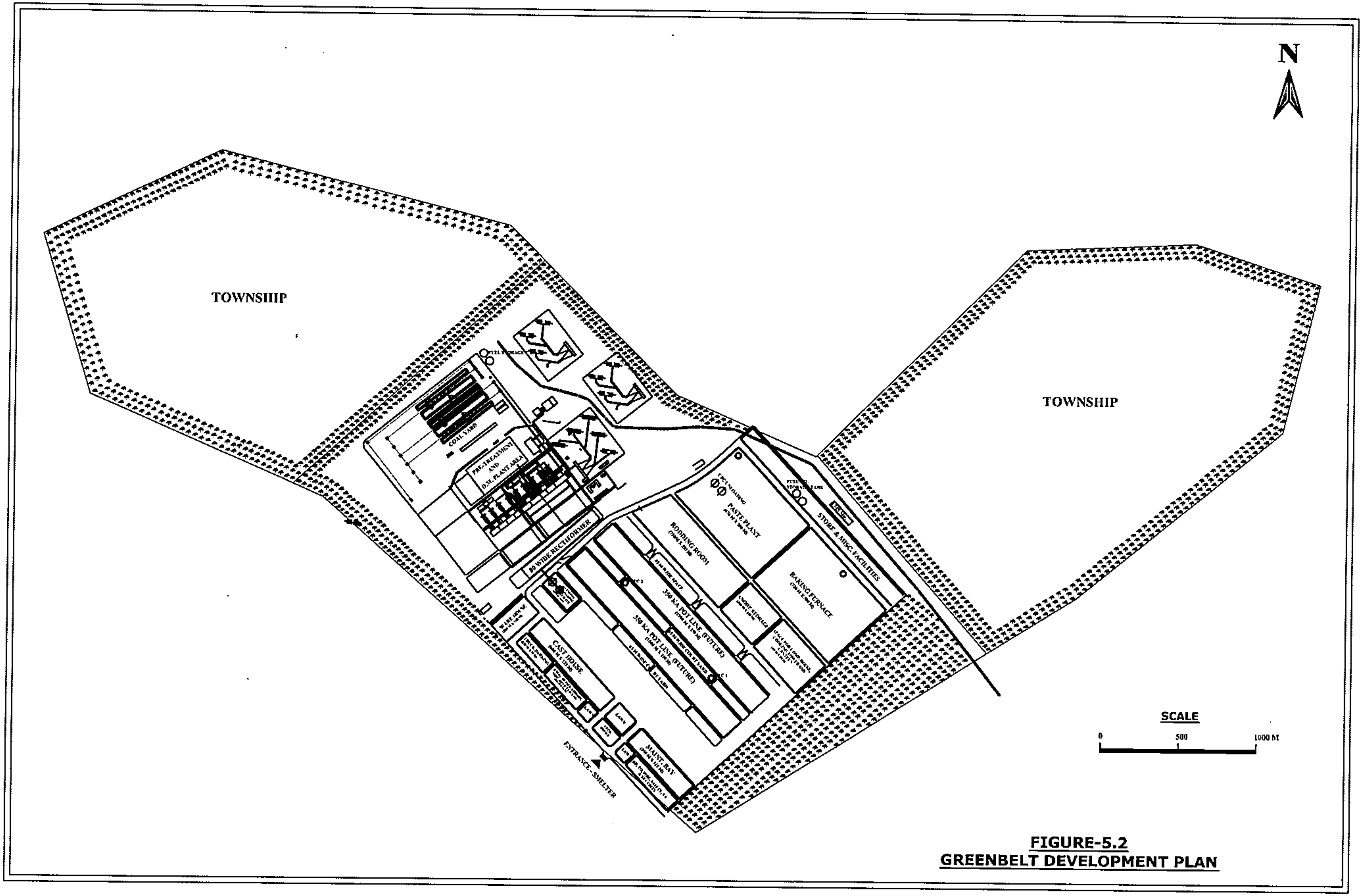



**FIGURE-5.2**
**GREENBELT DEVELOPMENT PLAN**

Based on the above, the recommended species for greenbelt and plantation are given in **Table-5.1.**

**TABLE-5.1**
**RECOMMENDED PLANTS FOR GREENBELT**

| Technical Name | Common Name | Habitat | Height (m) | Growth |
|---|---|---|---|---|
| *Acacia dealbata* | Silver wattle | Tree | 15 | Quick growing |
| *Acacia ferrugenia* | Safed khair | Tree | 3-4 | Quick growing |
| *Acacia nilotica* | Babul | Tree | 8 | Quick growing |
| *Acacia sinuate* | Kochi | Tree | 10 | Quick growing |
| *Adina cordifolia* | Haldu | Tree | 20 | Quick growing |
| *Aegle marmelos* | Beal | Tree | 12 | Slow growing |
| *Ailanthes excelsa* | Maharaksha | Tree | 20 | Quick growing |
| *Albizia lebbeck* | Siris | Tree | 20 | Quick growing |
| *Albizia odorattissima* | Black siris | Tree | 18 | Quick growing |
| *Albizia procera* | White siris | Tree | 18 | Quick growing |
| *Anogeissus latifolia* | Dhaura | Tree | 14 | Slow growing |
| *Anthocephalus cadamba* | Kadam | Tree | 20 | Quick growing |
| *Bauhinia purpuria* | Khairwal | Tree | 7 | Quick growing |
| *Buchanania lanzan* | Achar | Tree | 13 | Quick growing |
| *Cassia fistula* | Amaltas | Tree | 12 | Quick growing |
| *Dalbergia sisoo* | Sisham | Tree | 10 | Moderate |
| *Delonix regia* | Gulmohur | Tree | 15 | Quick growing |
| *Derris indica* | Pongam` | Tree | 10 | Quick growing |
| *Kigelia* | Sausage tree | Small Tree | 10 | Quick growing |
| *Mismusops elangi* | Bakul | Tree | 10 | Quick growing |
| *Nerium indicum* | Kaner | Shrub | 5 | Quick growing |
| *Peltoforrum pterocarpum* | Copper pod | Tree | 5 | Quick growing |
| *Samanea saman* | Rain tree | Tree | 20 | Quick growing |
| *Sesbania sesban* | Common tree | Tree | 10 | Quick growing |
| *Thespesia popuneoodes* | Tulip tree | Tree | 10 | Quick growing |

Further, the already existing / native species will be given preference.

## 5.5 Post Project Environment Monitoring

Post project environmental monitoring is important in terms of evaluating the performance of pollution control equipments installed in the project. The sampling and analysis of the environmental attributes will be as per the guidelines of CPCB/MPCB. The frequency of sampling and location of sampling stations will be as per the directives of Madhya Pradesh Pollution Control Board. Following attributes will be covered in the post project environmental monitoring in and around the project site:

1. Ambient air quality monitoring on weekly basis in the plant area and in the surrounding villages with respect to SPM, RPM, $SO_2$, NOx, Fluoride, PAH and CO;
2. Source emissions will be monitored on monthly basis for Particulate Matter, SO2, NOx, Fluoride, PAH and CO. Automatic continuous online monitoring system shall be installed in the stack for monitoring of SPM and fluoride;
3. Water quality monitoring at intake point, surface water bodies and ground water in the surrounding villages. Further, the observation wells around the

secured land fill area will be drilled and samples will be analyzed on monthly basis. All the water samples will be analyzed for physico-chemical parameters and heavy metals;

4. Treated wastewater before routing to raw water reservoir will be analyzed on fortnightly basis. The pH, temperature, electrical conductivity, TDS and flow will be monitored continuously by automatic instrument;
5. The noise levels will be recorded in and around plant on monthly basis;
6. The soil quality around the plant area will be monitored on six monthly basis for the fertility of the soil and fluoride concentrations;
7. The fluoride level in the forage will be monitored on monthly basis in the surrounding villages;
8. All the results will be compiled and thoroughly analyzed to assess the performance of the smelter; and
9. The results will be reported on regular basis to the Madhya Pradesh Pollution Control Board and Ministry of Environment and Forests.

## 5.6 Cost Provision for Environmental Measures

It is proposed to invest about Rs. 405 crores on pollution control, treatment and monitoring systems. In addition to this, Rs. 4.0 crores per annum will be spent during initial three years on greenbelt development for entire complex. The break-up of the investment is given in the following **Table-5.2**.

**TABLE-5.2**
**COST PROVISION FOR ENVIRONMENTAL MEASURES**

| Sr. No. | Description of Item | Cost (Rs in Crores) |
|---|---|---|
| **Smelter Expansion Project** | | |
| 1 | Fume Treatment Plant incl. Dry Scrubbers | 250.0 |
| 2 | Fume treatment Plant for anode baking furnace | 50.0 |
| 3 | Continuous gas analyser in stacks | 10.0 |
| 3 | Pitch fume recycling system | 20.0 |
| 4 | Dust extraction and Suppression System | 12.0 |
| 5 | Effluent Treatment Plant | 20.0 |
| **Captive Power Plant** | | |
| 1 | Stacks for wider dispersion of pollutants | 30.0 |
| 2 | Dust extraction and Suppression System | 13.0 |
| | **Total** | **405.0** |

Thus, with the above described Environment Management Plan, the proposed aluminium smelter and CPP will usher positive development in the region.

## 5.7 Rain Water Harvesting

It is proposed to construct roof tops harvesting structures in the plant area. The number of rain water harvesting pits and their location will be decided based on final contour survey. The pits will be designed to collect most of the rain water falling on open spaces and greenbelt. This will help in recharging the ground water in the area.

## 5.8 Compliance of CREP Guidelines

The proposed project is designed taking CREP guidelines into account for the efficient and environmental friendly operation. The compliance of the guidelines is given in **Table-5.3.**

**TABLE-5.3**
**COMPLIANCE OF THE CREP GUIDELINES**

| Sr. No. | Particulars | Compliance |
|---|---|---|
| 1 | Environmental clearance for new smelters to be given by MoEF only with pre-baked technology; | Smelter design is based on pre-baked technology |
| 2 | Fluoride emissions should be limited to 0.8 kg/ton of aluminium production and dry scrubbing of fluorides; | Fluoride emissions are controlled by FTP to 0.7 kg/ton of aluminium production |
| 3 | Fluoride consumption in the smelter should be limited to 10 kg/ton of aluminium produced; | Fluoride consumption will be limited to 10 kg/ton of aluminium production |
| 4 | The fluoride in forage should be limited to<br><br>Average of 12 consecutive months - 40 ppm<br>Average of 2 consecutive months - 60 ppm<br>One month - 80 ppm<br><br>Regular monitoring data to be submitted to SPCB and CPCB. | Fluoride in forage will be monitored on monthly basis as a part of post project monitoring. The monitored data will be regularly submitted to SPCB and CPCB. |
| 5 | The average life of the pots should be 2500 days. The possibility of using the SPL in cement or steel industry after recovery of aluminium fluoride should be explored. | The plant designed includes longer life of pots.<br><br>SPL will be supplied to cement or steel industries |
| 6 | The SPL should be disposed in secured landfill. | SPL will be supplied to cement or steel industries and balance if any will be disposed in secured landfill which will be designed based on CPCB design. |

# 6.0 ENVIRONMENTAL MONITORING PROGRAMME

The mitigation measures suggested in Chapter-4 shall be implemented so as to reduce the impact on environment due to the operations of the proposed project. In order to facilitate easy implementation of mitigation measures, these are phased as per the priority implementation as given in **Table-6.1.**

**TABLE-6.1**
**IMPLEMENTATION SCHEDULE**

| Sr. No. | Recommendations | Time Requirement | Schedule |
|---|---|---|---|
| 1 | Air pollution control measures | Before commissioning of respective units | Immediate |
| 2 | Water pollution control measures | Before commissioning of the plant | Immediate |
| 3 | Noise control measures | Along with the commissioning of the plant | Immediate |
| 4 | Ecological preservation and upgradation | Stage wise implementation | Immediate & Progressive |

## 6.1 Environmental Monitoring

The environmental monitoring for the proposed plant operations shall be conducted as follows:

- Air quality;
- Water and wastewater quality;
- Noise levels;
- Soil Quality; and
- Greenbelt Development

### 6.1.1 Monitoring and Reporting Procedure

Regular monitoring of important and crucial environmental parameters is of immense importance to assess the status of environment during plant operation. With the knowledge of baseline conditions, the monitoring program can serve as an indicator for any deterioration in environmental conditions due to operation of the plant and suitable mitigatory steps could be taken in time to safeguard the environment. Monitoring is as important as that of control of pollution since the efficiency of control measures can only be determined by monitoring. The following routine monitoring program will be implemented under the post-project monitoring in the proposed plant. The monitoring program for implementation is given below:

- ***Air Pollution and Meteorological Aspects***

Both ambient air quality and meteorology will be monitored. The ambient air will be monitored twice in a week [in line with the guidelines of Central Pollution Control Board] at about five locations around the plant area.

Meteorological parameters like wind speed, wind direction, temperature, relative humidity and rainfall will be recorded continuously at plant area.

- ***Water and Wastewater Quality***

The storm water will be analyzed in the rainy season. The ground water quality will be monitored in every season. The water depths will be monitored in the wells of surrounding villages in every season.

- ***Noise Levels***

Noise levels in the work zone environment will be monitored regularly. The ground vibration will be recorded at the time of blasting. The frequency of noise monitoring will be once in a month in the work zone. The ambient noise levels in the surrounding villages will be monitored once in six months.

- ***Soil Sampling***

Soil samples will be tested before plantation/vegetation of the area. The environmental monitoring cell will co-ordinate all monitoring programs at site and data thus generated will be regularly furnished to the State regulatory agencies.

The monitoring program to be implemented under environmental monitoring schedule is given in **Table-6.2.**

**TABLE-6.2**
**MONITORING SCHEDULE FOR ENVIRONMENTAL PARAMETERS**

| Sr. No. | | Particulars | Monitoring Frequency | Duration of Sampling | Important Monitoring Parameters |
|---|---|---|---|---|---|
| 1 | **Air Pollution and Meteorology** | | | | |
| | Air Quality | | | | |
| | A | Ambient Air Quality Monitoring | | | |
| | | Four Locations specified by MSPCB | Twice in a week | 24 hr continuously | SPM, RPM, $SO_2$, NOx, Fluoride, PAH and CO |
| | | Stack Monitoring | Monthly | As per Iso-kinetic method | PM, SO2, NOx, Fluoride, PAH, CO |
| | Meteorology | | | | |
| | a | Meteorological data to be monitored at the proposed plant site. | Daily | Continuous Monitoring | Wind speed, direction, temperature, relative humidity and rainfall. |
| 2 | **Water and Wastewater Quality** | | | | |
| | A | Industrial\Domestic | | | |
| | 1 | Effluents | Once in a month | 24 hr composite | As per EPA rules, 1989. |
| | B | Water quality in the study area | | | |
| | 1) | Ground Water<br><br>Six Samples in the study area one each on u/s and | Once in a month | Grab | As per the parameters specified |

| Sr. No. | Particulars | | Monitoring Frequency | Duration of Sampling | Important Monitoring Parameters |
|---|---|---|---|---|---|
| | | d/s of the ash pond and SPL disposal area | | | under IS:10500 |
| | 2) | Surface Water<br><br>Two Samples | Once in a month | Grab | Parameters specified under IS:2296 (Class C) |
| **3** | **Industrial Noise Levels** | | | | |
| | 1 | Plant | Every week | 24 hr continuous with 1 hr interval | Noise level in dB(A) |
| | 2 | Along the haul road for transportation noise | Every week | 24 hr continuous with 1 hr interval | Noise level in dB(A) |
| | Ambient Noise Levels | | | | |
| | | Four Locations | Seasonal | 24 hr continuous with one hr interval | Noise levels in dB(A) |
| **4.** | **Soil Characteristics** | | | | |
| | 1. | Two samples in nearby villages | Pre-Monsoon and Post-Monsoon | One Grab sample | pH, Electrical Conductivity, Organic matter, Na, N, K, $PO_4$, $SO_4$, SAR and Fluoride, |
| **5** | **Ecology** | | Once in pre-monsoon and post-monsoon season | | Biodiversity, health of vegetation, fluoride content in leaves, fruits, roots of the trees. |

### 6.1.2 Monitoring Equipment and Consumable

A well-equipped laboratory with consumable items shall be provided for monitoring of environmental parameters. Alternatively, monitoring can be outsourced to a recognized laboratory.

a) Air Quality and Meteorology

Following equipment and consumable items shall be made available with the environmental cell to meet the monitoring frequency and to implement the monitoring program.

- Respirable Dust Sampler (3 No.)
- Personal sampler (1 No.)
- CO Monitor (1 No.)
- Weather station (automatic recording) (1 Set)
- Spectrophotometer (visible range) (1 No.)
- Single pan balance (1 No.)
- Relevant chemicals as per IS:5182 (Lumpsum)
- Chemical/Glass ware : Lumpsum

b) Water and Waste Water Quality

The sampling should be done in jerry cans as per the standard procedures laid down by IS: 2488. Following equipment are recommended to be available with the environmental cell:

- BOD incubator
- Refrigerator
- Oven
- Stop watch
- Thermometer
- pH meter
- Distilled water plant
- Spectrophotometer
- Relevant chemicals and Glasswares

c) Noise Levels

The environmental cell shall have sound level meter to record noise levels in different scales like A, B and C with slow and fast response options.

## 6.2 Budgetary Allocation for Environmental Monitoring

As environmental protection will be monitored and implemented by a centralized environmental management cell, the fiscal estimates have been arrived for the plant activity, which is discussed in the following paragraphs.

The details of investment for procuring the equipments for efficient control and monitoring of pollution along with annual recurring cost are given in **Table-6.3.**

**TABLE-6.3**
**COST OF ENVIRONMENTAL MONITORING**

| Sr. No. | Particulars | Cost (Rs. in Lakhs) | |
|---|---|---|---|
| | | Capital | Recurring |
| 1 | Dust suppression | 10 | 5 |
| 2 | Water quality monitoring & management | 5 | 1 |
| 3 | Air quality and noise monitoring | 30 | 5 |
| 5 | Rural development | --- | 10 |
| | **Total** | **45** | **21** |

## 6.3 Institutional Arrangements for Pollution Control

The environment monitoring cell of the integrated complex will be given the charge of the proposed smelter and CPP expansion project. The cell may be strengthened if necessary.

The environmental cell of the smelter and CPP project under implementation will be headed by a senior executive (Head HSE department) having adequate experience and qualification. He will be supported by following technical personnel:

- Manager;
- Environment Engineers;
- Safety officer;
- Senior Chemists;
- Chemists;
- Ecologist/Horticulturist; and
- Support Staff.

The department will be the nodal agency to coordinate and provide necessary services on environmental issues during construction and operation of the project. This group will be responsible for implementation of Environment Management Plan and interaction with the environmental regulatory agencies, reviewing draft policy and planning. This department will interact with Madhya Pradesh Pollution Control Board (MPCB), Ministry of Environment and Forests (MoEF), Central Pollution Control Board (CPCB) and other environment regulatory agencies. The chief of the environmental division will report to the Head of Smelter on a day to day basis. The proposed organisation structure of the environment division is given in **Figure-6.1.**

The head of HSE department will be a member of Environment Protection Committee comprising of senior citizens, Block Development Officer and heads of the villages in the study area. The committee will be responsible to look into grievances of the surrounding population and monitor the community development program.

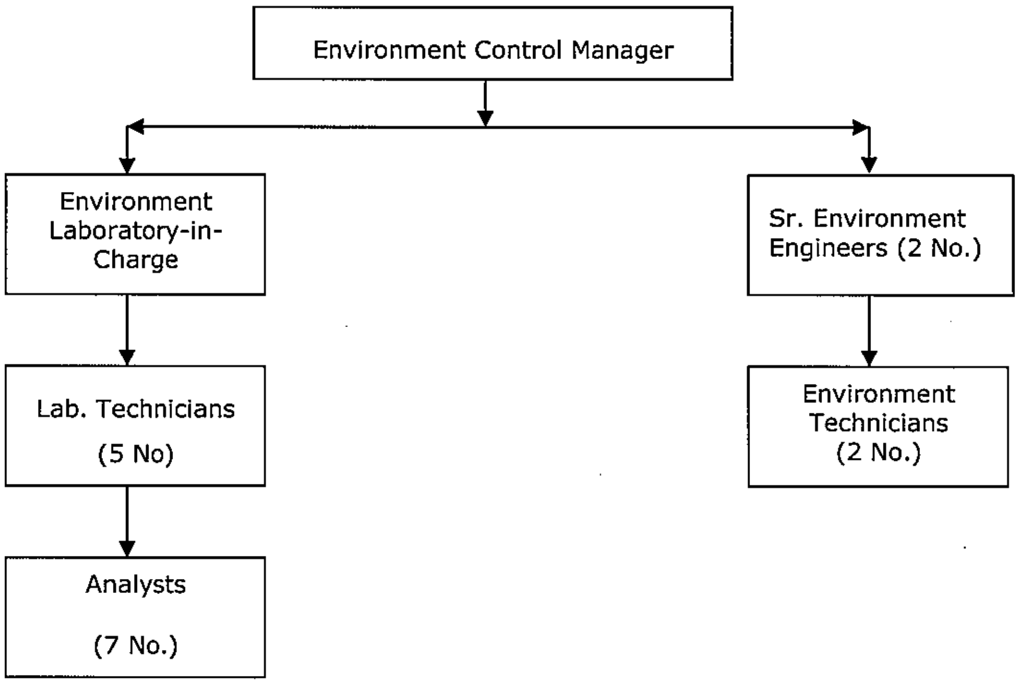



**FIGURE-6.1**
**ORGANIZATION STRUCTURE OF ENVIRONMENT DIVISION**

# 7.0 RISK ASSESSMENT AND DISASTER MANAGEMENT PLAN

## 7.1 Introduction

Hazard analysis involves the identification and quantification of the various hazards (unsafe conditions) that exist in the proposed smelter plant. On the other hand, risk analysis deals with the identification and quantification of risks, the plant equipment and personnel are exposed to, due to accidents resulting from the hazards present in the plant.

Risk analysis follows an extensive hazard analysis. It involves the identification and assessment of risks the neighboring populations are exposed to as a result of hazards present. This requires a thorough knowledge of failure probability, credible accident scenario, vulnerability of population etc. Much of this information is difficult to get or generate. Consequently, the risk analysis is often confined to maximum credible accident studies.

In the sections below, the identification of various hazards, probable risks in the proposed aluminum smelter complex, maximum credible accident analysis, consequence analysis are addressed which gives a broad identification of risks involved in the plant. Based on the risk estimation for fuel and chemical storage Disaster Management Plan (DMP) has been presented.

As the smelter and Captive Power Plant are adjacent to each other and fuel storages are common, risk assessment is carried out for the entire complex.

## 7.2 Approach to the Study

Risk involves the occurrence or potential occurrence of some accidents consisting of an event or sequence of events. The risk assessment study covers the following:

- Identification of potential hazard areas;
- Identification of representative failure cases;
- Visualization of the resulting scenarios in terms of fire (thermal radiation) and explosion;
- Assess the overall damage potential of the identified hazardous events and the impact zones from the accidental scenarios;
- Assess the overall suitability of the site from hazard minimization and disaster mitigation point of view;
- Furnish specific recommendations on the minimization of the worst accident possibilities; and
- Preparation of broad Disaster Management Plan (DMP), On-site and Off-site Emergency Plan, which includes Occupational and Health Safety Plan.

## 7.3 Hazard Identification

Identification of hazards in the proposed smelter project is of primary significance in the analysis, quantification and cost effective control of accidents involving chemicals and process. A classical definition of hazard states that hazard is in fact the characteristic of system/plant/process that presents potential for an accident. Hence, all the components of a system/plant/process need to be thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident. The following two methods for hazard identification have been employed in the study:

- Identification of major hazardous units based on Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 of Government of India (GOI Rules, 1989); and
- Identification of hazardous units and segments of plants and storage units based on relative ranking technique, viz. Fire-Explosion and Toxicity Index (FE&TI).

### 7.3.1 Classification of Major Hazardous Units

Hazardous substances may be classified into three main classes namely flammable substances, unstable substances and toxic substances. The ratings for a large number of chemicals based on flammability, reactivity and toxicity have been given in NFPA Codes 49 and 345 M. The major hazardous materials to be stored, transported, handled and utilised within the facility have been summarized in the **Table-7.1**. The fuel storage details and properties are given in **Table-7.2** and **Table-7.3** respectively.

**TABLE-7.1**
**HAZARDOUS MATERIALS STORED, TRANSPORTED AND HANDLED**

| Materials | Hazardous Properties |
|---|---|
| **Dangerous Goods** | |
| Spent Pot Lining<br>Spent Cathodes<br>Aluminium Dross | UN 3170. Dangerous Goods Class 4.3 "Aluminium Smelting By-Products"- in contact with water emit flammable (& toxic) gases.<br>Dross (hot or wet) Listed as Goods too Dangerous to be Transported. Toxic components may be leached from by-products in contact with water. |
| Coal Tar Pitch | UN 3257. Dangerous Goods class 9- Miscellaneous "Elevated Temperature Liquid NOS at above 100° C and below its Flash point. Carcinogen category 2 and skin (photo) sensitiser. |
| LDO | UN 1203. Dangerous Goods class 3 – Flammable Liquid |
| HFO | Dangerous Goods class 3 - Flammable Liquid |
| Diesel Fuel | UN 1202. Dangerous Goods class 3 – Flammable Liquid |
| **Hazardous/Toxic Substances** | |
| Pot Fume Emissions | Containing Inorganic Fluorides, Hydrogen Fluoride gas and Sulfur Dioxide gas – respiratory irritants |

**TABLE-7.2**
**CATEGORY WISE SCHEDULE OF STORAGE TANKS**

| Sr. No. | Material | No. of Tanks | Design Capacity (KL) | Classification |
|---|---|---|---|---|
| 1 | LDO | 1 | 200 | B |
| 2 | HFO | 2 | 1000 (each) | B |
| 3 | HFO | 1 | 200 | B |

*Note – B: Non-dangerous Petrolium*

**TABLE-7.3**
**PROPERTIES OF FUELS/CHEMICALS USED AT THE PLANT**

| Chemical | Codes/Label | TLV | FBP | MP | FP | UEL | LEL |
|---|---|---|---|---|---|---|---|
| | | | °c | | | % | |
| HFO | Flammable | 5 mg/m$^3$ | 350 | -26 | 66 | 6.0 | 0.5 |
| LDO | Flammable | 5 mg/m$^3$ | 400 | - | 32 - 96 | 7.5 | 0.6 |

TLV : Threshold Limit Value
MP : Melting Point
UEL : Upper Explosive Limit
FBP : Final Boiling Point
FP : Flash Point
LEL : Lower Explosive Limit

### 7.3.2 Identification of Major Hazard Installations Based on GOI Rules, 1989

Following accidents in the chemical industry in India over a few decades, a specific legislation covering major hazard activities has been enforced by Govt. of India in 1989 in conjunction with Environment Protection Act, 1986. This is referred here as GOI Rules 1989. For the purpose of identifying major hazard installations the rules employ certain criteria based on toxic, flammable and explosive properties of chemicals.

A systematic analysis of the fuels/chemicals and their quantities of storage has been carried out, to determine threshold quantities as notified by GOI Rules, 1989 and the applicable rules are identified. Applicability of storage rules are summarized in **Table-7.4.**

**TABLE-7.4**
**APPLICABILITY OF GOI RULES TO FUEL/CHEMICAL STORAGE**

| Sr. No. | Chemical/ Fuel | Listed in Schedule | Total Quantity (KL) | Threshold Quantity (T) for Application of Rules | |
|---|---|---|---|---|---|
| | | | | 5,7-9,13-15 | 10-12 |
| 1 | LDO | 3(1) | 200 | 25 MT | 200 MT |
| 2 | HFO | 3 (1) | 2200 | 25 MT | 200 MT |

## 7.4 Hazard Assessment and Evaluation

### 7.4.1 Methodology

An assessment of the conceptual design is conducted for the purpose of identifying and examining hazards related to feed stock materials, major process components, utility and support systems, environmental factors, proposed operations, facilities, and safeguards.

### 7.4.2 Preliminary Hazard Analysis (PHA)

A preliminary hazard analysis is carried out initially to identify the major hazards associated with storages and the processes of the plant. This is followed by consequence analysis to quantify these hazards. Finally, the vulnerable zones are plotted for which risk reducing measures are deduced and implemented. Preliminary hazard analysis for fuel storage area and whole plant is given in **Table-7.5** and **Table-7.6.**

**TABLE-7.5**
**PRELIMINARY HAZARD ANALYSIS FOR STORAGE AREAS**

| Unit | Capacity | Hazard Identified |
|---|---|---|
| LDO | 200 KL | Fire/Explosion |
| HFO | 2 x 1000 KL | Fire/Explosion |
| HFO | 200 KL | Fire/Explosion |

**TABLE-7.6**
**PRELIMINARY HAZARD ANALYSIS FOR THE WHOLE PLANT IN GENERAL**

| PHA Category | Description of Plausible Hazard | Recommendation | Provision |
|---|---|---|---|
| Environ-mental factors | If there is any leakage and eventuality of source of ignition. | -- | All electrical fittings and cables are provided as per the specified standards. All motor starters are flame proof. |
| Environ-mental factors | Highly inflammable nature of the chemicals may cause fire hazard in the storage facility. | A well designed fire protection including protein foam, dry powder, and CO2 extinguisher should be provided. | Fire extinguisher of small size and big size are provided at all potential fire hazard places. In addition to the above, fire hydrant network is also provided. |

### 7.4.3 Fire Explosion and Toxicity Index (FE&TI) Approach

Fire, Explosion and Toxicity Indexing (FE & TI) is a rapid ranking method for identifying the degree of hazard. The application of FE & TI would help to make a quick assessment of the nature and quantification of the hazard in these areas. However, this does not provide precise information.

The degree of hazard potential is identified based on the numerical value of F&EI as per the criteria given below:

| F&EI Range | Degree of Hazard |
|---|---|
| 0-60 | Light |
| 61-96 | Moderate |
| 97-127 | Intermediate |
| 128-158 | Heavy |
| 159-up | Severe |

By comparing the indices F&EI and TI, the unit in question is classified into one of the following three categories established for the purpose (**Table-7.7**).

**TABLE-7.7**
**FIRE EXPLOSION AND TOXICITY INDEX**

| Category | Fire and Explosion Index (F&EI) | Toxicity Index (TI) |
|---|---|---|
| I | F&EI < 65 | TI < 6 |
| II | 65 < or = F&EI < 95 | 6 < or = TI < 10 |
| III | F&EI > or = 95 | TI > or = 10 |

Certain basic minimum preventive and protective measures are recommended for the three hazard categories.

*7.4.3.1 Results of FE and TI for Storage/Process Units*

Based on the GOI Rules 1989, the hazardous fuels and chemicals used by the proposed smelter plant were identified. Fire and Explosion are the likely hazards, which may occur due to the fuel and chemical storage. Hence, Fire and Explosion index has been calculated for in plant storage. Detailed estimates of FE&TI are given in **Table-6.8.**

**TABLE-7.8**
**FIRE EXPLOSION AND TOXICITY INDEX FOR STORAGE FACILITIES**

| Sr. No. | Chemical/ Fuel | Total Capacity (KL) | F&EI | Category | TI | Category |
|---|---|---|---|---|---|---|
| 1 | LDO | 200 | 1.1 | Light | Nil | - |
| 2 | HFO | 2 x 1000 | 3.1 | Light | Nil | - |
| 3 | HFO | 200 | 1.1 | Light | Nil | - |

7.4.4 Conclusion

Results of FE&TI analysis show that the storage of LDO and HFO falls into ***Light*** category of fire and explosion index with a ***Nil*** toxicity index.

7.4.5 Maximum Credible Accident Analysis (MCAA)

Hazardous substances may be released as a result of failures or catastrophes, causing possible damage to the surrounding area. This section deals with the question of how the consequences of the release of such substances and the damage to the surrounding area can be determined by means of models. Major hazards posed by flammable storage can be identified taking recourse to MCA analysis. MCA analysis encompasses certain techniques to identify the hazards and calculate the consequent effects in terms of damage distances of heat radiation, toxic releases, vapour cloud explosion, etc. A host of probable or potential accidents of the major units in the complex arising due to use, storage and handling of the hazardous materials are examined to establish their credibility. Depending upon the effective hazardous attributes and their impact on the event, the maximum effect on the surrounding environment and the respective damage caused can be assessed. The reason and purpose of consequence analysis are many folds like:

- Part of Risk Assessment;
- Plant Layout/Code Requirements;
- Protection of other plants;

- Protection of the public;
- Emergency Planning; and
- Design Criteria.

The results of consequence analysis are useful for getting information about all known and unknown effects that are of importance when some failure scenario occurs in the plant and also to get information as how to deal with the possible catastrophic events. It also gives the workers in the plant and people living in the vicinity of the area, an understanding of their personal situation.

- **Selected Failure Cases**

The purpose of this listing is to examine consequences of such failure individually or in combination. It will be seen from the list that a vast range of failure cases have been identified. The frequency of occurrence of failure also varies widely. Guillotine failure of a pipeline of higher sizes has a low frequency of occurrence.

*7.4.5.1 Damage Criteria*

The fuel storage and unloading at the storage facility may lead to fire and explosion hazards. The damage criteria due to an accidental release of any hydrocarbon arise from fire and explosion. The vapors of these fuels are not toxic and hence no effects of toxicity are expected.

Tank fire would occur if the radiation intensity is high on the peripheral surface of the tank leading to increase in internal tank pressure. Pool fire would occur when fuels collected in the dyke due to leakage gets ignited.

- **Fire Damage**

A flammable liquid in a pool will burn with a large turbulent diffusion flame. This releases heat based on the heat of combustion and the burning rate of the liquid. A part of the heat is radiated while the rest is convected away by rising hot air and combustion products. The radiations can heat the contents of a nearby storage or process unit to above its ignition temperature and thus result in a spread of fire. The radiations can also cause severe burns or fatalities of workers or fire fighters located within a certain distance. Hence, it will be important to know beforehand the damage potential of a flammable liquid pool likely to be created due to leakage or catastrophic failure of a storage or process vessel. This will help to decide the location of other storage/process vessels, decide the type of protective clothing the workers/fire fighters need, the duration of time for which they can be in the zone, the fire extinguishing measures needed and the protection methods needed for the nearby storage/process vessels. **Table-7.9** tabulates the damage effect on equipment and people due to thermal radiation intensity.

## TABLE-7.9
## DAMAGE DUE TO INCIDENT RADIATION INTENSITIES

| Sr. No. | Incident Radiation ($kW/m^2$) | Type of Damage Intensity | |
|---|---|---|---|
| | | Damage to Equipment | Damage to People |
| 1 | 37.5 | Damage to process equipment | 100% lethality in 1 min. 1% lethality in 10 sec. |
| 2 | 25.0 | Minimum energy required to ignite wood at indefinitely long exposure without a flame | 50% Lethality in 1 min. Significant injury in 10 sec. |
| 3 | 19.0 | Maximum thermal radiation intensity allowed on thermally unprotected adjoining equipment | -- |
| 4 | 12.5 | Minimum energy to ignite with a flame; melts plastic tubing | 1% lethality in 1 min. |
| 5 | 4.5 | -- | Causes pain if duration is longer than 20 sec, however blistering is un-likely (First degree burns) |
| 6 | 1.6 | -- | Causes no discomfort on long exposures |

*Source: Techniques for Assessing Industrial Hazards by World Bank.*

The effect of incident radiation intensity and exposure time on lethality is given in **Table-7.10.**

## TABLE-7.10
## RADIATION EXPOSURE AND LETHALITY

| Radiation Intensity ($kW/m^2$) | Exposure Time (seconds) | Lethality (%) | Degree of Burns |
|---|---|---|---|
| 1.6 | -- | 0 | No Discomfort even after long exposure |
| 4.5 | 20 | 0 | 1 st |
| 4.5 | 50 | 0 | 1 st |
| 8.0 | 20 | 0 | 1 st |
| 8.0 | 50 | <1 | 3 rd |
| 8.0 | 60 | <1 | 3 rd |
| 12.0 | 20 | <1 | 2 nd |
| 12.0 | 50 | 8 | 3 rd |
| 12.5 | -- | 1 | -- |
| 25.0 | -- | 50 | -- |
| 37.5 | -- | 100 | -- |

### 7.4.6 Scenarios Considered for MCA Analysis

#### *7.4.6.1 Fuel Storage*

The details of storages in the proposed smelter plant are given Table-6.2 above. In case of fuel released in the area catching fire, a steady state fire will occur. Failures in pipeline may occur due to corrosion and mechanical defect. Failure of pipeline due to external interference is not considered as this area is licensed area and all the work within this area is closely supervised with trained personnel.

*7.4.6.2 Modeling Scenarios*

Based on the storage and consumption of various fuels and chemicals the following failure scenarios for the proposed smelter project have been identified for MCA analysis and the scenarios are discussed in **Table-7.11**. The fuel properties considered in modeling are given in **Table-7.12.**

**TABLE-7.11**
**SCENARIOS CONSIDERED FOR MCA ANALYSIS**

| Sr. No. | Fuel/Chemical | Total Quantity | Scenarios considered |
|---|---|---|---|
| 1 | Failure of LDO tank | 200 KL | Pool fire |
| 2 | Failure of two HFO tanks | 2200 KL | Pool fire |

**TABLE-7.12**
**PROPERTIES OF FUELS CONSIDERED FOR MODELING**

| Sr. No. | Fuel | Molecular weight (kg/kg mol) | Boiling Point (°F) | Density (kg/m$^3$) |
|---|---|---|---|---|
| 1 | LDO | 114.24 | 369 | 840 |
| 2 | HFO | 135.0 | 216 | 900 |

7.4.7 Pool Fire Models used for MCA Analysis

Heat Radiation program **'RADN'** has been used to estimate the steady state radiation effect from various storage of fuel and chemicals at different distances. The model is based on the equations compiled from various literature by Prof.J.P.Gupta, Department of Chemical Engineering, IIT Kanpur.

7.4.8 Results and Discussion

The results of MCA analysis are tabulated indicating the distances for various damages identified by the damage criteria, as explained earlier. Calculations are done for radiation intensities levels of 37.5, 25, 12.5, 4.5 and 1.6-kW/m$^2$, which are presented in **Table-7.13** for different scenarios. The distances computed for various scenarios are from the center of the pool fire.

**TABLE-7.13**
**OCCURRENCE OF VARIOUS RADIATION INTENSITIES- POOL FIRE**

| Radiation and Effect | Radiation Intensities (kW/m$^2$)/Distances (m) | | | | | |
|---|---|---|---|---|---|---|
| | **37.5** | **25.0** | **19.0** | **12.5** | **4.5** | **1.6** |
| Failure of LDO tank | 8.8 | 10.5 | 13.2 | 15.6 | 18.8 | 24.9 |
| Failure of HFO tank (1000 kl) | 42.6 | 50.3 | 57.3 | 67.3 | 78.1 | 85.9 |
| Failure of HFO tank (200 kl) | 8.5 | 10.0 | 11.4 | 13.4 | 17.3 | 23.0 |

- **Pool Fire Due to Failure of LDO Storage Tank**

The maximum capacity of storage of LDO will be 200 KL. The most credible failure is the rupture of the largest pipe connecting the storage tank. As the worst case, it is assumed that the entire contents leak out into the dyke forming a pool, which may catch fire on finding a source of ignition.

A perusal of the above table clearly indicates that 37.5 kW/m$^2$ (100% lethality) occurs within the radius of the pool which is computed at 8.8 m tank on pool fire. This vulnerable zone will damage fuel storage all equipment falling within the pool radius.

Similarly, the threshold limit for first degree burns is 4.5 kW/m$^2$, this vulnerable zone in which the thermal fluxes above the threshold limit for first degree is restricted to 18.8 m in case tank on pool fire.

- **Pool Fire Due to Failure of HFO Storage Tanks -2 x 1000 KL**

The maximum capacity of storage of HFO will be 2000 KL. The most credible failure is the rupture of the largest pipe connecting the storage tank. As the worst case, it is assumed that the entire contents leak out into the dyke forming a pool, which may catch fire on finding a source of ignition.

A perusal of the above table clearly indicates that 37.5 kW/m$^2$ (100% lethality) occurs within the radius of the pool which is computed at 42.6-m in case of HFO tanks on pool fire. This vulnerable zone will damage fuel storage all equipment falling within the pool radius.

Similarly, the threshold limit for first degree burns is 4.5 kW/m$^2$, this vulnerable zone in which the thermal fluxes above the threshold limit for first degree is restricted to 78.1-m in case of HFO tanks on pool fire.

7.4.9 Coal Handling Plant - Dust Explosion

Coal dust when dispersed in air and ignited would explode. Crusher house and conveyor systems are most susceptible to this hazard. To be explosive, the dust mixture should have:

- Particles dispersed in the air with minimum size (typical size is 400 microns);
- Dust concentrations must be reasonably uniform; and
- Minimum explosive concentration for coal dust (33% volatiles) is 50 gm/m$^3$.

Failure of dust extraction and suppression systems may lead to abnormal conditions and increasing the concentration of coal dust to the explosive limits. Sources of ignition present are incandescent bulbs with the glasses of bulkhead fittings missing, electric equipment and cables, friction, spontaneous combustion in accumulated dust.

Dust explosions may occur without any warnings with Maximum Explosion Pressure upto 6.4 bar. Another dangerous characteristic of dust explosions is that it sets off secondary explosions after the occurrence of the initial dust explosion. Many a times the secondary explosions are more damaging than primary ones.

The dust explosions are powerful enough to destroy structures, kill or injure people and set dangerous fires likely to damage a large portion of the Coal

Handling Plant including collapse of its steel structure which may cripple the life line of the power plant.

Stockpile areas shall be provided with automatic garden type sprinklers for dust suppression as well as to reduce spontaneous ignition of the coal stockpiles. Necessary water distribution network for drinking and service water with pumps, piping, tanks, valves etc will be provided for distributing water at all transfer points, crusher house, control rooms etc.

A centralized control room with microprocessor based control system (PLC) has been envisaged for operation of the coal handling plant. Except locally control equipment like travelling tripper, dust extraction/ dust suppression / ventilation equipment, sump pumps, water distribution system etc., all other in-line equipment will have provision for local control as well. All necessary interlocks, control panels, MCC's, mimic diagrams etc. will be provided for safe and reliable operation of the coal handling plant.

#### *7.4.9.1 Control Measures for Coal Yards*

The total quantity of coal will be stored in separate stack piles, with proper drains around to collect washouts during monsoon season.

Water sprinkling system will be installed on stocks of coal in required scales to prevent spontaneous combustion and consequent fire hazards. The stock geometry will be adopted to maintain minimum exposure of stock pile areas towards predominant wind direction. Temperature monitoring of the stock piles will be done to detect in time any abnormal rise in temperature inside the stock piles to enable prompt control of the same through necessary steps.

### 7.4.10 Identification of Hazards, Assessment and their Management

The various hazards associated, apart from fuel storage with the plant process has been identified and has been classified into broad bases and is outlined in **Table-7.14, Table-7.15, Table-7.16.**

## TABLE-7.14
## DISASTERS DUE TO ELECTRICAL EXPLOSIONS AND ENTRAPPING WATER INTO HOT METAL

| Type of Disaster | Properties of Material | Effects of Disaster | Departments | Preventive Measures | Facilities to be made available | Remarks |
|---|---|---|---|---|---|---|
| Electric Hazards in rectifier area | - | Electrical explosions and electrocution | Pot rooms | Connectors shall be periodically inspected. Compared with design values. If found defective change the connectors immediately.<br><br>The rectifier area needs to be maintained fire proof with good house keeping. | i. Trained staff<br>ii. Trained and vigilant maintenance crew<br>iii. Fool proof source of water<br>iv. Proper working space<br>v. Proper maintenance of connectors | Constant vigil and preventive maintenance recommended. |
| Explosion of Pot furnaces, holding furnace and casting machines | These operations are done at elevated temperature where molten metal is handled. If water from any source trickles into the molten metal bath, the water molecules break immediately into hydrogen and oxygen releasing immense amount of energy causing violent explosion | a) Such explosion due to water getting entrapped in molten metal are so violent that it can cause massive scale disaster and fatalities.<br>b) The resultant | Potrooms, casting plant, warehouse & caster pant | a) Constant vigilance shall be maintained to avoid water getting entrapped in molten metal<br>b) Water flow, pressure etc shall be continuously monitored | a) Trained staff<br>b) Trained and vigilant maintenance crew<br>c) Fool proof source of water<br>d) Proper working space | a) Constant improvements in design and working procedures to be carried out<br>b) Compliance to be discourage<br>c) Safety talks in every shift, stressing the |

| Type of Disaster | Properties of Material | Effects of Disaster | Departments | Preventive Measures | Facilities to be made available | Remarks |
|---|---|---|---|---|---|---|
| | | explosion can cause immense damage to furnace, equipment, structures, roof and personnel<br>c) The production activity may get stalled for a long duration<br>d) Work force may get totally demoralized | | c) Temperature of molten metal shall also be continuously monitored<br>d) Only highly skilled & experienced manpower to be engaged<br>e) Standards operating practices and laid down safety procedures shall be followed | e) Proper maintenance of moulds<br>f) Application of dycot oil in mounds<br>g) Emergency water tank and power supply | consequence off |

## TABLE-7.15
## FIRE DUE TO PITCH, COKE & INFLAMMABLE FUELS

| Sr. No. | Type of Disaster | Properties of Material | Effects of Disaster | Departments | Preventive Measures | Facilities to be made available | Remarks |
|---|---|---|---|---|---|---|---|
| i) | Fire in petroleum coke silos and during processing | a) Easily combustible particularly during summer<br>b) Inhalation of pulverized particles is highly hazardous to health | Being fast combustible the fire can spread easily and engulf men, material and machines | Carbon Plant | a) Separate stacking in safe locations and as per standard norms<br>b) Storage area declared for restricted entry<br>c) No inflammable material stored in the proximity<br>d) Prohibition of smoking and other sources of fire<br>e) Work permit system | a) Fire hydrants<br>b) Fire extinguishers<br>c) Trained work force employed | a) Smoke sensors and automatic water sprinkler installation shall be considered<br>b) Facility for emergency escape route being designed for future implementation<br>c) Leakages of pulverized coke during processing are immediately attending |
| ii) | Fire at coke pitch stack and during processing | a) Easily combustible due to low ignition temp<br>b) Inhalation of pulverized particles is highly hazardous to health | Same as above | Carbon plant | Same as above | Same as above | Same as above |
| iii) | Fire at storage tanks and | Highly inflammable and greately expands in volume after | Burning of oil can result into huge explosion of the | a) Storage tanks for furnace oil, | a) Oil level monitoring carried out as | a) Automatic water sprinklers | a) Proper house keeping to be ensured<br>b) All inflammable, |

| Sr. No. | Type of Disaster | Properties of Material | Effects of Disaster | Departments | Preventive Measures | Facilities to be made available | Remarks |
|---|---|---|---|---|---|---|---|
| | thermopac system | getting heated and changing into gaseous form | storage tanks causing wide spread fire and damage to men, material and machines | petrol, diesel etc<br>b) Carbon plant | per norms<br>b) Oil tank temperature monitored as per norms<br>c) Masonry dyke around the tanks<br>d) Inflammable vegetation constantly remove<br>e) Caution boards to be displayed<br>f) Entry only authorized persons to be allowed | around the tanks<br>b) Fire hydrants<br>c) Foam type fire extinguishers | combustible and explosive material to be removed immediately after the completion of work and not to be stored in the vicinity of the oil tanks |

## TABLE-7.16
## LEAKAGE OF TOXIC GASES AND PREVENTIVE MEASURES

| Sr.No. | Type of Disaster | Properties of Material | Effects of Disaster | Departments | Preventive measures | Facilities | Remakrs |
|---|---|---|---|---|---|---|---|
| 1 | Chlorine ($Cl_2$) | i. Greenish yellow in colour and acutely irritating in order<br>ii. Reacts slowly with water to form HCl. Most $Cl_2$ are therefore corrosive to most metals.<br>iii. Under sunlight it reacts explosively with $H_2$ to form HCl<br>iv. It irritates the mucous membrances. In extreme cases suffocation can occur resulting to death.<br>v. Exposure to $Cl_2$ causes burning of eyes and nose<br>vi. Non-combustible in air but most combustible materials will burn in $Cl_2$ as they do in oxygen. Flammable gases & vapours from | i. If exposed to heat or fire, the cylinder may explode violently releasing the contents. This will result into disaster causing wide spread fire and suffocation<br>ii. Since it reacts violently to form explosive mixture with $C_2H_2$, $H_2$ etc. hence it can cause disaster<br>iii. In case of leakage, it will react with body moisture to form acid and at high concentration it will act as asphyxiant and cause wide spread fatalities | Casting plant, warehouse & caster plant | i. Welding, cutting or any other hot work on the equipment of $Cl_2$ will be done only after the system is purged with steam and dried with hot air.<br>ii. Contact with combustible substances, Hydrogen, Acetylene shall be prevented<br>iii. Indoor storage, handling and use areas shall be properly ventilated with cool and dry atmosphere<br>iv. Cylinders stored in upright position with enough room between them to permit accessibility in case of emergency<br>v. Cylinders will be used on a FIFO basis | i. Proper system will be developed for storage handling and transportation<br>ii. Trained personnel<br>iii. Breathing apparatus and gas masks<br>iv. First aid<br>v. Sensors<br>vi. Sprinklers<br>vii. Fire and explosion proof fittings<br>viii. Provision of fiberglass hood to direct the leaking gas into the neutralization tank<br>ix. Neutralization tank with lime dosing facility | i. Periodical medical check up of all the concerned employees exposed to $Cl_2$ will be mandatory. The medical examination to have emphasis on eyes, respiratory tract, teeth, skin and pulmonary functions at least once in a year |

| Sr.No. | Type of Disaster | Properties of Material | Effects of Disaster | Departments | Preventive measures | Facilities | Remakrs |
|---|---|---|---|---|---|---|---|
| | | explosive mixture with $Cl_2$<br>vii. Reacts explosively or forms explosive compounds with many common chemicals such as acetylene, turpentine, hydro-carbons, hydrogen and finely divided metals | | | vi. Since the $Cl_2$ store is a part of the building used for other purposes the following care will be taken<br>vii. Store will be of non-combustible material.<br>viii. Separated from other part of the building by fire resisting walls and doors<br>ix. The vapour is heavier than air and travels along the ground, therefore the exhaust fans will be located near the floor of the store. The switches outside $Cl_2$ area | | |
| 2 | Ammonia | i. Colourless and pungent odour.<br>ii. Extremely soluble in water, Solubility decreases with increase in temperature.<br>iii. In presence of moisture corrosive to | i. If exposed to heat & fire, the cylinder may explode violently releasing the contents. This will result into disaster causing wide spread fire & suffocation | Casting plant | a) Welding & cutting or other hot work on the equipment of ammonia to be done only after the system is purged with steams and dried with hot air.<br>b) Keep away from oxidizing gases, | a) Proper systems will be developed for storage, Handling and transportation.<br>b) Trained personal<br>c) Breathing apparatus and gas masks<br>d) First aid<br>e) Sprinklers | Periodical medical check up of all the concerned employees exposed to $NH_3$ will be mandatory. The medical examination to have emphasis on eyes, respiratory |

| Sr.No. | Type of Disaster | Properties of Material | Effects of Disaster | Departments | Preventive measures | Facilities | Remakrs |
|---|---|---|---|---|---|---|---|
| | | copper, zinc, copper alloys & galvanized surfaces<br>iv. Being lighter than air, it will rise up in the air & its pocketing is likely to occur at roof level<br>v. The mixture of ammonia & air is flammable with explosion potentiality if the concentration of ammonia in air is less than 25% but greater than 15% by volume.<br>vi. It causes irritation of skin, eyes & respiratory tract. Concentration above 2000 ppm may be fatal | ii. The explosive/Flammable limits of the gas are from 16 to 25% by volume of air<br>iii. In case of leakage, it will react with skin, results chemical burns & at high concentration it will produce violent coughing. severe lung irritation & pulmonary oedema and cause fatalities | | chlorine, bromine, iodine and acids.<br>c) Indoor storage, handling and used area will be properly ventilated and dried atmosphere.<br>d) Cylinders stored in upright position with enough rooms between them to permit accessibility in case of emergency.<br>e) Cylinders will be used on a FIFO basis.<br>f) The vapor is lighter than air, It will rise up in the air and its pocketing is likely to occur at roof level, ventilation should be provided at the top of the structure. | | tract, skin and pulmonary functions at least once in a year |

**TABLE-7.17**
**HAZARD ANALYSIS FOR PROCESS IN CPP**

| Sr. No. | Blocks/Areas | Hazards Identified |
|---|---|---|
| 1 | Coal storage in open yard | Fire, Spontaneous Combustion |
| 2 | Coal Handling Plant including Bunker area | Fire and/or Dust Explosions |
| 3 | Boilers | Fire (mainly near oil burners), Steam Explosions, Fuel Explosions |
| 4 | Steam Turbine Generator Buildings | Fires in -<br>a) Lube oil system b) Cable galleries<br>c) Short circuits in i) Control rooms<br>ii) Switch-gears<br>Explosion due to leakage of Hydrogen and fire following it. Fire in Oil Drum Storage |
| 5 | Switch-yard Control Room | Fire in cable galleries and Switch-gear/Control Room |
| 6 | LDO Tank Farms<br>HFO Tank Farm | Fire |

7.4.11 Hazardous Events with Greatest Contribution to Fatility Risk

The hazardous event scenarios likely to make the greatest contribution to the risk of potential fatalities are summarized in **Table-7.18** and **Table-7.19**. 'Onsite facility' refers to the operating site at AAP, whereas 'offsite facility' refers to transport and handling systems, which are away from the AAP operating site.

**TABLE-7.18**
**HAZARDOUS EVENTS CONTRIBUTING TO ON-SITE FACILITY RISK**

| Hazardous Event | Risk Rank | Consequences of Interest |
|---|---|---|
| Onsite vehicle impact on personnel | 3 | Potential for single fatalities, onsite impact only |
| Entrapment/struck by Machinery | 3 | Potential for single fatalities, onsite impact only |
| Molten Metal explosions | 3 | Potential for multiple fatalities, onsite impact only |
| Fall from heights | 3 | Potential for single fatalities, onsite impact only |
| Electrocution | 3 | Potential for single fatalities, onsite impact only |
| Storage stack collapse | 3 | Potential for single fatalities, onsite impact only |

**TABLE-7.19**
**HAZARDOUS EVENTS CONTRIBUTING TO OFF-SITE FACILITY RISK**

| Hazardous Event | Risk Rank | Impact Distance (m) | Consequence of Interest or Worse Case Scenario |
|---|---|---|---|
| Aluminium dross off site transport Incident | 6 | 15m | Worst case is explosion in container and potential missile damage. |
| Coal tar pitch transport incident | 6 | 0m | Worst case is fire and smoke impact only, radiant heat minimal, and unlikely potential or fatality |
| Truck (not cargo related) incident and general road traffic incidents | 4 | 10m | Worse case is vehicle impact with other vehicle or pedestrians causing multiple fatalities. Immediate vicinity of road only |

### 7.4.12 Risk Assessment Summary

The preliminary risk assessment has been completed for the proposed smelter and associated facilities:

- There will be no significant community impacts or environmental damage consequences;
- Identified for the operation of the facility and potential hazardous events. However there will be some hazardous events including molten metal explosions which would cause significant onsite (facility) property damage;
- There are a number of likely events identified for the offsite facilities which may have an impact on the community but these are estimated to occur at extremely low incident;
- Frequencies and/or not to significant levels of consequence. These include the potential for an offsite truck incident involving Dangerous Goods (e.g. dross), potential fires in offsite storage facilities for Dangerous Goods (e.g. coal tar pitch) and general increase in offsite road traffic risk from the proposed smelter traffic; and
- The hazardous event scenarios and risks in general at this facility can be adequately managed to acceptable levels by performing the recommended safety studies as part of detailed design, applying recommended control strategies and implementing a Safety Management System.

### 7.4.13 Risk Reduction Opportunities

The following opportunities will be considered as a potential means of reducing identified risks during the detailed design phase:

- Buildings and plant structures designed for cyclone and seismic events (where appropriate), to prevent structural collapse and integrity of weather (water) proofing for storage of dangerous goods;
- Reduce inventory of dangerous goods storage on site (eg Spent Pot Lining and dross). Consider processing of spent potlining material to reduce Dangerous Goods Classification and hazardous properties;
- Provision for redundant water capacity to supply fire protection systems and critical process water;
- Isolate people from load carrying/mechanical handling systems, vehicle traffic and storage and stacking locations;
- Installation of fit-for-purpose access ways and fall protection systems to facilitate safe access to fixed and mobile plant;
- Provision and integrity of process tanks, waste holding tanks and bunded areas as per relevant standards;
- Segregation of incomplete products and ingredients;
- Containment of hazardous materials;
- Collection, treatment and disposal facilities and procedures for spillage of hazardous materials and wastes;
- Potline buildings designed with natural ventilation capacity to protect operators in the event of a failure of the forced extraction/ventilation system;
- Security of facility to prevent unauthorised access to plant, introduction of prohibited items, and control of onsite traffic; and

Development of emergency response management systems commensurate with site specific hazards and risks (fire, explosion, rescue and first aid).

## 7.5 Disaster Management Plan

### 7.5.1 Disasters

A disaster is a catastrophic situation in which suddenly, people are plunged into helplessness and suffering and, as a result, need protection, clothing, shelter, medical and social care and other necessities of life.

Disasters can be divided into two main groups. In the first, are disasters resulting from natural phenomena like earthquakes, volcanic eruptions, storm surges, cyclones, tropical storms, floods, avalanches, landslides, forest fires. The second group includes disastrous events occasioned by man, or by man's impact upon the environment. Examples are armed conflict, industrial accidents, radiation accidents, factory fires, explosions and escape of toxic gases or chemical substances, river pollution, mining or other structural collapses, air, sea, rail and road transport accidents and can reach catastrophic dimensions in terms of human loss.

There can be no set criteria for assessing the gravity of a disaster in the abstract since this depends to a large extent on the physical, economic and social environment in which it occurs. What would be consider a major disaster in a developing country, ill equipped to cope with the problems involved, may not mean more than a temporary emergency elsewhere. However, all disasters bring in their wake similar consequences that call for immediate action, whether at the local, national or international level, for the rescue and relief of the victims. This includes the search for the dead and injured, medical and social care, removal of the debris, the provision of temporary shelter for the homeless, food, clothing and medical supplies, and the rapid re-establishment of essential services.

### 7.5.2 Objectives of Disaster Management Plan [DMP]

The Disaster Management Plan is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operations in this same order of priorities. For effective implementation of the Disaster Management Plan, it should be widely circulated and personnel training through rehearsals/drills.

The Disaster Management Plan should reflect the probable consequential severalties of the undesired event due to deteriorating conditions or through 'Knock on' effects. Further the management should be able to demonstrate that their assessment of the consequences uses good supporting evidence and is based on currently available and reliable information, incident data from internal and external sources and if necessary the reports of out side agencies.

To tackle the consequences of a major emergency inside the factory or immediate vicinity of the factory, a Disaster Management Plan has to be formulated and this planned emergency document is called "Disaster Management Plan".

The objective of the Industrial Disaster Management Plan is to make use of the combined resources of the plant and the outside services to achieve the following:

- Effect the rescue and medical treatment of casualties;
- Safeguard other people;
- Minimize damage to property and the environment;
- Initially contain and ultimately bring the incident under control;
- Identify any dead;
- Provide for the needs of relatives;
- Provide authoritative information to the news media;
- Secure the safe rehabilitation of affected area;
- Preserve relevant records and equipment for the subsequent inquiry into the cause and circumstances of the Emergency.

In effect, it is to optimize operational efficiency to rescue, rehabilitation and render medical help and to restore normalcy.

### 7.5.3 Emergencies

#### *7.5.3.1 General, Industrial, Emergencies*

The emergencies that could be envisaged in the plant and fuel storage are as follows:

- A situation of fire at the Hydrogen Plant;
- A situation of fire at the tank farm of all storages;
- Slow isolated fires;
- Fast spreading fires;
- Structural failures;
- Contamination of food/water; and
- Sabotage/Social disorder.

#### *7.5.3.2 Specific Emergencies Anticipated*

- ***Fire and Explosion***

Fire consequences can be disastrous, since they involve huge quantities of fuel either stored or in dynamic inventory in pipe lines or in nearby areas. Toxic releases can affect persons working around. Preliminary hazard analysis has provided a basis for consequence estimation. Estimation can be made by using various pool fire, tank fire consequence calculations. During the study of Risk Assessment, the nature of damages is worked out and probability of occurrence of such hazards is also drawn up.

### 7.5.4 Emergency Organization

It is recommended to setup an Emergency Organization. A senior executive who has control over the affairs of the plant should lead the Emergency Organization. He shall be designated at Site Controller. General Manager [O & M] shall be designated as the Incident Controller. In the case of stores, utilities, open areas, which are not under the control of the Production Heads, Senior Executive responsible for maintenance of utilities would be designated as Incident Controller. All the Incident Controllers would be reporting to the Site Controller.

Each Incident Controller, for himself, organizes a team responsible for controlling the incidence with the personnel under his control. Shift In-charge would be the reporting officer, who would bring the incidence to the notice of the Incidence Controller and Site Controller.

Emergency Co-ordinators would be appointed who would undertake the responsibilities like fire fighting, rescue, rehabilitation, transport and provide essential and support services. For this purposes, Security In-charge, Personnel Department, Essential services personnel would be engaged. All these personnel would be designated as Key personnel.

In each shift, electrical supervisor, electrical fitters, pump house in-charge, and other maintenance staff would be drafted for emergency operations. In the event of power or communication system failure, some of staff members in the office/plant offices would be drafted and their services would be utilized as messengers for quick passing of communications. All these personnel would be declared as essential personnel.

*7.5.4.1 Emergency Communication*

Whoever notices an emergency situation such as fire, growth of fire, leakage etc would inform his immediate superior and Emergency Control Center. A place nearer to the Gate House Complex shall be identified as Emergency Control Center. The person on duty in the Emergency Control Center would appraise the Site Controller. Site Controller verifies the situation from the Incident Controller of that area or the Shift In-charge and takes a decision about an impending On Site Emergency. This would be communicated to all the Incident Controllers, Emergency Co-ordinators. Simultaneously, the emergency warning system would be activated on the instructions of the Site Controller.

7.5.5 Emergency Responsibilities

The responsibilities of the key personnel are appended below:

*7.5.5.1 Site Controller*

On receiving information about emergency he would rush to Emergency Control Center (ECC) and take charge of ECC and the situation and

- Assesses the magnitude of the situation on the advice of incident Controller and decides,
- Whether the effected area needs to be evacuated,
- Whether personnel who are at assembly points need to be evacuated,
- Declares Emergency and orders for operation of emergency siren,
- Organizes announcement by public address system about location of emergency,
- Assesses which areas are likely to be affected, or need to be evacuated or are to be alerted,

- Maintains a continuous review of possible development and assesses the situation in consultation with Incident Controller and other Key Personnel as to whether shutting down the plant or any section of the plant required and if evacuation of persons is required,
- Directs personnel for Rescue, rehabilitation, transport, fire, brigade, medical and other designated mutual support systems locally available, for meeting emergencies,
- Controls evacuation of affected areas, if the situation is likely to go out of control or effects are likely to go beyond the premises of the factory, informs to District Emergency Authority, Police, Hospital and seeks their intervention and help,
- Informs Inspector of Factories, Deputy Chief Inspector of Factories, APPCB and other statutory authorities,
- Gives a public statement if necessary,
- Keeps record of chronological events and prepares an investigation report and preserves evidence,
- On completion of On Site Emergency and restoration of normalcy, declares all clear and orders for all clear warning.

*7.5.5.2 Incident Controller*

- Assembles the incident control team.
- Directs operations within the affected areas with the priorities for safety to personnel minimize damage to the plant, property and environment and minimize the loss of materials.
- Directs the shutting down and evacuation of plant and areas likely to be adversely affected by the emergency.
- Ensure that key personnel help is sought.
- Provides advice and information to the Fire and Security Officer and the Local Fire Services as and when they arrive.
- Ensures that all non-essential workers/staff of the affected areas evacuated to the appropriate assembly points, and the areas are searched for casualties.
- Has regard to the need for preservation of evidence so as to facilitate any inquiry into the caused and circumstances, which caused or escalated the emergency.
- Co-ordinates with emergency services at the site.
- Provides tools and safety equipment to the team members.
- Keeps in touch with the team and advise them regarding the method of control to be used.
- Keeps the Site Controller of Emergency informed of the progress being made.

*7.5.5.3 Emergency Coordinator - Rescue, Fire Fighting*

- On knowing about emergency, rushes to ECC
- Helps the incident Controller in containment of the emergency
- Ensure fire pumps in operating conditions and instructs pump house operator to ready for any emergency with standby arrangement
- Guides the fire fighting crew i.e. firemen, trained plant personnel and security staff
- Organizes shifting the fire fighting facilities to the emergency site, if required

- Takes guidance of the Incident Controller for fire fighting as well as assesses the requirements of outside help
- Arranges to control the traffic at the gate and the incident area
- Directs the security staff to the incident site to take part in the emergency operations under his guidance and supervision
- Evacuates the people in the plant or in the nearby areas as advised by Site Controller
- Searches for casualties and arranges proper aid for them
- Assembles search and evacuation team
- Arranges for safety equipment for the members of this team
- Decides which paths the evacuated workers should follow
- Maintains law and order in the area, and if necessary seeks the help of police

*7.5.5.4 Emergency Coordinator-Medical, Mutual Aid, Rehabilitation, Transport and Communication*

- In the event of failure of electric supply and thereby internal telephone, sets up communication point and establishes contact with the ECC.
- Organizes medical treatment to the injured and if necessary will shift the injured to near by hospitals.
- Mobilizes extra medical help from outside, if necessary.
- Keeps a list of qualified first aid providers of the factory and seek their assistance.
- Maintains first aid and medical emergency requirements.
- Makes sure that all safety equipment is made available to the emergency team.
- Assists Site Controller with necessary data and to coordinate the emergency activities.
- Assists Site Controller in updating emergency plan, organizing mock drills verification of inventory of emergency facilities and furnishing report to Site Controller.
- Maintains liaison with Civil Administration.
- Ensure availability of canteen facilities and maintenance of rehabilitation center.
- He will be in liaison with Site Controller/Incident Controller.
- Ensure transportation facility.
- Ensures availability of necessary cash for rescue/rehabilitation and emergency expenditure.
- Controls rehabilitation of affected areas on discontinuation of emergency.
- Makes available diesel/petrol for transport vehicles engaged in emergency operation.

*7.5.5.5 Emergency Coordinator - Essential Services*

- He would assist Site Controller and Incident Controller.
- Maintains essential services like Diesel Generator, Water, Fire Water, Compressed Air/Instrument Air, power supply for lighting.
- He would plan alternate facilities in the event of power failure, to maintain essential services such as lighting, refrigeration plant etc.
- He would organize separate electrical connections for all utilities and emergency services so that in the event of emergency or fires, essential services and utilities are not affected.

- Gives necessary instructions regarding emergency electrical supply, isolation of certain sections etc. to shift in-charge and electricians.
- Ensures availability of adequate quantities of protective equipment and other emergency materials, spares etc.

*7.5.5.6 General Responsibilities of Employees during an Emergency*

During an emergency, it becomes more enhanced and pronounced when an emergency warning is raised, the workers if they are in-charge of process equipment, should adopt safe and emergency shut down and attend any prescribed duty as essential employee. If no such responsibility is assigned, he should adopt a safe course to assembly point and await instructions. He should not resort to spread panic. On the other hand, he must assist emergency personnel towards objectives of DMP.

### 7.5.6 Emergency Facilities

*7.5.6.1 Emergency Control Center (ECC)*

For the time being Office Block or a place nearer to the Gate House Complex is identified as Emergency Control Center. It would have external Telephone, Fax, Telex facility. All the Site Controller/ Incident Controller Officers, Senior Personnel would be located here. Also, it would be an elevated place.

The following information and equipment are to be provided at the Emergency Control Center (ECC):

- Intercom, telephone
- P and T telephone
- Safe contained breathing apparatus
- Fire suit/gas tight goggles/gloves/helmets
- Hand tools, wind direction/velocities indications
- Public address megaphone, hand bell, telephone directories
- (internal, P and T) factory layout, site plan
- Emergency lamp/torch light/batteries
- Plan indicating locations of hazard inventories, plant control room, sources of safety equipment, work road plan, assembly points, rescue location vulnerable zones, escape routes.
- Hazard chart
- Emergency shut-down procedures
- Nominal roll of employees
- List of key personnel, list of essential employees, list of Emergency Co-ordinators
- Duties of key personnel
- Address with telephone numbers and key personnel, emergency coordinator, essential employees.
- Important address and telephone numbers including Government agencies, neighboring industries and sources of help, out side experts, chemical fact sheets population details around the factory.

#### *7.5.6.2 Assembly Point*

Number of assembly depending upon the plant location would be identified wherein employees who are not directly connected with the disaster management would be assembled for safety and rescue. Emergency breathing apparatus, minimum facilities like water etc. would be organized.

In view of the size of plant, different locations are ear marked as assembly points. Depending upon the location of hazard, the assembly points are to be used.

#### *7.5.6.3 Fire Fighting Facilities*

First Aid Fire fighting equipment suitable for emergency should be maintained in each section in the plant. This would be as per statutory requirements. However, fire hydrant line covering major areas would be laid. It would be maintained as 6 $kg/cm^2$ pressure. Fire alarms would be located in the bulk storage areas. Fire officer will be the commanding officer of fire fighting services.

#### *7.5.6.4 Location of Wind Sock*

On the top of the Administration block, top of each production blocks, wind socks shall be installed to indicate direction of wind for emergency escape.

#### *7.5.6.5 Emergency Medical Facilities*

Stretchers, gas masks and general first aid materials for dealing with chemical burns, fire burns etc would be maintained in the medical center as well as in the emergency control room. Medical superintendent of the township will be the head of the casuality services ward. Private medical practitioners help would be also be sought. Government hospital would be approached for emergency help.

Apart from plant first aid facilities, external facilities would be augmented. Names of Medical Personnel, Medical facilities in the area would be prepared and updated. Necessary specific medicines for emergency treatment of Burns Patients, and for those affected by toxicity would be maintained.

Breathing apparatus and other emergency medical equipment would be provided and maintained. The help of near by industrial management in this regard would be taken on mutual support basis.

#### *7.5.6.6 Ambulance*

An ambulance with driver availability in all the shifts, emergency shift vehicle would be ensured and maintained to transport injured or affected persons. Number of persons would be trained in first aid so that, in every shift first aid personnel would be available.

### 7.5.7 Emergency Actions

#### *7.5.7.1 Emergency Warning*

Communication of emergency would be made familiar to the personnel inside the plant and people outside. An emergency warning system shall be established.

#### *7.5.7.2 Emergency Shutdown*

There are number of facilities, which can be provided to help deal with hazardous conditions, when a tank is on fire. The suggested arrangements are:

1. Stop feed;
2. Dilute contents;
3. Remove heat;
4. Deluge with water; and
5. Transfer contents.

Whether a given method is appropriate depends on the particular case. Cessation of agitation may be the best action in some instances but not in others. Stopping of the feed may require the provision of by pass arrangements.

Methods of removing additional heat include removal through the normal cooling arrangements or use of an emergency cooling system. Cooling facilities, which use vapouring liquid may be particularly effective, since a large increase in vaporization can be obtained by dropping pressure.

#### *7.5.7.3 Evacuation of Personnel*

There could be more number of persons in the storage area and other areas in the vicinity. The area would have adequate number of exits, staircases. In the event of an emergency, unconnected personnel have to escape to assembly point. Operators have to take emergency shutdown procedure and escape. Time Office shall maintain a copy of deployment of employees in each shift, at ECC. If necessary, persons can be evacuated by rescue teams.

#### *7.5.7.4 All Clear Signal*

Also, at the end of an emergency, after discussing with Incident Controllers and Emergency Co-ordinators, the Site Controller orders an all clear signal. When it becomes essential, the Site Controller communicates to the District Emergency Authority, Police, Fire Service personnel regarding help required or development of the situation into an Off-Site Emergency.

### 7.5.8 General

#### *7.5.8.1 Employee Information*

During an emergency, employees would be warned by raising siren in specific pattern. Employees would be given training of escape routes, taking shelter, protecting from toxic effects. Employees would be provided with information related to fire hazards, antidotes and first aid measures. Those who would be designated as key personnel and essential employees should be given training to emergency response.

*7.5.8.2 Public Information and Warning*

The industrial disaster effects related to this plant may mostly be confined to the plant area. The detailed risk analysis has indicated that the pool fire effects would not be felt outside. However, as an abundant precaution, the information related to chemicals in use would be furnished to District Emergency Authority for necessary dissemination to general public and for any use during an off site emergency. Factories of this size and nature are in existence in our state since long time.

*7.5.8.3 Co-ordination with Local Authorities*

Keeping in view of the nature of emergency, two levels of coordination are proposed. In the case of an On Site Emergency, resources within the organization would be mobilized and in the event extreme emergency local authorities help should be sought.

In the event of an emergency developing into an off site emergency, local authority and District emergency Authority (normally the Collector) would be appraised and under his supervision, the Off Site Disaster Management Plan would be exercised. For this purpose, the facilities that are available locally, i.e. medical, transport, personnel, rescue accommodation, voluntary organizations etc. would be mustered. Necessary rehearsals and training in the form of mock drills should be organized.

*7.5.8.4 Mutual Aid*

Mutual aid in the form of technical personnel, runners, helpers, special protective equipment, transport vehicles, communication facility etc should be sought from the neighboring industrial management.

*7.5.8.5 Mock Drills*

Emergency preparedness is an important on that of planning in Industrial Disaster Management. Personnel would be trained suitably and prepared mentally and physically in emergency response through carefully planned, simulated procedures. Similarly, the key personnel and essential personnel should be trained in the operations.

*7.5.8.6 Important Information*

Once the Plant goes into stream, important information such names and addresses of key personnel, essential employees, medical personnel, out side the plant, transporters address, address of those connected with Off Site Emergency such as Police, Local Authorities, Fire Services, District Emergency Authority should be prepared and maintained. The on-site emergency organization chart for various emergencies is shown in **Figure-7.1.**

## 7.6 Off-site Emergency Preparedness Plan

The task of preparing the Off-Site Emergency Plan lies with the district collector, however the off-site plan will be prepared with the help of the local district authorities. The proposed plan will be based on the following guidelines.

### 7.6.1 Introduction

Off-site emergency plan follows the on-site emergency plan. When the consequences of an emergency situation go beyond the plant boundaries, it becomes an off-site emergency. Off-site emergency is essentially the responsibility of the public administration. However, the factory management will provide the public administration with the technical information relating to the nature, quantum and probable consequences on the neighboring population.

The off-site plan in detail will be based on those events, which are most likely to occur, but other less likely events, which have severe consequence, will also be considered. Incidents which have very severe consequences yet have a small probability of occurrence should also be considered during the preparation of the plan. However, the key feature of a good off-site emergency plan is flexibility in its application to emergencies other than those specifically included in the formation of the plan.

The roles of the various parties who will be involved in the implementation of an off-site plan are described below. Depending on local arrangements, the responsibility for the off-site plan should be either rest with the works management or, with the local authority. Either way, the plan should identify an emergency co-ordinating officer, who would take the overall command of the off-site activities. As with the on-site plan, an emergency control center should be setup within which the emergency co-ordinating officer can operate.

An early decision will be required in many cases on the advice to be given to people living "within range" of the accident - in particular whether they should be evacuated or told to go indoors. In the latter case, the decision can regularly be reviewed in the event of an escalation of the incident. Consideration of evacuation may include the following factors:

- In the case of a major fire but without explosion risk (e.g. an oil storage tank), only houses close to the fire are likely to need evacuation, although a severe smoke hazard may require this to be reviewed periodically;

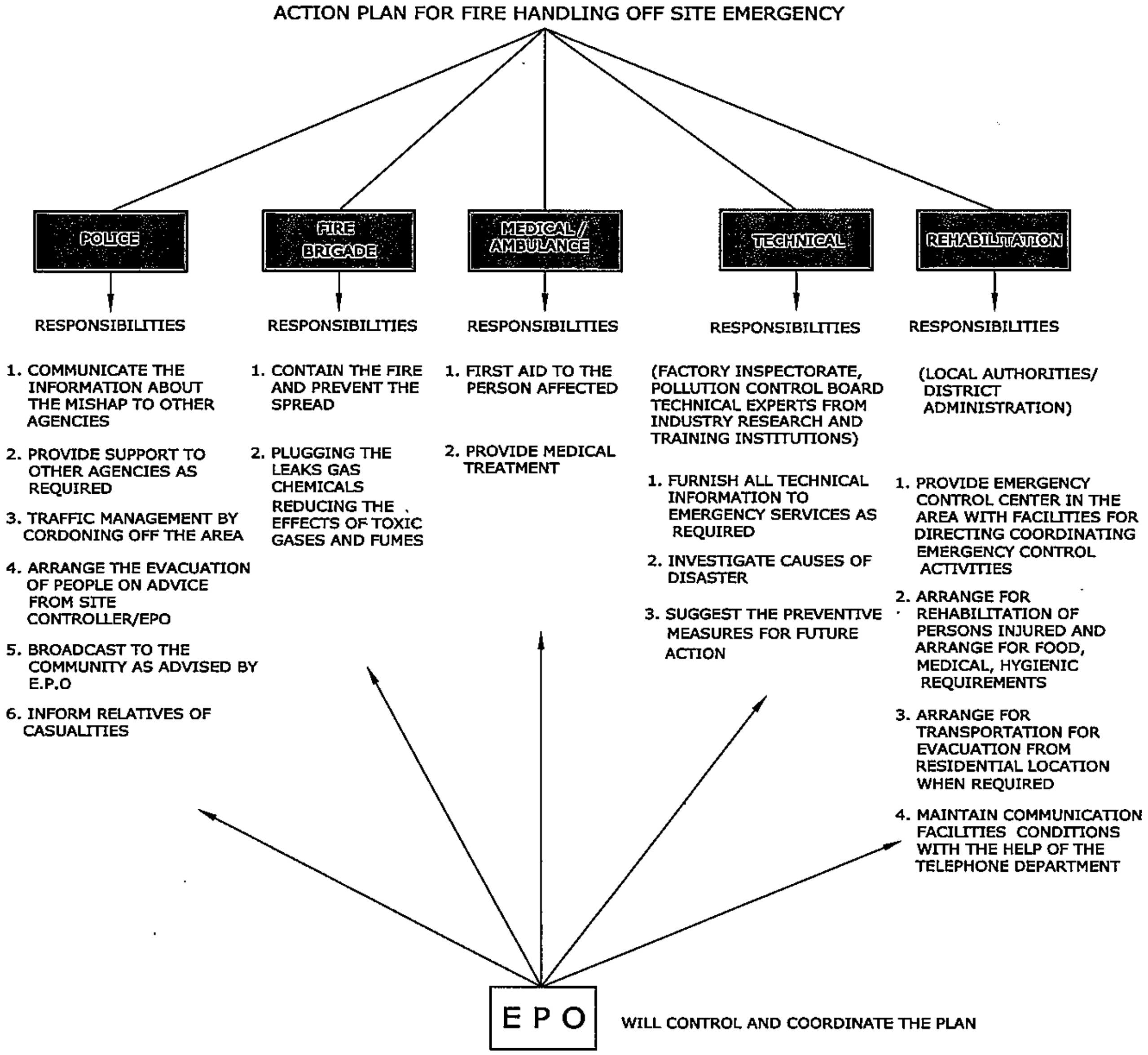



**FIGURE-7.1**
**ON-SITE EMERGENCY ORGANIZATION CHART**

- If a fire is escalating and in turn threatening a store of hazardous material, it might be necessary to evacuate people nearby, but only if there is time; if insufficient time exists, people should be advised to stay indoors and shield themselves from the fire. This latter case particularly applies if the installation at risk could produce a fireball with vary severe thermal radiation effects; and
- For release or potential release of toxic materials, limited evacuation may be appropriate down wind if there is time. The decision would depend partly on the type of housing "at risk". Conventional housing of solid construction with windows closed offers substantial protection from the effects of a toxic cloud, while shanty house, which can exist close to factories, offer little or no protection.

The major difference between releases of toxic and flammable materials is that toxic clouds are generally hazardous down to much lower concentrations and therefore hazardous over greater distances. Also, a toxic cloud drifting at, say 300 m per minute covers a large area of land very quickly. Any consideration of evacuation should take this into account. Although the plan will have sufficient flexibility built in to cover the consequences of the range of accidents identified for the on-site plan, it will cover in some detail the handling of the emergency to a particular distance from each major hazard works.

### 7.6.2 Aspects Proposed to be Considered in the Off-Site Emergency Plan

The main aspects, which should be included in the emergency plan are:

- **Organization**

Detail of command structure, warning systems, implementation procedures, emergency control centers.

Names and appointments of incident controller, site main controller, their deputies and other key personnel.

- **Communications**

Identification of personnel involved, communication center, call signs, network, list of telephone numbers.

- **Specialized knowledge**

Details of specialist bodies, firms and people upon whom it may be necessary to call e.g. those with specialized chemical knowledge, laboratories.

- **Voluntary organizations**

Details of organizers, telephone numbers, resources etc.

- **Chemical information**

Details of the hazardous substances stored or procedure on each site and a summary of the risk associated with them.

- **Meteorological information**

Arrangements for obtaining details of weather conditions prevailing at the time and whether forecasts.

- **Humanitarian arrangements**

Transport, evacuation centers, emergency feeding treatment of injured, first aid, ambulances and temporary mortuaries.

- **Public information**

Arrangements for (a) dealing with the media press office; (b) informing relatives, etc.

- **Assessment of emergency plan**

Arrangements for:

(a) Collecting information on the causes of the emergency;
(b) Reviewing the efficiency and effectiveness of all aspects of the emergency plan.

### 7.6.3 Role of the Emergency Co-ordinating Officer

The various emergency services should be co-ordinated by an emergency co-ordinating officer (ECO), who will be designated by the district collector. The ECO should liaison closely with the site main controller. Again depending on local arrangements, for very severe incidents with major or prolonged off-site consequences, the external control should be passed to a senior local authority administrator or even an administrator appointed by the central or state government. The ECO will be equipped with address and phone numbers of important agencies.

### 7.6.4 Role of the Local Authority

The duty to prepare the off-site plan lies with the local authorities. The emergency planning officer (EPO) appointed should carry out his duty in preparing for a whole range of different emergencies within the local authority area. The EPO should liaison with the works, to obtain the information to provide the basis for the plan. This liaison should ensure that the plan is continually kept upto date.

It will be the responsibility of the EPO to ensure that all those organizations which will be involved off site in handling the emergency, know of their role and are able to accept it by having for example, sufficient staff and appropriate equipment to cover their particular responsibilities. Rehearsals for off-site plans should be organized by the EPO.

### 7.6.5 Role of Police

Formal duties of the police during an emergency include protecting life and property and controlling traffic movements.

Their functions should include controlling bystanders evacuating the public, identifying the dead and dealing with casualties, and informing relatives of death or injury.

### 7.6.6 Role of Fire Authorities

The control of a fire should be normally the responsibility of the senior fire brigade officer who would take over the handling of the fire from the site incident controller on arrival at the site. The senior fire brigade officer should also have a similar responsibility for other events, such as explosions and toxic release. Fire authorities in the region should be apprised about the location of all stores of flammable materials, water and foam supply points, and fire-fighting equipment. They should be involved in on-site emergency rehearsals both as participants and, on occasion, as observers of exercises involving only site personnel.

### 7.6.7 Role of Health Authorities

Health authorities, including doctors, surgeons, hospitals, ambulances, and so on, should have a vital part to play following a major accident, and they should form an integral part of the emergency plan.

For major fires, injuries should be the result of the effects of thermal radiation to a varying degree, and the knowledge and experience to handle this in all but extreme cases may be generally available in most hospitals. For major toxic releases, the effects vary according to the chemical in question, and the health authorities should be apprised about the likely toxic releases from the plant, which will unable then in dealing with the aftermath of a toxic release with treatment appropriate to such casualties.

Major off-site incidents are likely to require medical equipment and facilities additional to those available locally, and a medical "mutual aid" scheme should exist to enable the assistance of neighboring authorities to be obtained in the event of an emergency.

### 7.6.8 Role of Government Safety Authority

This will be the factory inspectorate available in the region. Inspectors are likely to satisfy themselves that the organization responsible for producing the off-site plan has made adequate arrangements for handling emergencies of all types including major emergencies. They may wish to see well-documented procedures and evidence of exercise undertaken to test the plan.

In the event of an accident, local arrangements regarding the role of the factory inspector will apply. These may vary from keeping a watching brief to a close involvement in advising on operations in case involvement in advising on operations. In cases where toxic gases may have been released, the factory inspectorate may be the only external agency with equipment and resources to carry out tests.

The action plan suggested for control of the off-site emergencies is given in **Table-7.20.**

## TABLE-7.20
## OFF-SITE ACTION PLAN

| Sr. No. | Action required to be taken to mitigate disaster by aid giving agency | Responsible agencies for taking action | Equipments/material facilities required at site to mitigate emergency |
|---|---|---|---|
| A1 | Arrangements for evacuation/rescue of persons from zone of influence to predetermined camps | Police Department | Self Breathing apparatus with spare cylinder<br><br>Chemical gas mask with spare canister<br><br>Vehicle with PA system<br>Transportation for evacuation of people |
| 2 | Caution to public by announcement | | |
| 3 | Traffic and Mob control by cordoning of the area | | |
| 4 | Law & order | | |
| 5 | Request to railway authority for keeping the nearer by railway gate open & to stop the up & down trains. at the nearest railway station | | |
| B1 | Control of fire | District Fire Brigade | Self breathing apparatus with spare cylinders<br>Foam/water fire tenders<br>Gas mask with spare canisters<br>Lime<br>Neck to toe complete asbestos suit, PVC hand gloves, gumboots, safety goggles<br>Mobile scrubbing system along with suction arrangement. |
| 1 | Scrubbing of the flashed of gas cloud with water curtain | | |
| 2 | To rescue trapped persons | | |
| 3 | If fire is big due to LPG, keep surrounding area cool by spraying water | | |
| 4 | Communication to OSEB to continue or cut off electric supply | | |
| 5 | Communication to water supply department for supplying water | | |
| C1 | Medical facilities for affected parsons (first aid and treatment) | Hospital and public health | Ambulance with onboard resuscitation unit first aid, antidotes for toxicity, stretchers |
| D1 | Identification of concentration of gas in zone of influence | Pollution control board | Gas detector |
| 2 | Communication to PHED for decontamination of affected water | | |
| E1 | Removal of debris and damaged structures | Municipal corporation | Provide bulldozers<br>Provide cranes |
| F1 | Monitor the incoming and out going transports | Transport department | Provide traffic police at site<br>Provide emergency shifting vehicles at site<br>Provide stock of fuel for vehicles |
| 02 | Arrange emergency shifting of affected persons and non affected person to specified area | | |
| 03 | Arrange diesel/petrol for needed vehicles | | |
| G1 | Give all information related to meteorological for safe handling of affected area for living beings | Meteorological Department | Provide wind direction and velocity instruments with temperature measure<br>Mobile van for meteorological parameter measurements |
| 02 | Forecast if any important weather | | |

| Sr. No. | Action required to be taken to mitigate disaster by aid giving agency | Responsible agencies for taking action | Equipments/material facilities required at site to mitigate emergency |
|---|---|---|---|
| | change | | |
| H1 | Representative of all department are in local crisis group therefore it is expected to ender services available with them since it is a group of experts and authority, the mitigating measures can be implemented in speed upway. The representative from locals are also there so communication with local people is easy and fast | | Must have all resources at hand, specially disaster management plan and is implementation method. All relevant information related to hazardous chemical industry are generally available with crisis group News paper editor is a part of the group so right and timely media released can be done |
| 02 | The district emergency or disaster control officer is the president and he is used to mock drill etc. so action can be taken in right direction in time | | |
| I1 | Collector is the President of District Crisis Group therefore all district infrastructure facilities are diverted to affected zone | District Crisis group | All necessary facilities available at district can be made available at affected zone<br><br>Control of law and order situation |
| 02 | All other functions as mention in local crisis group | | |

## 7.7 Occupational Health and Safety

Large industries, where multifarious activities are involved during construction, erection, testing, commissioning, operation and maintenance, the men, materials and machines are the basic inputs. Along with the boons, the industrialization generally brings several problems like occupational health and safety.

The industrial planner, therefore, has to properly plan and take the steps to minimize the impacts of industrialization and to ensure appropriate occupational health, safety including fire plans. All these activities again may be classified under construction and erection, and operation and maintenance.

### 7.7.1 Occupational Health

Occupational health needs attention both during construction and erection and operation and maintenance phases. However, the problem varies both in magnitude and variety in the above phases.

- **Construction and Erection**

The occupational health problems envisaged at this stage can mainly be due to constructional accident and noise.

To overcome these hazards, in addition to arrangements to reduce it within TLV's, people protective equipments shall also be supplied to workers.

- **Operation and Maintenance**

The problem of occupational health, in the operation and maintenance phase is due to noise hearing losses. The personal protective equipments will be given to all the workers.

The working personnel shall be given the following appropriate personnel protective equipments.

- Industrial Safety Helmet;
- Crash Helmets;
- Face shield with replacement acrylic vision;
- Zero power plain goggles with cut type filters on both ends;
- Zero power goggles with cut type filters on both sides and blue color glasses;
- Welders equipment for eye and face protection;
- Cylindrical type earplug;
- Ear muffs;
- Canister Gas mask;
- Self contained breathing apparatus;
- Leather apron;
- Aluminized fiber glass fix proximity suit with hood and gloves;
- Boiler suit;
- Safety belt/line man's safety belt;
- Leather hand gloves;
- Asbestos hand gloves;
- Acid/Alkali proof rubberized hand gloves;
- Canvas cum leather hand gloves with leather palm;
- Lead hand glove;
- Electrically tested electrical resistance hand gloves; and
- Industrial safety shoes with steel toe.

The same will be supplied to workers and staff after expansion. Full-fledged hospital facilities are available round the clock for attending emergency arising out of accidents, if any. All working personnel are medically examined at least once in every year and at the end of his term of employment. This is in addition to the pre-employment medical examination.

### 7.7.2 Safety Plan

Safety of both men and materials during construction and operation phases is of concern. Safety plan shall be prepared and implemented in the proposed smelter plant. The preparedness of an industry for the occurrence of possible disasters is known as emergency plan. The disaster in the plant is possible due to leakage of hazardous chemicals like chlorine, collapse of structures and fire/explosion etc.

Keeping in view the safety requirement during construction, operation and maintenance phases, proposed smelter plant should formulate safety policy with the following regulations:

- To allocate sufficient resources to maintain safe and healthy conditions of work;

- To take steps to ensure that all known safety factors are taken into account in the design, construction, operation and maintenance of plants, machinery and equipment;
- To ensure that adequate safety instructions are given to all employees;
- To provide wherever necessary protective equipment, safety appliances and clothing and to ensure their proper use;
- To inform employees about materials, equipment or processes used in their work which are known to be potentially hazardous to health or safety;
- To keep all operations and methods of work under regular review for making necessary changes from the point of view of safety in the light of experience and upto date knowledge;
- To provide appropriate facilities for first aid and prompt treatment of injuries and illness at work;
- To provide appropriate instruction, training, retraining and supervision to employees in health and safety, first aid and to ensure that adequate publicity is given to these matters;
- To ensure proper implementation of fire prevention methods and an appropriate fire fighting service together with training facilities for personnel involved in this service;
- To organize collection, analysis and presentation of data on accident, sickness and incident involving people injury or injury to health with a view to taking corrective, remedial and preventive action;
- To promote through the established machinery, joint consultation in health and safety matters to ensure effective participation by all employees;
- To publish/notify regulations, instructions and notices in the common language of employees;
- To prepare separate safety rules for each types of occupation/processes involved in a project; and
- To ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipments, work places and operations.

### 7.7.3 Safety Organization

- **Construction and Erection Phase**

A qualified and experienced safety officer shall be appointed. The responsibilities of the safety officers include identification of the hazardous conditions and unsafe acts of workers and advise on corrective actions, conduct safety audit, organize training programs and provide professional expert advice on various issues related to occupational safety and health. He is also responsible to ensure compliance of Safety Rules/ Statutory Provisions. In addition to employment of safety officer by AAP every contractor, who employs more than 250 workers, shall also employ one safety officer to ensure safety of the worker, in accordance with the conditions of contract.

- **Operation and Maintenance Phase**

When the construction is completed the posting of safety officers shall be in accordance with the requirement of Factories Act and their duties and responsibilities shall be as defined there of.

7.7.4 Safety Circle

In order to fully develop the capabilities of the employees in identification of hazardous processes and improving safety and health, safety circles would be constituted in each area of work. The circle would consist of 5-6 employees from that area. The circle normally shall meet for about an hour every week.

7.7.5 Safety Training

A full-fledged training center shall be set up at the plant. Safety training shall be provided by the Safety Officers with the assistance of faculty members called from Corporate Center, Professional Safety Institutions and Universities. In addition to regular employees, limited contractor labors shall also be provided safety training. To create safety awareness safety films shall be shown to workers and leaflets etc. Some precautions and remedial measures proposed to be adopted to prevent fires are:

- Compartmentation of cable galleries, use of proper sealing techniques of cable passages and crevices in all directions would help in localizing and identifying the area of occurrence of fire as well as ensure effective automatic and manual fire fighting operations;
- Spread of fire in horizontal direction would be checked by providing fire stops for cable shafts;
- Reliable and dependable type of fire detection system with proper zoning and interlocks for alarms are effective protection methods for conveyor galleries;
- Housekeeping of high standard helps in eliminating the causes of fire and regular fire watching system strengthens fire prevention and fire fighting; and
- Proper fire watching by all concerned would be ensured.

7.7.6 Health and Safety Monitoring Plan

The health of all employees shall be monitored once in a year for early detection of any ailment due to exposure to heat and hazardous chemicals.

# 8.0 PROJECT BENEFITS

## 8.1 Employment Potential

The impact of plant on the economic aspects can be clearly observed. The proposed plant activities will provide employment to persons of different skills and trades. The local population will have preference to get an employment. The employment potential will ameliorate economic conditions of these families directly and provide employment to many other families indirectly who are involved in business and service oriented activities.

The employment of local people in primary and secondary sectors of project shall upgrade the prosperity of the region. This will in-turn improve the socio-economic conditions of the area. The total manpower required for the proposed project under various categories is 1495 persons.

## 8.2 Community Development Action Plan

The proposed Mahan smelter Project would benefit the communities residing in various affected villages around plant site as well as the peripheral villages either directly or indirectly while generating many positive impacts in villages around the project site. All efforts would be kept by Hindalco for the development of the region under its peripheral area development programmes, particularly the affected villages due to establishment and operation of the proposed plant project. As a part of corporate responsibility of proponent under its Development Policy aims at creation of a new era of progress and prosperity for ensuring more and more benefits to the communities.

During the initial stages of implementation of the project, on account of land and property acquisition, some adverse impacts are likely to occur. However, it is worth noting that the project is in initial stages and the anticipated adverse impacts will be mitigated with effective implementation of the suggested mitigation measures in the already prepared Environment Management Plan and the Rehabilitation and Resettlement Plan for the Project Affected Persons. As the project will give impetus for further development of the region while creating more income generation opportunities, this would lead to the overall socio-economic development of the region while enriching the quality of life of people.

### 8.2.1 Suggested Measures

In order to mitigate the anticipated adverse impacts, if any due to the proposed projects, an action plan covering mitigative measures on environmental and social issues have been developed. The proposed plan clearly focuses on the key issues, and recommends effective implementation of the suggested action plan for negating the environmental and social impacts in a systematic manner, and promoting sustainable development of the community in the post-project period. While formulating the action plan for the development of the affected villages as well as the peripheral area, utmost care has been taken and some special considerations have been selected while keeping the peculiar socio-cultural and economic aspects of the communities, particularly the tribals, in mind.

All the possible felt needs of the community mentioned in the previous chapter would be undertaken up at appropriate junctures. The action plan involving various activities and programmes as well as their implementation arrangements have been kept simple, in view of illiteracy limitations and simplest living of the tribals. The suggested mitigative measures and the action plan have been detailed out in the following sections.

- ***Repairing/Construction of Approach Roads to Villages and Internal Roads***

The action plan suggests for construction of good quality approach roads to all villages in the study area, under various schemes of the Government of Madhya Pradesh directly as part of their ongoing developmental programmes.

All the internal roads of villages should be repaired by respective village panchayats under the financial support from the Government of Madhya Pradesh, a part of this expenditure may be borne by Hindalco.

- ***Provision of Water Supply/Installation of Tube wells***

The Government of Madhya Pradesh has provided adequate number of tube wells in each village for the water needs of the villagers. In all big villages, the government is providing either a full-fledged water supply scheme with provision of piped water supply or at least distributing water through stand posts. In order to facilitate the villagers with adequate quantum of water particularly during summer, this plan suggests for provision of water supply at least through stand posts in all affected villages, by constructing storage reservoirs. The water supply would be done by the Government of MP under its infrastructure development schemes. Hindalco may contribute for partial funding of this scheme under its peripheral area development schemes, on humanitarian grounds.

- ***Construction of Primary Health Centres***

This plan suggests for construction of a Primary Health Centre the project area, so that the villagers can avail the medical services without travelling for longer distances or Construction of the PHC building may be jointly funded by Go. MP and Hindalco with a mutual understanding. The maintenance of the PHC would be the responsibility of Government of Madhya Pradesh, under its regular healthcare schemes.

- ***Provision of Electricity to the villages***

Under its intensive developmental policy, the Government of Madhya Pradesh is aiming at providing power supply to all villages of the state, in phases by 2010 and moving in this positive direction. Accordingly, the Government of Madhya Pradesh would extend electricity supply lines to all villages in the state in the near future. Hindalco may extend its helping hand to the communities by extending the power distribution lines to the affected villages and peripheral villages.

The internal power distribution for domestic and non-domestic uses would be the responsibility of GoMP. This could be integrated with local developmental programme of GoMP aiming at providing electric connections to all houses in the state.

- ***Provision of Post Offices***

In order to provide the most economical way of communication facilities to all villages, this plan suggests for construction of post offices in some selected affected villages and some peripheral villages. The post offices would have phone facility besides the postal services.

- ***Construction of Community Halls***

Almost all affected villages have cultural clubs, however without a formal club building or community hall. For facilitating the villagers to celebrate village functions in a congenial manner, this plan suggests construction of community halls in all affected and peripheral villages with the financial assistance from the GoMP and Hindalco.

- ***Construction of an Industrial Technical Institute***

This plan suggests for development of an ITI, which may be funded by Hindalco. The ITI would impart skill development training to the PAPs.

- ***Repairing of Schools and Public Buildings***

Provision of elementary education has been considered as the basic need of the community and this would be the prime responsibility of the Government of Madhya Pradesh. Under its developmental policy, the GoMP is providing free textbooks to the students of Class-I to Class VII and also providing free school uniforms to the girl students.

The community requested for undertaking periodic repairs of school buildings for safety as well security of the students. Accordingly this CDP suggests for undertaking periodical repairs to the school buildings by the GoMP under its regular budget. Hindalco may extend some financial help for repairing a few school buildings in the adjoining villages around the project site.

- ***Construction of Village Ponds***

For facilitating the village communities for taking bath, this plan suggests construction of bathing ponds. The ponds will also be used for fishing. This plan suggests undertaking the formation of ponds and also development of plantation along periphery of pond, which results increase in aesthetic value of the area and provides shelter for several varieties of birds by the State Government under its ongoing Employment Generation Schemes.

- ***Support to Anganwadi or Balwadi Kendras***

For surrounding villages around the plant area, Anganwadi and Balwadi kendras will be constructed or renovated with financial assistance from Hindalco and will be handed over to Panchayat offices.

- ***Construction of water harvesting structures***

For conserving water resources and recharging the groundwater with surface water runoff, this plan suggests construction of most suitable water harvesting structures such as check-dams, percolation tanks, bandharas, minor irrigation tanks, etc. by the government in all affected as well as the peripheral villages. The water harvesting constructions should be undertaken by DRDA and the Agriculture Departments regularly.

- ***Distribution of Free Agricultural Inputs and Training on Scientific Agriculture***

Based on the felt needs of the community, the plan suggests for distribution of agricultural inputs, improved seeds, fertilizers, pesticides etc. by the government under its agricultural extension programmes.

- ***Compensatory Afforestation***

This plan suggests for undertaking compensatory afforestation schemes in suitable lands within the district, against the loss of forest due to the project. This would be implemented by the Forest Department with the total financial support from Hindalco.

- ***Social forestry / Mixed Plantation***

This plan suggested for undertaking social forestry schemes in the vacant village common lands by the Government with community participation. Besides improving the ecological conditions, these schemes would generate income to the village communities.

The government would put efforts for development of nurseries in coordination of the Village Development Authority and ensures tree plantations in the possible vacant community places.

- ***Training Programmes for Self-Employment***

Presently almost all the villagers are devoid of higher education or any formal vocational training for enabling them to opt for their self-employment schemes. The State Employment Policy is aiming at providing massive self-employment opportunities to the unemployed youth. By integration of the anticipated training programmes of the government with those proposed for the youth of the affected and peripheral villages, the communities would be immensely benefited. Partial funding for imparting training to the rural youth in the affected villages would be done by Hindalco under its peripheral development schemes.

Also for empowering the rural women under schemes of GoMP has created Self Help Groups (SHG) in the state and giving more emphasis for forming many SHGs further. This plan suggests for integration of the training programmes of the PAPs of the project with the programme of GoMP, for fetching benefits to the PAPs.

### 8.2.2 Conclusions

Peripheral area development and community development are continuous processes in the industrial development areas, where many projects are on anvil.

A few other major industries are coming up in the vicinity of the Hindalco project and the peripheral area defined by each project may sometimes overlap with each other, while giving a chance that each industry makes development provision for the same village under its peripheral development programme. In order to avoid overlapping of facilities proposed by different industries in a particular village, proper coordination between the nearby industries in coordination with the GoO would be most essential. On a collective basis, the peripheral development schemes of various industries could be expanded to a regional scale and most appropriate community development schemes beneficial to the region could be implemented.

If planned systematically, with proper coordination of various industrial establishments in the vicinity of Hindalco project, the community development measures and programmes would immensely benefit the communities and result in cohesion between the communities, Hindalco as well as other industries and the Government of Madhya Pradesh.

The priority schemes and the priority beneficial areas would be decided based on the necessity and degree of urgency for a particular facility and for implementation of the proposed schemes; the Government of MP, Hindalco and other nearby industries would work together with the cooperation of the involved communities. Phase-wise implementation of the CDP could be taken-up by Hindalco in coordination with the Government of Madhya Pradesh and other industrial establishments in its vicinity.

It is suggested to implement the proposed developmental programmes in the affected villages on priority basis, under the first phase of the project implementation. The developmental works in the peripheral villages away from the project site could be undertaken at the subsequent phases of the project. The priority schemes for implementation and the priority villages for undertaking schemes in different phases would be decided mutually by the Hindalco, Government of Madhya Pradesh and the communities.

By undertaking their regular developmental schemes in the affected villages and peripheral villages based on the priority as well as rotation basis, the Government of Madhya Pradesh and Hindalco and other industries would help for the overall development of area and better living conditions of the communities.

# 9.0 ADDITIONAL STUDIES

## 9.1 Rehabilitation & Resettlement Action Plans

The rehabilitation and resettlement plan is under progress. The plan will be prepared based on the State Government Rehabilitation and Resettlement Policy and National R&R Policy. The best of these policies will be considered during preparation of the plan.

# 10.0 SUMMARY & CONCLUSION

## 10.1 Justification for Implementation of the Project

Coal production is insufficient to cope with growing demand for electricity and industrial energy a supply gap of some 133 Mt per year is forecast by 2007. For this reason India imports much of its coking coal Australia and South Africa.

Exploiting the coal in the Mahan coal block is going to be critically important for the country's long-term economic growth. The Mahan coal Block has a reserve of about 144.2 million tonnes (proved) of high quality thermal coal.

Hindalco Industries limited is proposing to set-up a Greenfield integrated Aluminum Complex project under the name of Mahan Aluminium with a production capacity 3,25,000 TPA (primary aluminium metal) near Bargawan, Deosar tehsil in Sidhi District (MP). To cater the demand of electricity on continuous basis a 750 MW coal base captive power plant is proposed in the complex. The coal requirement for the project is about 3.5 MTPA.

ESSAR Group is proposing to set-up 2000 MW (Ultimate capacity) Thermal power plant a Greenfield project under the name of Essar Power (MP) Limited near Karsua village, Waidhan Block, Singrauli Tehsil, Sidhi District (MP). The coal requirement for the project is about 5.0 MTPA.

As both the greenfield projects are proposed in the same district of Madhya Pradesh and coal being the basic raw material for the power projects, both the companies had proposed jointly for a captive coal deposits to source requirement of coal for their respective power plants.

The proposed project will provide direct employment to a large number of personnel. This project will also generate indirect employment to a considerable number of families, who will render their services for the employees of the project.

In view of the above, the proposal for power plant project is considered justified from basic raw material requirement considerations.

## 10.2 Summary of Anticipated Environmental Impacts and Mitigation

The summary of anticipated adverse environmental impacts and mitigation measures are given in **Table-10.1**.

## 10.3 Conclusion

The proposed project will have marginal impacts on the local environment with proper mitigation measures. However, development of this project has beneficial impact/effects in terms growth in regional economy, transform the region's economy from predominantly agricultural to significantly industrial, increase Government earnings and revenues and accelerate the pace of industrial development in the region.

The proposed project will provide direct employment to a large number of personnel. This project will also generate indirect employment to a considerable number of families, who will render their services for the employees of the project.

Thus, in view of considerable benefits from the project, the proposed project is most advantageous to the region as well as to the nation.

**TABLE-10.1**
**ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION**

| Discipline | Potential Negative Impacts | Probable Source | Mitigative Measures | Remarks |
|---|---|---|---|---|
| **Constructional Impact** | | | | |
| Water Quality | Increase in suspended solids due to soil run-off during heavy precipitation | Loose soil at construction site | During monsoon season run off from construction site will be routed to a temporary sedimentation tank for settlement of suspended solids. | - |
| Air Quality | Increase in dust and NOx concentration | Levelling activity and Heavy vehicular movement | Sprinkling of water in the construction area and unpaved roads. Proper maintenance of vehicles will be done. | The impact will be low, as the main approach road will be tarred. |
| Noise | Increase in noise level | Construction equipment | Equipment will be kept in good condition to keep the noise level within 90 dB(A). | Workers will be provided with necessary protective equipment *e.g.* ear plug, earmuffs. |
| Terrestrial Ecology | Clearing of Vegetation | Soil enabling activities | Landscaping and extensive plantation will be done. | Plantation will be done in consultation with the local forest department. |
| **Operational Impact** | | | | |
| Water Quality | Deterioration of surface water quality | Discharge from various plant units. | Adequate treatment facilities will be provided so that the treated effluents conform to the regulatory standards. | The plant effluent after treatment will be reused to maximum possible extent. |
| Air Quality | Increase in SPM, $SO_2$ and NOx levels in ambient air. | Stack emissions and coal storage yards. | High efficiency, Dust extraction system will be installed to control Particulates. Adequate stack heights will be provided as per CPCB guidelines for the proper dispersion of pollutants. Motorable roads in the plant area will be paved to reduce dust emission. Plantation programs will be undertaken around the plant area. Dust suppression measures will be implemented raw material handling area. | The resultant air quality will conform to the stipulated standards.<br><br>Particulate emission from stack will be kept below the CPCB/CREP standards |
| Solid Waste | Fly ash and bottom ash | CPP | The ash will be utilized in various construction | |

| Discipline | Potential Negative Impacts | Probable Source | Mitigative Measures | Remarks |
|---|---|---|---|---|
| | | | material and balance will be disposed off in ash pond using HCSD method. | |
| Ecology | | | | |
| a. Terrestrial | Impact on plant species | Emissions from stack | Emission will be controlled as well as dispersed through appropriate design. | As ambient air quality will be within limits, no active injury to the vegetation is expected. |
| b. Aquatic | Impact on aquatic life of river | Treated waste water from plant | The wastewater will be provided with adequate treatment facilities and reused for the process | As all the effluents will be treated to conform to prescribed limits, no significant impact on aquatic life is expected. |
| Noise | Increase in noise levels in the plant area. | Equipment in main plant and auxiliaries. | Equipment will be designed to conform to noise levels prescribed by regulatory agencies. Provision of green belt and plantation would further help in attenuating noise. | Employees working in high noise areas would be provided earplugs/ earmuffs as protective device. |
| Demography and Socio-economics | Strain on existing amenities like housing, water sources and sanitation, medical and infrastructure facilities. | Influx of people of proposed plant employees as well as contractor's employees/ labourers. | No significant impact is envisaged. Additional facilities will be developed by the project proponents. | Overall socio-economic status of the area is expected to improve. |

# 11.0 DISCLOSURE OF CONSULTANTS

## 11.1 Introduction

**Vimta Labs Limited** is a leading multi-disciplinary testing and research laboratory in India. VIMTA provides contract research and testing services in the areas of clinical research, pre-clinical (animal) studies, clinical reference lab services, environmental assessments and analytical testing of a wide variety of products.

**VIMTA-Environment Division** has been in the forefront of its vision to provide better environment through guiding and assisting the industry for sustainable development. A stalwart in the mission to protect and preserve the natural resources on earth for future generations, Vimta offers extensive research and consultancy services in the field of Environment. With its rich experience, multi-disciplinary expertise and with the support of its state-of the-art analytical equipment, the services offered by Vimta are wide ranging and encompasses entire gamut of Environmental Management and Monitoring Services. With its emphasis on quality services, Vimta, over the years, has evolved itself into a single reference point in India for Comprehensive Environmental Services.

## 11.2 The Quality Policy

- VIMTA is committed to good professional practices and quality of operations in its testing, validation and research services.
- VIMTA shall ensure customer satisfaction by maintaining independence, impartiality and integrity in its operations.
- VIMTA shall provide the services in accordance with national and international norms.
- VIMTA shall implement quality system as per ISO/IEC 17025 and applicable GLPs & GCPs, to generate technically valid results/data.
- VIMTA shall ensure that all its personnel familiarize with the policies and procedures of the quality system and implement the same in their work.

## 11.3 Milestones and Accreditations

- 1984 - Registered with an initial investment of Rs.2 Lakhs.
- 1985 - Recognized by ISI (now known as Bureau of Indian Standards).
- 1987 - Qualified by the criteria of Ministry of Environment and Forests was notified as one of the 14 standard Environmental Laboratories published in the Gazettee of India.
- 1988 - Licensed for carrying out tests on Drugs and Pharmaceuticals.
- 1990 - Cherlapally land purchased with plans of larger, more comprehensive facility.
- 1991 - Accredited by NCTCF, DST, Government of India (the forerunner of NABL).
- 1992 - Laboratories shifted to new facility at Cherlapally.
- 1993 - State-of-the-art equipment worth Rs.60 million procured.
- 1995 - Accredited by NABL under its revised scheme, certified by Standards Australia, Quality Assurance Services as per ISO/IEC Guide 25 and ISO 9002.

- 1996 - GLP Compliance.
- 1997 - Restructuring of Vimta from 165 to 100 associates with same performance.
- 1998 - Accreditation by GOSSTANDART and joint venture for certification of Food Exports with ROSTEST, Russia.
- 2001 - World Bank Recognition.
- 2002 - ANVISA Brazil certification.
- 2003 - USFDA accepts Vimta Bioequivalence study report. Showcased Vimta at AAPS (USA) and ICSE-CPHI (Germany).
- 2003 - Vimta VHS Research Center inaugurated at Chennai, Launched district laboratories at Visakhapatnam and Vijayawada, Patient service centers launched at 160 locations across the country.
- 2003 – Vimta Labs Recognized by Saudi Arabian Standards Organization.
- 2004 - Vimta increases people strength from 225 in 2003 to 400 in 2004. Vimta achieves export turnover of $ 2.5 million.
- 2004 - Vimta releases its first fortnightly medical newsletter "Vaidyalekha", Vimta enters Gulf market - bags a contract for Environmental Consultancy in Kuwait.
- 2004 - Vimta acquires 10.7 acres of land in S.P.Biotech Park – Genome Valley, Hyderabad, to create a world class Research Laboratory of 150000 sq.ft by July 2005.
- 2004 – Vimta starts a new state of the art speciality services in Molecular Diagnostics at TICEL Bio-Tech Park" at Chennai.
- 2006 – Vimta expands its overseas activities. Undertakes environmental assignments in Saudi Arabia and Tanzania.

## 11.4 Services Offered

Spread over the 70,000 Sq.ft lush green garden premises at Cherlapally, Hyderabad (India), the scientifically designed and meticulously groomed infrastructural facility of the Central Laboratory of **VIMTA** has the most sophisticated instruments backed by an excellent team of professionals. The 40,000 Sq.ft, three-storied, 120 roomed, centrally air conditioned state-of-the-art Laboratory equipped with Rs.100 million worth analytical instruments and computerized data management systems, all under one roof is perhaps the only one of its kind in South Asia in the contract testing and research sector.

Vimta offers various services under the following divisions:

- Environment
- Analytical
- Clinical Reference Lab
- Clinical Research

The environment division of VIMTA Labs Limited (VLL) has its presence all over India including a strong association with international consultants like Japan Bank for International Cooperation (JBIC), Kennametal Inc. - USA, BBL - UK, Rudal

Blanchard - UK, E&E Solutions - Japan, NEPESCO & KNPC - Kuwait, Marafiq - Saudi Arabia and others. Vimta Laboratory has the following credentials:

- Recognitions by BIS;
- Recognitions by Ministry of Environment and Forests, Govt. of India;
- Recognitions by State Pollution Control Boards (wherever applicable) ;
- Recognitions by Department of Science & Technology, Govt. of India (NABL) ;
- Recognitions by Ministry of Defense, Govt. of India;
- Recognitions by APEDA, Ministry of Commerce, Govt. of India;
- Recognitions by Saudi Arabia Standard Organization (SASO), Saudi Arabia;
- Recognitions from NEMC, Tanzania;
- Accreditations by NCTCF;
- Certification from Standard Australia;
- Recognition from ANVISA Brazil;
- Quality Assurance Services as per ISO/IEC 17025; and
- Quality Assurance Services as per ICH Guidelines

VIMTA-Environment Division has been in the forefront of its vision to provide better environment through guiding and assisting the industry for sustainable development. A stalwart in the mission to protect and preserve the natural resources on earth for future generations, Vimta offers extensive research and consultancy services in the field of Environment. With its rich experience, multi-disciplinary expertise and with the support of its state-of the-art analytical equipment, the services offered by Vimta are wide ranging and encompasses entire gamut of Environmental Management and Monitoring Services. With its emphasis on quality services, Vimta, over the years, has evolved itself into a single reference point in India for Comprehensive Environmental Services.

## 11.5 Services

Environment essentially being a multi-disciplinary science, the range of services offered by the Division are also comprehensive and caters to the needs of industry, pollution control agencies, regulatory authorities and in a larger pursuit of a green globe. The services under Environmental Assessments include:

- Site Selection and Liability Studies;
- Environmental Impact Assessments;
- Environment Management Plans;
- Carrying Capacity based Regional Studies;
- Environmental Audits;
- Solid and Hazardous Waste Management;
- Risk Assessment (MCA,HAZON,HAZOP) & DMP;
- Occupational Health and Safety, Industrial Hygiene;
- Environmental Monitoring for Air, Meteorology, Water, Soil, Noise, Ecology and Socio-Economic;
- Industrial Emission Source Monitoring;
- Offshore Sampling and Analysis of Marine Water and Sediments;
- Marine Ecological Studies;
- Marine Impact Assessment;
- Rehabilitation and Resettlement Studies;

- Forestry and Ecological Studies;
- Geological and Hydro-geological Studies;
- Land Use /Land Cover Studies based on Remote Sensing;
- Socio-Economic Studies;
- Due Diligence Studies;
- Epidemiological Studies;
- Wasteland Management Studies; and
- Study on Bio-indicators.

The services under Environmental Chemistry include:

- Analysis of Water, Wastewater, Soil, Solid Waste, Hazardous waste as per Indian and International Codes;
- Source Emissions and Work Zone Air/Noise quality monitoring;
- Analysis of SVOCs, VOCs, PAH, BTEX, AOX, PCB's, TCLP metals, TOC etc.;
- Categorization of Hazardous Waste; and
- Pesticide Residue Analysis.

## 11.6 Facilities

Vimta-Environment Division is located in scientifically designed Central Laboratory with the state-of the-art modern facilities to offer vide range of services in indoor and outdoor monitoring and analytical characterization in the field of Environment. Further, it is ably supported by highly skilled and experienced team of professionals in the fields of Science, Engineering, Ecology, Meteorology, Social Planning, Geo & Hydro-geology, and Environmental Planning.

Besides the regular monitoring equipment such as Respirable Dust Samplers, Automatic Weather Monitoring Stations, Stack Monitoring Kits, Personal Samplers, Noise Meters, Portable Water Kits etc, the other major specialized equipment include:

- Monostatic Sodar–Designed by National Physical Laboratory, GOI;
- Integrated Noise Level Meter–Quest, U.S.A;
- Flue Gas Analyzers–Testo, Germany;
- 113-A Gravimetric Dust Sampler-Casella, London;
- ICP AES- Varian, USA;
- Gas Liquid Chromatographs with FID, ECD & pFPD–Varian, USA;
- Gas Chromatograph with Mass Detector–Varian, USA;
- Atomic Absorption Spectrometer [AAS]–Varian, USA;
- PAS-AFC-123 instrument;
- High Performance Liquid Chromatograph;
- Laser Particle Size Analyzer;
- Bomb Calorimeter;
- Polarographs;
- X-ray Fluorescent Spectrometer;
- Flame Photometer;
- Carbon Sulphur Analyzer;
- Computerized Fatigue Testing Machine;
- Electronic Universal Testing Machine;

- Fourier Transmission Infrared Spectroscope; and
- Water Flow Current Meter - make Lawrence & Mayo.

## 11.7 Quality Systems

The fact that Environment division and its supporting Site Laboratories are accredited by NABL (IS0-17025) and Ministry of Environment and Forests and by other international bodies such as Asian Development Bank (ADB) and World Bank stands testimony to its emphasis on Quality Systems.

## 11.8 Achievements

Being the first laboratory to be recognized under Environment Protection (EP) Act by GOI in 1986, Environment Division with its best mind power and industrial knowledge competency that allows it to compare with the best in the business.

- The Environment Division till date has executed about 350 Environmental Impact Assessment (EIA) and Environment Management Studies with Risk Assessment and Disaster Management Plans and obtained statutory approvals.
- Supported by the strong modern laboratory support and experienced hands, Environment division is well equipped in conducting Due Diligence, Phase-I and Phase-II studies.
- Undertaken specialized studies such as Regional Environmental Impact Assessment on Carrying Capacity Principle; Upper Air Meteorological studies using SODAR for major Industrial Complexes.
- Associated with prestigious studies such as Environmental Pollution monitoring around Taj Trapezium, Pre and Post Satellite launch studies for SHAR, ISRO and monitoring for offshore Oil & Gas exploration for deep-sea water and sediment sampling.
- The services offered include vide spectrum of industries covering Power, Chemical, Cement, Mining, Steel & Alloys, Metallurgical, Dye & Intermediates, Bulk Drugs, Pesticides, Agro-Chemicals, Petro-Chemicals, Refineries, Pulp & Paper, Oil & Gas Exploration & Production, Asbestos, Infrastructure, River valley, Foundries etc.
- The Environment division has also offered its services to major infrastructure projects such as Ports, Oil & Gas Pipelines, Green field Air Ports, Roads and Highways.
- The Environment division has undertaken the performance evaluation and capacity expansion of Sewage Treatment Plant and Industrial Wastewater Treatment Plant for Marafiq, Saudi Arabia.
- The Environment division has also undertaken Environmental Impact Assessment studies for Paper Plant expansion of Mufindi Paper Mills, Tanzania.

The remaining team members too have the experience of working on various aspects of EIA studies. All have the site experience for collection of the environmental data and have prepared EIA/EMP reports. The details of the persons involved in the preparation EIA/EMP report is presented below:

## DETAILS OF PERSONNEL INVOLVED IN EIA/EMP STUDIES

| Sr. No. | Name | Qualification | Position | Contribution | Experience |
|---|---|---|---|---|---|
| 1 | Mr. M.Janardhan | M.Tech (Env. Engg) | Vice President (Environment) | Co-ordination | About 15 years of experience in the field of environmental management and environmental engineering |
| 2 | Mr. E.Shyam Sundar | M.Sc., M.Phil (Chem) PGDES | Assoc. Vice President (Env.Projects) | Project Manager | About 15 years of experience in the field of environmental chemistry and monitoring |
| 3 | Mr. Anand Harapanhalli | B.Tech (Env.) | Manager (Env.) | Project Leader | About 12 years of experience in the field of environmental engineering |
| 4 | Dr.M.V.R.N.Acharyulu | M.Sc., Ph.D (Ecology) | Group Leader | Expert | About 16 years of experience in the field of Terrestrial, Aquatic and Marine Ecology |
| 5 | Dr. D.M.R.Rao | M.Sc., Ph.D (Zoology) | Manager | Expert | About 22 years of experience in the field of Terrestrial, Aquatic ecology |
| 6 | Dr. Y.L.Paruchuri | M.Sc., Ph.D (Chem) | Manager | Expert | About 16 years of experience in the field of environmental chemistry |
| 7 | Dr. B. Chandra Sekhar | M.Sc., Ph.D (Atmospheric Science) | Group Leader | Project Incharge | About 7 years of experience in the field of air pollution meteorology. |
| 8 | Mr. K.V.Kishore Babu | M.Tech (Env) | Env. Engineer | Expert | About 8 years of experience in the field of wastewater management |
| 9 | Mr. P.Niranjan Babu | B.Com | Asst Manager | Secretarial Support | About 18 years of experience in the field of environmental monitoring |
| 10 | Mr. P.Krishna | I.T.I (Civil) | Draughtsman | Cartography | About 6 years experience in the field of environmental management and civil drawings |
| 11 | Mr. J.Rama krishna | I.T.I (Civil) | Draughtsman | Cartography | About 5 years experience in the field of environmental management and civil drawings |

**ANNEXURE-I**
**ENVIRONMENTAL COMPLIANCE**

F. No. J-11011/217/2007- IA II (I)
**Government of India**
**Ministry of Environment and Forests**
**(I.A. Division)**

**Paryavaran Bhawan**
**CGO Complex, Lodhi Road**
**New Delhi ? 110 003**

**E-mail : pb.rastogi@nic.in**
**Telefax : 011: 2436 7668**

Dated 2nd January, 2009

To,

M/s Hindalco Industries Ltd.
Renusagar ? 231218
Sonebhadra, UP`

**E-mail : mihirm@adityabirla.com ; Fax No. : 05446-252107 / 252427**

**Subject : Integrated Aluminium Smelter Complex (3.25 LTPA & Primary Aluminium) alongwith coal based Captive Power Plant (750 MW) at Village Orgari, Bargawan, District Sidhi, Madhya Pradesh by M/s Hindalco Industries Ltd. - Environment clearance reg.**

**Ref. : Your letter no. HIL/MAHAN PROJ/183 dated 31st January, 2007.**

Sir,

This has reference to your communication no. HIL/MAHAN PROJ/183 dated 31st January, 2007 alongwith application in Form I, Terms Of Reference, Pre-feasibility Report, EIA/EMP and related project documents and subsequent clarifications furnished by you vide letters dated 1st June, 2007, 24th June, 2007, 7th November, 2008, 11th November, 2008 and 29th December, 2008 for environmental clearance of the above mentioned project.

2.0 **The Ministry of Environment and Forests has examined your application. It is noted that the proposal involves setting up of a green field Integrated Aluminium Smelter Complex (3.25 LTPA & Primary Aluminium) alongwith coal based Captive Power Plant (750 MW) at Village Orgari, Bargawan, District Sidhi, Madhya Pradesh by M/s Hindalco Industries Ltd. As per the revised plan, total land will not exceed 1,500 ha. in place of 2006.20 ha. 18.80 ha forest land will be surrendered. No forest land will be involved. Rehabilitation and resettlement (R & R) of 1,750 families is prepared and submitted to the District Authorities. No national park, sanctuary or archaeological monuments exist within 25 Km radius of the site. Mohanban RF (4 km WSW), Jiwan RF (5.5 km NNE), Muher RF (9.2 km SE), Pokhara RF (6.3 km NE), Orgari PF (0.2 km N), Majhigawan PF (7 km NNE), Teldah PF (4.6 km SE), Pachwar PF (9.9 km NNE), Gidher PF (2.7 km NW), Uska PF (6.3 km E), Lohara PF (4.5 km NNW), Bichhi PF (6.6 km N), Parihasi PF (4.6 km NNE) and Bori PF (7.8 km N) are located within 10 km radius of the proposed project site. Total cost of the project is Rs. 7,700 Crores..**

3.0 Coal (3.5 MTPA) will be sourced from captive Mahan Coal Mines located at 25 km. Alumina (631, 450 TPA) will be sourced from captive Alumina Refinery of Orissa (located at 200 km.) and U.P. and Utkal Alumina Ltd.

**4.0** **Gas treatment centers (GTC) will be provided to treat the fumes from pot line. Electrostatic precipitators (ESPs) will be provided to captive power plant (CPP) to control air emissions to 100 mg/Nm$^3$. High efficiency collection hoods, flue gas treatment plant and dry scrubbers will be provided to keep the Fluoride emissions below 0.7 kgs/ton from Anode bake oven. Internal roads will be**

**paved/asphalted. Dust suppression and collection system will be provided to control fugitive emissions. Total water requirement from River Gopad will be 4,600 $m^3$/hr and the permission has been accorded by the Energy Department of Govt. of M. P. All the wastewater will be treated in ETP and used for dust suppression, green belt development and coal/ash handling. ?Zero? discharge will be adopted. Fly ash will be 100% utilized. Aluminium Fluoride will be used. Spent pot lining, dross, waste oils and grease will be recycled in-house after treatment or disposed off to authorized vendors. A secured landfill as per CPCB design will be constructed for disposal of SPL.**

5.0 Public Hearing / Public Consultation meeting was held on 14th March, 2008.

6.0 The Ministry of Environment and Forests hereby accords environmental clearance to the above project under the provisions of EIA Notification dated 14th September, 2006 as amended subsequently subject to strict compliance of the following specific and general conditions.

**A. SPECIFIC CONDITIONS:**

i) Efforts shall be made to reduce RSPM levels in the ambient air and a time bound action plan shall be submitted. On-line ambient air monitoring and continuous stack monitoring facilities for all the stacks and sufficient air pollution control devices shall be provided to all the stacks including captive power plant to keep the emission levels below 100 mg/$Nm^3$.

ii) Electrostatic precipitator(s) shall be provided to calciners of Alumina Refinery and boiler stacks of Power Plant to control gaseous emissions within 100 mg/$Nm^3$. The stacks of adequate height shall be provided to power plant and anode plant as per the CPCB guidelines. Gaseous emissions shall be regularly monitored and records maintained and reports submitted to this Ministry including its Regional Office at Bhopal / Central Pollution Control Board (CPCB) and M.P. Pollution Control Board (MPPCB) six monthly.

iii) Particulate fluoride emissions shall not be more than 0.65 mg/$Nm^3$ and fugitive particulate fluoride emissions from pot room shall not be more than 1.85 mg/$Nm^3$. Continuous fluoride emission monitoring system shall be installed at pot room stack.

iv) The particulate emissions from the bake oven plant shall not exceed 50 mg/$Nm^3$.

v) The company shall obtain necessary clearances for the linked bauxite mining component before operationalising the Alumina Refinery and the Captive Power Plant and a copy submitted to the Ministry and its Regional Office at Bhopal. In case of any other source like import etc., Ministry shall be informed about the source of bauxite time to time.

vi) In plant, control measures for checking fugitive emissions from spillage/raw materials handling shall be provided. Fluoride emissions shall be monitored from the pot room and in the forage around the smelter complex and the data submitted regularly to the Ministry/ Regional Office at Bhopal and MPPCB. Further dry scrubbing system to control the emissions from the pot lines shall be provided. Total fluoride emissions shall not exceed 0.7 kg/ton of Aluminium produced. Further, the pot emissions through fume treatment plant shall not exceed 0.30 kg/ton of Aluminium produced. Fugitive fluoride emissions from the pot room shall be monitored and report submitted regularly to the Ministry/Regional Office at Bhopal and MPPCB.

vii) The company shall install fume extraction system and bag filters to control the emissions from all melting and casting units. The emissions shall conform to the standards prescribed by the Ministry/CPCB/MPPCB which ever is more stringent.

viii) Bag filters shall be provided to anode baking plant and transfer points to control fugitive emissions. Gas treatment centers (GTC) shall be provided to treat the fumes from pot line. Closed Alumina wagon and dense phase conveying for Alumina handling shall be provided to reduce fugitive emissions. High efficiency collection hoods, flue gas treatment plant and dry scrubbers shall be provided to keep the Fluoride emissions below 0.7 Kg/Ton from Anode bake oven. Internal roads shall be paved/asphalted. Calcined petroleum based dry scrubber, dust suppression and collection system shall be provided to Carbon paste plant. De-dusting system shall be provided to control fugitive emissions. Dust suppression system shall be provided to control fugitive emissions from the crushing house, dumpers, conveyor belt, moving vehicles, pneumatic compressors, raw material handling etc.

ix) The poly-aromatic hydrocarbons (PAH) from the carbon plant (anode bake oven) shall not exceed 2 $mg/Nm^3$. The data on PAH shall be monitored quarterly and report submitted regularly to the Ministry/Regional Office at Bhopal and MPPCB.

x) Fluoride consumption shall be less than 10 kg/ton of Aluminium produced as specified by the CREP guidelines. Accordingly, Fluoride emission load shall be reduced.

xi) Efforts shall be made to reduce the impact of transport system due to movement of raw material, semi finished products and finished products on the surrounding environment.

xii) Total water requirement from River Gopad shall not exceed 4,600 $m^3/hr$ and prior permission from the drawl of 4,600 $m^3/hr$ water from concerned department shall be obtained. Closed circuit system shall be adopted to reduce water consumption and control water pollution. As reflected in the EIA /EMP, all the process effluent shall be treated in the effluent treatment plant (ETP) and treated waste water shall be recycled and reused for cooling, dust suppression, green belt development and coal/ash handling to achieve ?zero? discharge. Domestic effluent shall be treated in sewage treatment plant (STP) and treated wastewater conforming to the standards for land application shall be reused for green belt development within the plant premises.

xiii) A detailed hydrological study of ground water movement shall be carried out for the assessment of ground water contamination from red mud ponds to assess the risk of ground water contamination and report submitted to the Ministry and its Regional Office at Bhopal within six months.

xiv) Proper care shall be taken to ensure no run off or seepage from the disposal site to natural drainage. Ground water all around the disposal area shall be monitored regularly and report submitted to the MPPCB/CPCB and Regional Office of the Ministry at Bhopal.

xv) The spent pot lining generated from the smelter shall be properly treated by setting up of spent pot lining treatment plant to remove fluoride and cyanide and disposed off in a secured landfill site. The location and design of the landfill site shall be approved by the MPPCB as per Hazardous Wastes (Management and Handling) Rules, 2003 and should be as per CPCB guidelines. The ground water quality around the landfill site shall be monitored and data submitted to the Ministry/MPPCB. Spent pot lining generation shall not exceed as per guidelines mentioned in the Corporate Responsibility for Environment Protection (CREP) for the Aluminium Sector and shall be disposed off in secured land fill (SLF) designed and constructed as per CPCB guidelines with proper leachate collection system. ETP & STP sludge will be used as a soil conditioner for green belt development. All the dross, used oil and batteries shall be sold to the authorized recyclers/reprocessors.

xvi) Efforts shall be made to find application and use of spent pot lining generated from the smelter.

xvii) Proper utilization of fly ash shall be ensured as per Fly ash Notification, 1999 and subsequent amendment in 2003. All the fly ash generated shall be properly stored in ash storage pond and provided to cement and brick manufacturers for further utilization.

xviii) Occupational Health Surveillance of the workers shall be done on a regular basis and records maintained as per the Factories Act.

xix) Green belt shall be developed in 500 ha. (33 %) out of total 1500 ha. area to mitigate the impact of fugitive emissions as per the CPCB guidelines.

xx) The company shall develop rain water structures to harvest the run off water for recharge of ground water in consultation with the Central Ground Water Authority / Board.

xxi) Land acquisition for the proposed Integrated Aluminium Smelter Complex (3.25 LTPA & Primary Aluminium) alongwith coal based Captive Power Plant (750 MW) at Village Orgari, Bargawan, District Sidhi, Madhya Pradesh shall not exceed 1,500 ha.

xxii) As proposed, no forest land shall be used.

xxiii) Recommendations of the State Forest Department regarding impact of the proposed expansion plant on the surrounding reserve forests viz. Mohanban RF (4 km WSW), Jiwan RF (5.5 km NNE), Muher RF (9.2 km SE), Pokhara RF (6.3 km NE), Orgari PF (0.2 km N), Majhigawan PF (7 km NNE), Teldah PF (4.6 km SE), Pachwar PF (9.9 km NNE), Gidher PF (2.7 km NW), Uska PF (6.3 km E), Lohara PF (4.5 km NNW), Bichhi PF (6.6 km N), Parihasi PF (4.6 km NNE) and Bori PF (7.8 km N) shall be obtained and implemented.

xxiv) Measures shall also be taken to prevent impact of particulate emissions / fugitive emissions, if any from the proposed plant on the surrounding forest located within 10 km radius of the project. Further, Conservation Plan for the conservation of wild fauna of Schedule I located in the forest/reserve forests in consultation with the State Forest Department shall be prepared and implemented.

xxv) Rehabilitation and Resettlement shall be implemented as per the R & R Policy of the State Govt. of Madhya Pradesh. Suitable employment to all the oustees shall be provided. Compensation paid to the land oustees in any case shall not be less than the norms prescribed under the National Resettlement and Rehabilitation Policy, 2007.

xxvi) All the recommendations made in the Charter on Corporate Responsibility for Environment Protection (CREP) for the Aluminium sector shall be strictly implemented.

xxvii) The project proponent shall also comply with all the environmental protection measures and safeguards recommended in the EIA/EMP report and suggested during the public hearing meeting.

xxviii) The company shall provide housing for construction labour within the site with all necessary infrastructure and facilities such as fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care, crèche etc. The housing may be in the form of temporary structures to be removed after the completion of the project.

## B. GENERAL CONDITIONS :

i. The project authorities must strictly adhere to the stipulations made by the M.P. Pollution Control Board (MPPCB) and the State Government.

ii. No expansion or modification in the plant shall be carried out without prior approval of the Ministry of Environment and Forests.

## ANNEXURE-I
## ENVIRONMENTAL COMPLIANCE

iii. The gaseous emissions from various process units should conform to the standards prescribed by the concerned authorities from time to time. The MPPCB may specify more stringent standards for the relevant parameters keeping in view the nature of the industry and its size and location. At no time the emissions level should go beyond the prescribed standards. In the event of failure of any pollution control system adopted by the unit, the respective unit should not be restarted until the control measures are rectified to achieve the desired efficiency.

iv. Adequate ambient air quality monitoring stations shall be established in the downward direction as well as where maximum ground level concentration of SPM, $SO_2$ and $NO_X$ are anticipated in consultation with the MPPCB. Data on ambient air quality, fugitive emission and stack emissions shall be regularly submitted to this Ministry including its Regional Office at Bangalore and APCB once in six months.

v. In-plant control measures for checking fugitive emissions from spillage/raw materials handling etc. should be provided and particulate matter from Bauxite transport and crushing shall be provided with highly efficient bag filters and covered conveyers and adequate water sprinkling shall be done.

vi. The overall noise levels in and around the plant area should be kept well within the standards (85 dBA) by providing noise control measures including acoustic hoods, silencers, enclosures etc. on all sources of noise generation. The ambient noise levels should conform to the standards prescribed under EPA Rules, 1989 viz. 75 dBA (daytime) and 70 dBA (nighttime).

vii. Occupational health surveillance of the workers shall be done on a regular basis and records maintained as per the Factories Act.

viii. The company shall also comply with all the environmental protection measures and safeguards recommended in the EIA / EMP report. Further, the company shall earmark funds separately for improving socio-economy and ecology of the region.

ix. As proposed, Rs. 405.00 Crores for environmental management plan, Rs. 45.00 Lakhs towards total capital cost and Rs. 21.00 Lakhs earmaked towards recurring cost/annum for environmental pollution control measures shall be judiciously utilized for implementation of the conditions stipulated by the Ministry of Environment and Forests as well as the State Government alongwith the implementation schedule for all the conditions stipulated herein. The funds so provided should not be diverted for any other purposes.

x. The Regional Office of this Ministry at Bhopal/MPPCB/OSPCB will monitor the stipulated conditions. A six monthly compliance report and the monitored data along with statistical interpretation should be submitted to them regularly.

xi. The company shall inform the public that the project has been accorded environmental clearance by the Ministry and copies of the clearance letter are available with the MPPCB and may also be seen at Website of the Ministry of Environment and Forests at http:/envfor.nic.in. This should be advertised within seven days from the date of issue of the clearance letter at least in two local newspapers that are widely circulated in the region of which one shall be in the vernacular language of the locality concerned and a copy of the same should be forwarded to the Regional office.

xii. The project authorities shall inform the Regional Office as well as the Ministry, the date of financial closure and final approval of the project by the concerned authorities and the date of commencing the land development work.

8.0. The Ministry may revoke or suspend the clearance, if implementation of any of the above conditions is not satisfactory.

**ANNEXURE-I**
**ENVIRONMENTAL COMPLIANCE**

9.0 The Ministry reserves the right to stipulate additional conditions if found necessary. The company in a time bound manner will implement these conditions.

10.0. Any appeal against this environmental clearance shall lie with the National Environment Appellate Authority, if preferred within a period of 30 days as prescribed under Section 11 of the National Environment Appellate Act, 1997.

11.0. The above conditions will be enforced, inter-alia under the provisions of the Water (Prevention & Control of Pollution) Act, 1974, the Air (Prevention & Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986, the Hazardous Wastes (Management and Handling) Rules, 2003 and the Public Liability Insurance Act, 1991 along with their amendments and rules.

**(Dr. P. B. Rastogi)**
**Director**

Copy to :

1. The Secretary, State Department of Environment, Govt. of M.P., Bhopal, M.P.
2. The Chairman, Central Pollution Control Board, Parivesh Bhavan, CBD-cum-Office Complex, East Arjun Nagar, Delhi-110032.
3. The Chairman, Madhya Pradesh Pollution Control Board, Paryavaran Parisar, E-5, Arera Colony, Bhopal ? 462 016, Madhya Pradesh.
4. The Chairman, M.P. State Election Commission, 30, Nishat Colony, Bhopal, MP-462003
5. The Chief Conservator of Forests (Central), Ministry of Environment & Forests, Regional Office, Link Road No.3, E - 5, Arera Colony, Bhopal - 462 016, M.P.
6. Adviser, IA?II(I), Ministry of Environment and Forests, Paryavaran Bhavan, CGO Complex, New Delhi
7. Monitoring Cell, Ministry of Environment and Forests, Paryavaran Bhavan, CGO Complex, New Delhi.
8. Guard File.
9. Monitoring File.
10. Record File.

**(Dr. P. B. Rastogi)**
**Director**

## ANNEXURE-II
## METHODOLOGY FOR SAMPLING AND ANALYSIS

### 1.0 Meteorology

The methodology adopted for monitoring surface observations is as per the standard norms laid down by Bureau of Indian Standards (IS : 8829) and India Meteorological Department (IMD).

### 1.1 Methodology of Data Generation

The Central Monitoring Station (CMS) equipped with continuous monitoring equipment was installed at site at a height of about 10-m above ground level to record wind speed, direction, relative humidity and temperature. The meteorological monitoring station was located in such a way that it is free from any obstructions and as per the guidelines specified under IS:8829. Cloud cover was recorded by visual observation. Rainfall was monitored by rain gauge.

The continuous recording meteorological instrument of Dynalab, Pune (Model No.WDL1002) has been used for recording the met data. The sensitivity of the equipment is as given in **Table-1**.

**TABLE-1**
**SENSITIVITY OF METEOROLOGY MONITORING STATION**

| Sr. No. | Sensor | Sensitivity |
|---|---|---|
| 1 | Wind speed Sensor | ± 0.02 m/s |
| 2 | Wind direction Sensor | ± 3 degrees |
| 3 | Temperature Sensor | ± 0.2°C |

Hourly maximum, minimum and average values of wind speed, direction and temperature were recorded continuously with continuous monitoring equipment. All the sensors were connected to filter and then logged on to datalogger. The readings were recorded in a memory module, which was attached to datalogger. The memory module was downloaded in computer through Dynalab software. The storage capacity of memory module was 256 KB. Data was downloaded every fortnight into the computer. The data was recorded continuously. The recovery of data was about 98%. The rest of 2 % data gaps were filled by referring to IMD data and daily weather reports in the local newspapers. However, Relative Humidity and Rainfall were recorded manually.

### 1.2 Ambient Air Quality

1.2.1 Method of Analysis

The air samples were analyzed as per standard methods specified by Central Pollution Control Board (CPCB), IS: 5184 and American Public Health Association (APHA).

1.2.2 Instruments used for Sampling

Respirable Dust Samplers APM-451 instruments have been used for monitoring Total Suspended Particulate Matter (TSPM), Respirable fraction (<10 microns) and gaseous pollutants like $SO_2$ and NOx. Charcoal filled glass tubes were deployed for collection of carbon monoxide. Gas Chromatography techniques have been used for the estimation of CO.

## ANNEXURE-II
## METHODOLOGY FOR SAMPLING AND ANALYSIS

1.2.3 Instruments used for Analysis

The make and model of the instruments used for analysis of the samples collected during the field monitoring are given in **Table-2.**

**TABLE-2**
**INSTRUMENTS USED FOR ANALYSIS OF SAMPLES**

| Sr. No | Instrument Name | Make | Model | Parameters |
|---|---|---|---|---|
| 1 | Spectrophotometer | HACH | DR 2000; Sl. No. 911016344 | $SO_2$, NOx |
| 2 | Electronic Balance | Metler | AE 200S; Sl. No M10774 | TSPM, SPM, RPM |
| 3 | Gas Chromatograph With FID, pFPD, ECD | GC-3, VARIAN | CP- 3800-44; Sl. No. 8094 | CO |

1.2.4 Sampling and Analytical Techniques

### 1] Total Suspended Particulate Matter TSPM, RPM, $SO_2$ and NOx

SPM (>10 μ) and RPM (<10 μ) present in ambient air is drawn through the cyclone. Coarse and non-respirable dust (>10μ) is separated from the air stream by centrifugal forces acting on the solid particles. These separated particulates fall through the cyclone's conical hopper and collect in the sampling cup placed at the bottom of the cyclone. The fine dust (<10 microns) forming the respirable fraction passes the cyclone and is retained by the filter paper. The TSPM is estimated by summing up the SPM and RPM fractions collected separately as above.

A tapping is provided on the suction side of the blower to provide suction for sampling air through a set of impingers. Samples of gases are drawn at a flow rate of 0.2 Liters Per Minute (LPM).

TSPM and RPM have been estimated by Gravimetric method (IS: 5182, Part IV). Modified West and Gaeke method (IS-5182 Part-II, 1969) has been adopted for estimation of $SO_2$. Jacobs-Hochheiser method (IS-5182 Part-VI, 1975) has been adopted for the estimation of NOx.

**Calibration:**

Calibration charts have been prepared for all gaseous pollutants. The calibration is carried out whenever new absorbing solutions are prepared. All the Resirable Dust Samplers are calibrated as per ASTM D-4096. The rotameter is calibrated using soap bubble meter.

### 2] Carbon Monoxide

Charcoal filled glass tubes have been used for collecting the samples of Carbon monoxide. The CO levels were analyzed through Gas Chromatography techniques.

The techniques used for ambient air quality monitoring and minimum detectable level are given in **Table-3.**

## ANNEXURE-II
## METHODOLOGY FOR SAMPLING AND ANALYSIS

### TABLE-3
### TECHNIQUES USED FOR AMBIENT AIR QUALITY MONITORING

| Sr. No. | Parameter | Technique | Technical Protocol | Minimum Detectable Limit ($\mu g/m^3$) |
|---|---|---|---|---|
| 1 | Total Suspended Particulate Matter | Respirable Dust Sampler (Gravimetric method) | IS-5182 (Part-IV) | 5.0 |
| 2 | Respirable Particulate Matter | Respirable Dust Sampler (Gravimetric method) | IS-5182 (Part-IV) | 5.0 |
| 3 | Sulphur dioxide | Modified West and Gaeke | IS-5182 (Part-II) | 4.0 |
| 4 | Oxide of Nitrogen | Jacob & Hochheiser | IS-5182 (Part-VI) | 4.0 |
| 5 | Carbon Monoxide | Gas Chromatography | IS-5182 (Part-X) | 12.5 |
| 6 | Fluoride | Ion selective Method | EPA-13B | 0.1 |

### 1.3 Method adopted in Fluoride Monitoring

SPADNS method was adopted for monitoring of Fluoride in ambient air quality.

Colorimetric method is based on the reaction between Fluoride and Zirconium-dye lake. F reacts in the dye lake, dissociation a portion of it into a colourless anion ($Zr\ F_6^{-2}$) and the dye.

As the amount of fluoride increases, the colour produced becomes progressively lighter. The reaction rate between Fluoride and Zirconium ions is influenced by the acidity of the reaction mixture. If the proportion of the acid in the reagent is increased, the reaction can be made almost instantaneous.

The gaseous fluoride is absorbed into 0.1 N NaOH solution at 0.2 LPM. The solution is dried in a hot air oven at 600°C and fused with sodium hydroxide solution. After the fusion, it is dissolved in water pH is adjusted to 8 -9 with HCl and absorbance is detected using Zirconyl-SPADNS reagent at 580 nm.

Particulate fluoride is detected by ashing the filter paper and then fusing the ash as described above. The absorbance and concentration of fluoride will be detected as mentioned above.

### 1.4 Water Analysis

Samples for chemical analysis were collected in polyethylene carboys. Samples collected for metal content were acidified with 1 ml $HNO_3$. Samples for bacteriological analysis were collected in sterilized glass bottles. Selected physico-chemical and bacteriological parameters have been analyzed for projecting the existing water quality status in the study area. Parameters like temperature, Dissolved Oxygen (DO) and pH were analyzed at the time of sample collection.

The methodology for sample collection and preservation techniques was followed as per the Standard Operating Procedures (SOP) mentioned in **Table-4.**

## ANNEXURE-II
## METHODOLOGY FOR SAMPLING AND ANALYSIS

### TABLE-4
### STANDARD OPERATING PROCEDURES (SOP) FOR WATER AND WASTEWATER SAMPLING

| Parameter | Sample Collection | Sample Size | Storage/ Preservation |
|---|---|---|---|
| pH | Grab sampling Plastic /glass container | 50 ml | On site analysis |
| Electrical Conductivity | Grab sampling Plastic /glass container | 50 ml | On site parameter |
| Total suspended solids | Grab sampling Plastic /glass container | 100 ml | Refrigeration, can be stored for 7 days |
| Total Dissolved Solids | Grab sampling Plastic /glass container | 100 ml | Refrigeration, can be stored for 7 days |
| BOD | Grab sampling Plastic /glass container | 500 ml | Refrigeration, 48 hrs |
| Hardness | Grab sampling Plastic /glass container | 100 ml | Add $HNO_3$ to pH<2, refrigeration; 6 months |
| Chlorides | Grab sampling Plastic /glass container | 50 ml | Not required; 28 days |
| Sulphates | Grab sampling Plastic /glass container | 100 ml | Refrigeration; 28 days |
| Sodium, Potassium | Plastic container | 100 ml | Not required; 6 months |
| Nitrates | Plastic containers | 100 ml | Refrigeration; 48 hrs |
| Fluorides | Plastic containers only | 100 ml | Not required; 28 days |
| Alkalinity | Plastic/ glass containers | 100 ml | Refrigeration; 14 days |
| Ammonia | Plastic/ glass containers | 100 ml | Add $H_2SO_4$ to pH>2, refrigeration, 28 days |
| Hexavalent Chromium, $Cr^{+6}$ | Plastic/ Glass rinse with 1+1 $HNO_3$ | 100 ml | Grab sample; refrigeration; 24 hrs |
| Heavy Metals (Hg, Cd, Cr, Cu, Fe, Zn, Pb etc.) | Plastic/ Glass rinse with 1+1 $HNO_3$ | 500 ml | Filter, add $HNO_3$ to pH>2; Grab sample; 6 months |

*Source: Standard Methods for the Examination of Water and Wastewater, Published By APHA, AWWA, WEF 19th Edition, 1995*

### 1.4.1 Analytical Techniques

The analytical techniques used for water and wastewater analysis is given in the **Table-5**.

### TABLE-5
### ANALYTICAL TECHNIQUES FOR WATER AND WASTEWATER ANALYSIS

| Parameter | Method |
|---|---|
| pH | APHA-4500-$H^+$ |
| Colour | APHA-2120 C |
| Odour | IS: 3025, Part-4 |
| Temperature | APHA-2550 B |
| Dissolved Oxygen | APHA-4500 O |
| BOD | APHA-5210 B |
| Electrical conductivity | APHA-2510 B |
| Turbidity | APHA-2130 B |
| Chlorides | APHA-4500 $Cl^-$ |
| Fluorides | APHA-4500 $F^-$ |
| Total dissolved solids | APHA-2540 C |
| Total suspended solids | APHA-2540 D |
| Total hardness | APHA-2340 C |
| Sulphates | APHA-4500 $SO_4^{-2}$ |
| Arsenic | APHA-3120 B/ APHA-3114 B/ APHA-3500 As |
| Calcium | APHA-3120 B/ APHA-3500 Ca |
| Magnesium | APHA-3120 B/ APHA-3500 Mg |

| Parameter | Method |
|---|---|
| Sodium | APHA-3120 B/ APHA-3500 Na |
| Potassium | APHA-3120 B/ APHA-3500 K |
| Manganese | APHA-3120 B/ APHA-3500 Mn |
| Mercury | APHA-3112 B/ APHA-3500 Hg |
| Selenium | APHA-3120 B/ APHA-3114 B/ APHA-3500 Se |
| Lead | APHA-3120 B/ APHA-3500 Pb |
| Copper | APHA-3120 B/ APHA-3500 Cu |
| Cadmium | APHA-3120 B/ APHA-3500 Cd |
| Iron | APHA-3120 B/ APHA-3500 Fe |
| Zinc | APHA-3120 B/ APHA-3500 Zn |
| Boron | APHA-4500 B |
| Coliform organisms | APHA-9215 D |
| Alkalinity | APHA-2320 B |

## 1.5 Soil Quality

At each location, soil samples were collected from three different depths viz. 30 cm, 60 cm and 90 cm below the surface and are homogenized. This is in line with IS: 2720 & Methods of Soil Analysis, Part-1, 2nd edition, 1986 of (American Society for Agronomy and Soil Science Society of America). The homogenized samples were analyzed for physical and chemical characteristics. The soil samples were collected and analyzed once in each season.

The samples have been analyzed as per the established scientific methods for physico-chemical parameters. The heavy metals have been analyzed by using Atomic Absorption Spectrophotometer and Inductive Coupled Plasma Analyzer.

The methodology adopted for each parameter is described in **Table-6**.

**TABLE-6**
**ANALYTICAL TECHNIQUES FOR SOIL ANALYSIS**

| Parameter | Method (ASTM number) |
|---|---|
| Grain size distribution | Sieve analysis (D 422 – 63) |
| Textural classification | Chart developed by Public Roads Administration |
| Infiltration capacity | Infiltrometer |
| Bulk density | Sand replacement, core cutter |
| Porosity | Void ratio |
| Sodium absorption ratio | Flame colourimetric (D 1428-82) |
| PH | pH meter (D 1293-84) |
| Electrical conductivity | Conductivity meter (D 1125-82) |
| Nitrogen | Kjeldahl distillation (D 3590-84) |
| Phosphorus | Molybdenum blue, colourimetric (D 515-82) |
| Potassium | Flame photometric (D 1428-82) |
| Copper | AAS (D 1688-84) |
| Iron | AAS (D 1068-84) |
| Zinc | AAS (D 1691-84) |
| Boron | Surcumin, colourimetric (D 3082-79) |
| Chlorides | Argentometric (D 512-81 Rev 85) |
| Fluorides | Fusion followed by distillation and estimation by Ion selective electrod. |

## ANNEXURE-II
## METHODOLOGY FOR SAMPLING AND ANALYSIS

### 1.6 Noise Levels

1.6.1 Method of Monitoring

Noise level monitoring was carried out continuously for 24-hours with one hour interval starting at 0030 hrs to 0030 hrs next day. The noise levels were monitored on working days only and Saturdays, Sundays and public holidays were not monitored. During each hour $L_{eq}$ were directly computed by the instrument based on the sound pressure levels. Lday (Ld), Lnight (Ln) and Ldn values were computed using corresponding hourly Leq of day and night respectively. Monitoring was carried out at 'A' response and fast mode.

*Parameters Measured During Monitoring*

For noise levels measured over a given period of time interval, it is possible to describe important features of noise using statistical quantities. This is calculated using the percent of the time certain noise levels exceeds the time interval. The notation for the statistical quantities of noise levels is described below:

- Hourly $L_{eq}$ values have been computed by integrating sound level meter.
- $L_{day}$: As per the CPCB guidelines the day time limit is between 07:00 hours to 22.00 hours as outlined in Ministry of Environment and Forest Notification S.O. 123 (E) dated 14/02/2000.
- $L_{night}$: As per the CPCB guidelines the night time limit is between 22:00 hours to 07.00 hours as outlined in Ministry of Environment and Forest Notification S.O. 123 (E) dated 14/02/2000.

A rating developed by Environmental Protection Agency, (US-EPA) for specification of community noise from all the sources is the Day-Night Sound Level, ($L_{dn}$).

$L_{dn}$: It is similar to a 24 hr equivalent sound level except that during night time period (10 pm to 07 am) a 10 dB (A) weighting penalty is added to the instantaneous sound level before computing the 24 hr average. This nighttime penalty is added to account for the fact that noise during night when people usually sleep is judged as more annoying than the same noise during the daytime.

The $L_{dn}$ for a given location in a community may be calculated from the hourly $L_{eq}$'s, by the following equation.

$$L_{dn} = 10Log \frac{[\sum_{i=1}^{15} 10^{(L_{eq}i/10)} + \sum_{i=1}^{9} 10^{(L_{eq}i+10/10)}]}{24}$$

## ANNEXURE-III
## ADMINISTRATIVE AND LEGISLATIVE BACKGROUND

The legal framework is covered under several legislations. Brief details of the same are given below:

Legislative Framework

This section provides a brief summary of India's environmental legislation. Ministry of Environment and Forests (MoEF) is the nodal agency for drafting the new environmental legislations and giving the environmental clearance to the new projects. State Pollution Control Boards (SPCB) are responsible for implementing environmental legislation and issuing local Rules, Regulations and Notifications.

Regulatory Control of the Project

The proposed project is covered under the Environmental Impact Assessment (EIA) Notification, 1994 and amendments promulgated under Environment (Protection) Act (EPA), 1986.

The key environmental legislations pertaining to the proposed operations include:

- The Forest (Conservation) Act, 1980;
- The Water (Prevention and Control of Pollution) Act, 1974;
- The Air (Prevention and Control of Pollution) Act, 1981;
- The Environment Protection Act, 1986, Rules there under (with amendments);
- The Hazardous Wastes (Management & Handling) Rules 2000
- Environmental Impact Assessment Notification, 2006;and
- Mines Legislation Pertaining to Environmental Protection.

These key instruments and all subsequent and relevant amendments to them are discussed in further details as below.

- ***The Forest (Conservation) Act, 1980***

Specified activities in forest areas are controlled under the Forest (Conservation) Act 1980 and clearances are required for such activities. The diversion of forestland for non-forestry purposes is not encouraged and clearances for such activities are difficult to obtain. Seismic surveys, are however, exempted from the provisions of the Forest Act providing these activities are restricted to clearing of undergrowth and lopping of tree branches and do not involve the felling of trees.

- ***The Water (Prevention and Control of Pollution) Act, 1974***

This Act introduced the State Pollution Control Boards to grant Consent For Establishment (CFE) and Consent For Operation (CFO) to the industries. The investor intending to set up an industry is required to apply to the SPCB to obtain a CFE followed by CFO. While granting the consent, SPCB can stipulate conditions pertaining to the effluents arising from the process. The consent to operate is granted for a specific period (usually one year) after which conditions attached are reviewed by the SPCB before renewal.

## ANNEXURE-III
## ADMINISTRATIVE AND LEGISLATIVE BACKGROUND

- ***The Air (Prevention and Control of Pollution) Act, 1981***

This Act is very similar in scope to the Water Act, 1974. The Act stipulates the establishment of State Boards for the Prevention and Control of Air Pollution. In States where a water pollution board had already been established under the earlier Water Act, the two boards were combined to form SPCBs. The establishment or operation of any industry cannot be undertaken without the prior consent of the SPCB. A decision on any application for consent must be made by the SPCB within four months of receipt of the application.

- ***Environment Protection (EP) Act and Rules, 1986***

EP Act was enacted to provide for the protection and improvement of environment and for matters connected there with. A decision was taken by India to protect and improve the human environment at the United Nations Conference on Human Environment held at Stockholm in June 1972. It is considered necessary to prevent the hazards to human beings, other living creatures, plants and property.

This Act is an umbrella act and gave birth to many sub acts and rules. The EP Act call for procedural requirements for:

- Obtaining Environmental Clearance; and
- Submission of Environmental Statement.

The main Rules pertinent here are indicated below:

- The Hazardous Waste (Management and Handling) Rules, 1989 (with amendments upto 2000);
- Environmental Impact Assessment Notification; and
- Public Hearing Notification.

- ***E.I.A Notification, 2006 and Subsequent Amendments***

The principal Environmental Regulatory Agency in India is the Ministry of Environment and Forests (MoEF), New Delhi. MoEF formulates environmental policies and accords environmental clearance for the proposed, expansion/modernization of projects.

As per the Notification of the MoEF dated 14-09-2006 and its amendments, Environmental Clearance (EC) needs to be obtained from the MoEF for various identified industries. Any expansion or modernization of any activity shall not be undertaken in any part of India unless it is accorded environmental clearance by the central government in accordance with the procedures specified in this Notification. As per the procedure, anybody who desires to undertake any project in any part of India or expansion or modernization of any existing industry, a Detailed Project Report, which shall *inter alia* include an Environmental Impact Assessment (EIA) report, needs to be submitted.

In addition to the above requirements, the MoEF can notify certain areas as ecologically sensitive/fragile and all developmental projects which are to be located in these notified areas need to obtain EC. Areas so far notified include some coastal areas identified under the Coastal Regulation Zone Notification, forests, wildlife sanctuaries, national parks, wetlands and mangroves.

**ANNEXURE-III**
**ADMINISTRATIVE AND LEGISLATIVE BACKGROUND**

- ***The Hazardous Wastes (Management & Handling) Rules 2000***

These rules make the occupier and the occupier of a facility responsible for proper collection, reception, treatment, storage and disposal of hazardous wastes listed in schedule-1, 2, and 3.

This rule also recommends to obtain and renew the authorization to collection, reception, treatment, storage and disposal of hazardous wastes from state pollution control board (SPCB) by filing Form-1.

**Applicable Environmental Standards**

The MoEF has the overall responsibility to set policy and standards for the protection of environment along with Central Pollution Control Board (CPCB).

Ambient Air Quality Standards

The existing standards for National Ambient Air Quality (NAAQ), as prescribed by CPCB vide Gazette Notification S.O.384 (E) dated 11th April, 1994, which are applicable for land-based applications for onshore areas. The prescribed standards are presented below in **Table-1.**

**TABLE-1**
**NATIONAL AMBIENT AIR QUALITY STANDARDS**

| Pollutant | Time Weighted Average | Concentration in Ambient Air ($\mu g/m^3$) | | |
|---|---|---|---|---|
| | | Industrial Area | Residential, Rural & Other Areas | Sensitive Areas |
| Sulphur dioxide ($SO_2$) | Annual Average* | 80 | 60 | 15 |
| | 24 Hours** | 120 | 80 | 30 |
| Oxides of Nitrogen (NOx) | Annual Average* | 80 | 60 | 15 |
| | 24 Hours** | 120 | 80 | 30 |
| Suspended Particulate Matter (SPM) | Annual Average* | 360 | 140 | 70 |
| | 24 Hours** | 500 | 200 | 100 |
| Respirable Particulate Matter (Size less than 10 microns) | Annual Average* | 120 | 60 | 50 |
| | 24 Hours** | 150 | 100 | 75 |
| Lead (Pb) | Annual Average* | 1.0 | 0.75 | 0.50 |
| | 24 Hours** | 1.5 | 1.0 | 0.75 |
| Carbon monoxide (CO) | 8 Hours | 5000 | 2000 | 1000 |
| | 1 Hour** | 10000 | 4000 | 2000 |
| Ammonia | Annual Average* | 100 | 100 | 100 |
| | 24 Hours** | 400 | 400 | 400 |

*Note:*
* *Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.*
** *24 hourly/8 hourly values should be met 98% of the time in a year. However 2% of the time, it may exceed but not on two consecutive days.*

Noise Limits and Guidelines for Diesel Generators

- Noise from DG set shall be controlled by providing an acoustic enclosure or by treating the room acoustically, at the users end;
- The acoustic enclosure or acoustic treatment of the room shall be designed for minimum 25 dB (A) insertion loss or for meeting the ambient noise standards, whichever is on the higher side (if the actual ambient noise is on the higher

side, it may not be possible to check the performance of the acoustic enclosure/acoustic treatment. Under such circumstances the performance may be checked for noise reduction upto actual ambient noise level, preferably, in the nighttime). The measurement for Insertion Loss may be done at different points at 0.5 m from the acoustic enclosure/room, and then averaged;

- These limits shall be regulated by the State Pollution Control Boards and the State Pollution Control Committees;
- The manufacturer shall offer to the user a standard acoustic enclosure of 25 dB (A) insertion loss and also a suitable exhaust muffler with insertion loss of 25 dB (A);
- The user shall make efforts to bring down the noise levels due to the DG set, outside his premises, within the ambient noise requirements by proper siting and control measures;
- Installation of a DG set must be strictly in compliance with the recommendations of the DG set manufacturer; and
- A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

Ambient Noise Standards

Ambient standards with respect to noise have been notified by the Ministry of Environment and Forests vide gazette notification dated 26th December 1989 (amended in February, 2000). It is based on the 'A' weighted equivalent noise level ($L_{eq}$). The ambient noise standards are presented in **Table-2.**

**TABLE-2**
**AMBIENT NOISE STANDARDS**

| Area Code | Category of Area | Noise Levels dB(A) Leq | |
|---|---|---|---|
| | | Day time* | Night Time |
| A | Industrial Area | 75 | 70 |
| B | Commercial Area | 65 | 55 |
| C | Residential Area | 55 | 45 |
| D | Silence Zone** | 50 | 40 |

*Note:*

* *Daytime is from 7 am to 10 pm.*

** *Silence zone is defined as area up to 100 meters around premises of hospitals, educational institutions and courts. Use of vehicle horns, loud speakers and bursting of crackers are banned in these zones.*

Permissible Standards for Vibrations During Blasting

As per DGMS mines, depending on the type of structure and the dominant excitation frequency, the peak particle velocity (ppv) on the ground adjacent to the structure shall not exceed the values given in the **Table-3.**

## ANNEXURE-III
## ADMINISTRATIVE AND LEGISLATIVE BACKGROUND

### TABLE-3
### PERMISSIBLE PPV AT THE FOUNDATION LEVEL OF STRUCTURES IN MINING AREAS

| Type of structure | Dominant excitation Frequency, Hz | | |
|---|---|---|---|
| | <8 Hz | 8-25 Hz | >25 Hz |
| **I. Buildings/structures not belong to the owner** | | | |
| A. Domestic houses/structures (Kuchha, Brick, & Cement) | 5 | 10 | 15 |
| B. Industrial buildings (R.C.C & Framed structures) | 10 | 20 | 25 |
| C. Objects of historical importance & sensitive structures | 2 | 5 | 10 |
| **II. Buildings belonging to owner with limited span of life** | | | |
| A. Domestic houses/structures (Kuchha, Brick, & Cement) | 10 | 15 | 25 |
| B. Industrial buildings (R.C.C & Framed structures) | 15 | 25 | 50 |

Noise Standards for Occupational Exposure

Noise standards in the work environment are specified by Occupational Safety and Health Administration (OSHA-USA) which in-turn are being enforced by Government of India through model rules framed under Factories Act. These are given in **Table-4**.

### TABLE-4
### STANDARDS FOR OCCUPATIONAL EXPOSURE

| Total Time of Exposure per Day in Hours (Continuous or Short term Exposure) | Sound Pressure Level in dB(A) |
|---|---|
| 8 | 90 |
| 6 | 92 |
| 4 | 95 |
| 3 | 97 |
| 2 | 100 |
| 3/2 | 102 |
| 1 | 105 |
| ¾ | 107 |
| ½ | 110 |
| ¼ | 115 |
| Never | >115 |

*Note:*

1. *No exposure in excess of 115 dB(A) is to be permitted.*
2. *For any period of exposure falling in between any figure and the next higher or lower figure as indicated in column (1), the permissible level is to be determined by extrapolation on a proportionate scale.*

Wastewater Discharge Standards

The wastewater discharge standards as per EPA Notification (GSR 176 (E), April 1996) are given in **Table-5**.

## ANNEXURE-III
## ADMINISTRATIVE AND LEGISLATIVE BACKGROUND

### TABLE-1.5
### WASTE WATER DISCHARGE STANDARDS

| Sr. No. | List of Parameters | Units | Standard (On land Irrigation) | Standard (Surface Waters) |
|---|---|---|---|---|
| 1 | Colour and Odour | -- | All efforts should be made to remove colour and unpleasant odour as far as practicable. | All efforts should be made to remove colour and unpleasant odour as far as practicable. |
| 2 | Suspended Solids | mg/l | 200.0 | 100.0 |
| 3 | Particle size of Suspended Solids | -- | Shall pass 850 micron IS Sieve | Shall pass 850 micron IS Sieve |
| 4 | pH value | -- | 5.5 to 9.0 | 5.5 to 9.0 |
| 5 | Temperature | -- | Not Specified | Shall not exceed 5 °C above the receiving water temperature. |
| 6 | Oil and grease, Max. | mg/l | 10.0 | 10.0 |
| 7 | Total residual chlorine, Max. | mg/l | Not Specified | 1.0 |
| 8 | Ammonical nitrogen (as N), Max. | mg/l | Not Specified | 50 |
| 9 | Total Kjeldhal nitrogen (as N),Max | mg/l | Not Specified | 100 |
| 10 | Free ammonia (as $NH_3$), Max. | mg/l | Not Specified | 5 |
| 11 | Biochemical oxygen demand (3 days at 27□C), Max. | mg/l | 100.0 | 30.0 |
| 12 | Chemical oxygen demand, Max. | mg/l | Not Specified | 250 |
| 13 | Arsenic (as As), Max. | mg/l | 0.2 | 0.2 |
| 14 | Mercury (as Hg), Max. | mg/l | Not Specified | 0.01 |
| 15 | Lead (as Pb), Max. | mg/l | Not Specified | 0.1 |
| 16 | Cadmium (as Cd), Max. | mg/l | Not Specified | 2.0 |
| 17 | Hexavalent chromium (as $Cr^{+6}$), Max. | mg/l | Not Specified | 0.1 |
| 18 | Total chromium (as Cr), Max. | mg/l | Not Specified | 2.0 |
| 19 | Copper (as Cu), Max. | mg/l | Not Specified | 3.0 |
| 20 | Zinc (as Zn), Max. | mg/l | Not Specified | 5.0 |
| 21 | Selenium (as Se), Max. | mg/l | Not Specified | 0.05 |
| 22 | Nickel (as Ni), Max. | mg/l | Not Specified | 3.0 |
| 23 | Cyanide (as CN), Max. | mg/l | 0.2 | 0.2 |
| 24 | Fluorides as F | mg/l | Not Specified | 2.0 |
| 25 | Dissolved phosphates (as P),Max | mg/l | Not Specified | 5.0 |
| 26 | Sulphides as (S), Max. | mg/l | Not Specified | 2.0 |
| 27 | Phenolic compounds (as $C_2H_5OH$), | mg/l | Not Specified | 1.0 |
| 28 | Radioactive Materials | | | |
| A] | Alpha Emitters, Max. | µC/ml | $10^{-7}$ | $10^{-7}$ |
| B] | Beta Emitters, Max. | µC/ml | $10^{-7}$ | $10^{-6}$ |
| 29 | Bio-assay test | -- | 90% survival of fish after 96 hours in 100% effluent. | 90% survival of fish after 96 hours in 100% effluent. |
| 30 | Manganese (as Mn) | mg/l | Not Specified | 2.0 |
| 31 | Iron (as Fe) | mg/l | Not Specified | 3.0 |
| 32 | Vanadium (as V) | mg/l | Not Specified | 0.2 |
| 33 | Nitrate nitrogen | mg/l | Not Specified | 10.0 |

## ANNEXURE-IV
## EMISSION CALCULATIONS & ISOPLETHS

### 1.0 General Calculations

- ***Area Calculations***

$$Area\ (m^2) = \frac{3.142 \quad x \quad (Top\ Stack\ Diameter)^2}{4}$$

- ***Temperature Correction***

Temperature correction is calculated based on standard ambient temperature of 25° C.

$$Temperature \quad Corection = \frac{273 \ + \ 25^0\ C}{273 \ + \ Stack\ Temperature^0\ C}$$

- ***Volumetric Flow Rate***

$$\text{Volumetric flow } (\frac{\text{Nm}^3}{\text{s}}) = \text{Area } (\text{m}^2) \text{ x Exit Velocity } (\text{m / s}) \text{ x Temperature Correction}$$

- ***Emission Rate Calculations***

$$Emission\ Rate\ (\frac{g}{s}) = Limit\ (mg / Nm^3)\ x\ Volumetric\ flow\ (Nm^3 / s)\ x\ 10^{-3}$$

- ***Minimum Stack Height Calculation***

**1** *Based on Sulphur dioxide emissions*

Stack Height (m) = 14 $(Q)^{0.3}$
where Q = emission rate of Sulphur dioxide in Kg / hr

**2** *Based on Particulate Matter (PM) emissions*

$$Stack\ Height\ (m) = 74\ (Q)^{0.27}$$
$$where\ Q = emission\ rate\ of\ Particulate\ Matter\ in\ Tonnes / hr$$

When stacks are emitting both the pollutants i.e. $SO_2$ and PM, the stack height is calculated based on $SO_2$ emissions.

### 1.1 Emission Calculations for Proposed Aluminium Smelter

1.1.1 <u>Sulphur dioxide ($SO_2$) from Gas Treatment Plant</u>

| | | |
|---|---|---|
| Sulphur Emission | = | 3500 TPY (as per technical details given by Hindalco) |
| | = | 9589 kg/day |
| | = | 399.5 kg/hr |

= 110.9 gm/sec
= 55.4 gm/sec/Gas Treatment Plant (199.4 kg/hr)

- **Stack Height**

$$Stack\ Height\ (m) = 14\,(199.4)^{0.3} \quad = 68.55\ m$$

*where* $Q$ = *emission rate of Sulphur dioxide in Kg / hr*

1.1.2 Sulphur dioxide ($SO_2$) from Baking Furnace

| | | |
|---|---|---|
| Sulphur Emission | = | 650 TPY (as per technical details given by Hindalco) |
| | = | 1780.8 kg/day |
| | = | 74.2 kg/hr |
| | = | 20.6 gm/sec |

- **Stack Height**

$$Stack\ Height\ (m) = 14\,(74.2)^{0.3} \quad = 50\ m$$

*where* $Q$ = *emission rate of Sulphur dioxide in Kg / hr*

1.1.3 Particulate Matter Emissions

The pollution load of Particulate matter is calculated based on the norms specified by MoEF. The norms specified are given below:

| | | |
|---|---|---|
| Particulate matter in Green Anode Shop | : | 100 mg/Nm$^3$ |
| Particulate matter in Anode Bake oven | : | 50 mg/Nm$^3$ |
| Particulate matter in Pot room through FTP | : | 100 mg/Nm$^3$ |
| Dross recovery | : | 100 mg/Nm$^3$ |

⇒ **Particulate Matter through FTP**

$$Emission\ \ rate = 100\frac{mg}{Nm^3}\times 238.4\frac{Nm^3}{S}\times\frac{1}{1000} = 23.84\frac{g}{s}$$

**SPM emission from each FTP stack = 23.84 g/s**

⇒ **Particulate Matter through Baking Furnace**

$$Emission\ \ rate = 50\frac{mg}{Nm^3}\times 32.3\frac{Nm^3}{S}\times\frac{1}{1000} = 1.6\frac{g}{s}$$

**SPM emission from Baking Furnace stack = 1.6 g/s**

## ANNEXURE-IV
## EMISSION CALCULATIONS & ISOPLETHS

### 1.2 Emission Calculations for Proposed Power Plant (5 X 135 MW)

1.2.1 Sulphur dioxide ($SO_2$)

| | | |
|---|---|---|
| Coal Consumption | = | 399 TPH |
| | = | 399000 kg/hr |
| Sulphur content in coal | = | 0.5% |
| Sulphur dioxide emission factor | = | (0.50/100) x (64/32) = 0.01 |
| $SO_2$ emission rate | = | Emission factor x consumption of coal<br>0.01 x 399000= 3990 kg/hr |
| | = | **1108.3 gm/sec** |
| | = | **221 gm/sec/flue** |

1.2.2 Particulate Matter Emissions

- **Based on the Stipulated Limit**

The emission rate is computed based on the design limit of 100 mg/Nm$^3$.

$$Emission\ \ rate = 100\frac{mg}{Nm^3}\times 164\frac{Nm^3}{S}\times\frac{1}{1000} = 16.4\frac{g}{s}$$ **(for each flue)**

Total particulate emissions from CPP = 16.4 x 5 = **82 g/s**

1.2.3 NOx Emissions

9 kg of NOx emission per ton of coal consumed.

| | | |
|---|---|---|
| 9 kg x 399 tons/hr | = | 3591 kg/hr |
| | = | 997.5 gm/sec |
| | = | 199.7 gm/sec/flue |

### 1.3 Method adopted in Fluoride Monitoring

SPADNS method was adopted for monitoring of Fluoride in ambient air quality.

Colorimetric method is based on the reaction between Fluoride and Zirconium-dye lake. F reacts in the dye lake, dissociation a portion of it into a colourless anion (Zr $F_6^{-2}$) and the dye.

As the amount of fluoride increases, the colour produced becomes progressively lighter. The reaction rate between Fluoride and Zirconium ions is influenced by the acidity of the reaction mixture. If the proportion of the acid in the reagent is increased, the reaction can be made almost instantaneous.

The gaseous fluoride is absorbed into 0.1 N NaOH solution at 0.2 lpm. The solution is dried in a hot air oven at 600°C and fused with sodium hydroxide solution. After the fusion, it is dissolved in water pH is adjusted to 8 -9 with HCl and absorbance is detected using Zirconyl-SPADNS reagent at 580 nm.

Particulate fluoride is detected by ashing the filter paper and then fusing the ash as described above. The absorbance and concentration of fluoride will be detected as mentioned above.

# ANNEXURE-IV
## EMISSION CALCULATIONS & ISOPLETHS

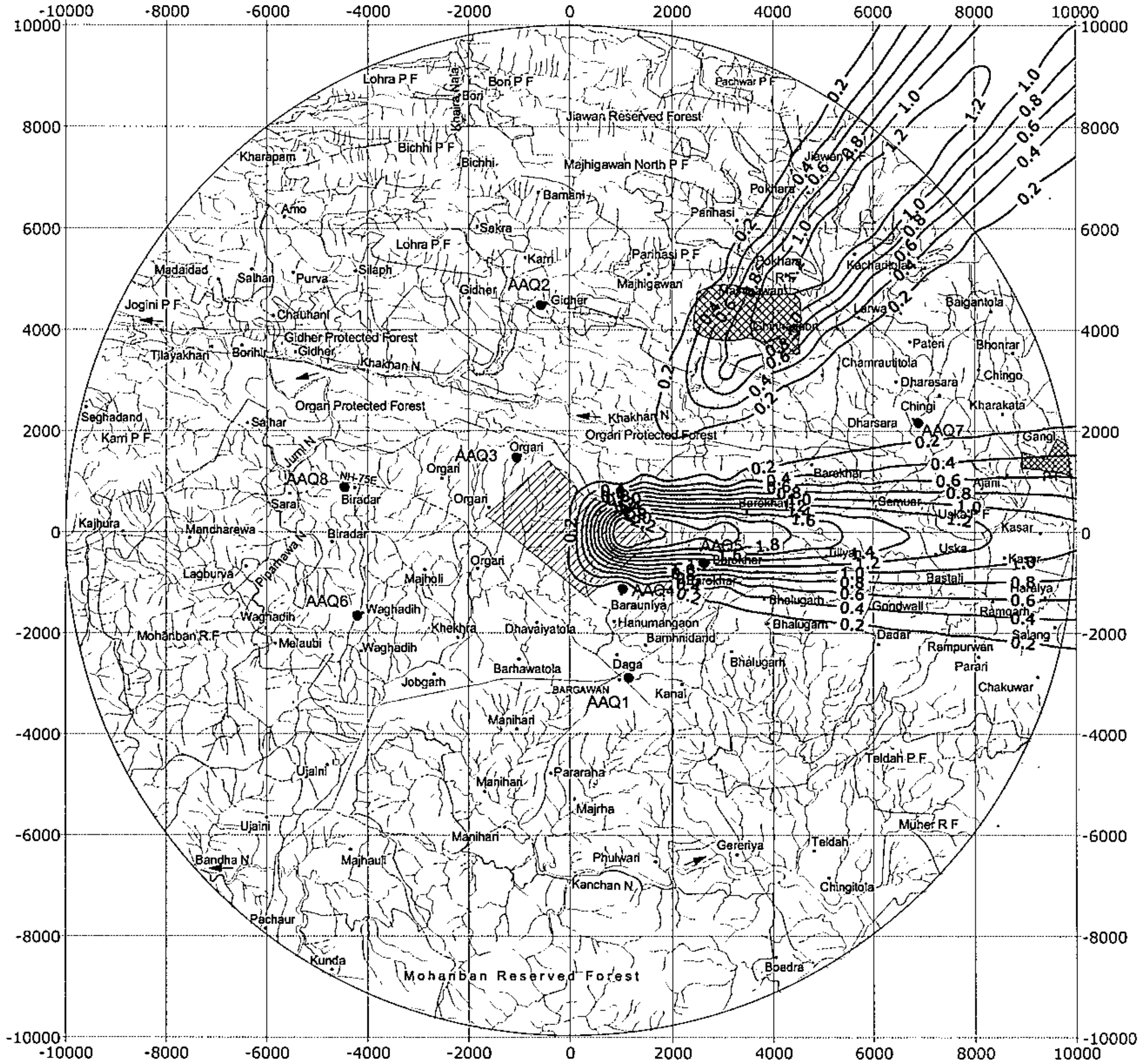



**FIGURE-1**
**SHORT TERM 24 HOURLY GLCs OF SPM (WINTER)**

## ANNEXURE-IV
## EMISSION CALCULATIONS & ISOPLETHS

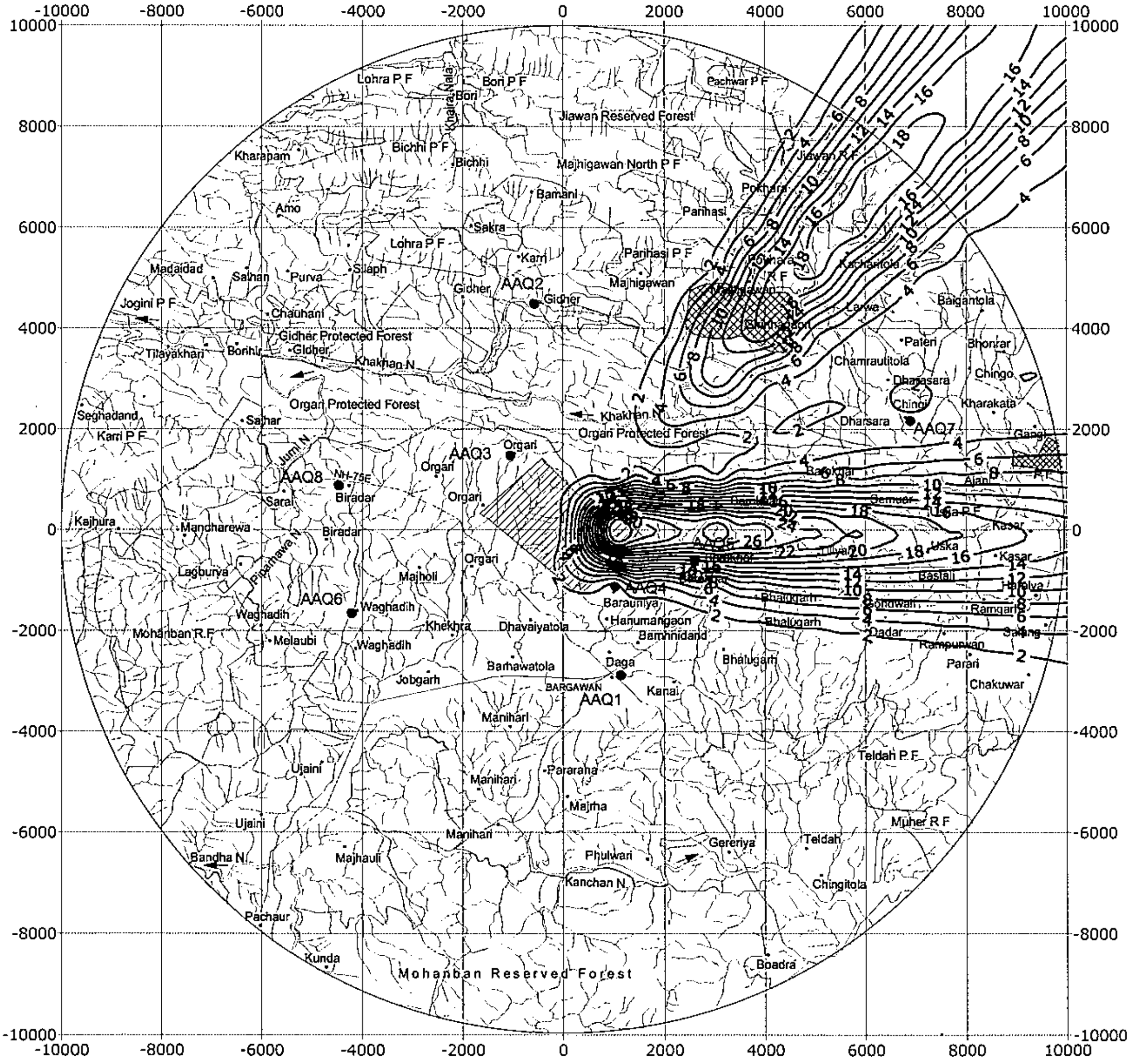


**FIGURE-2**
**SHORT TERM 24 HOURLY GLCs OF $SO_2$ (WINTER)**

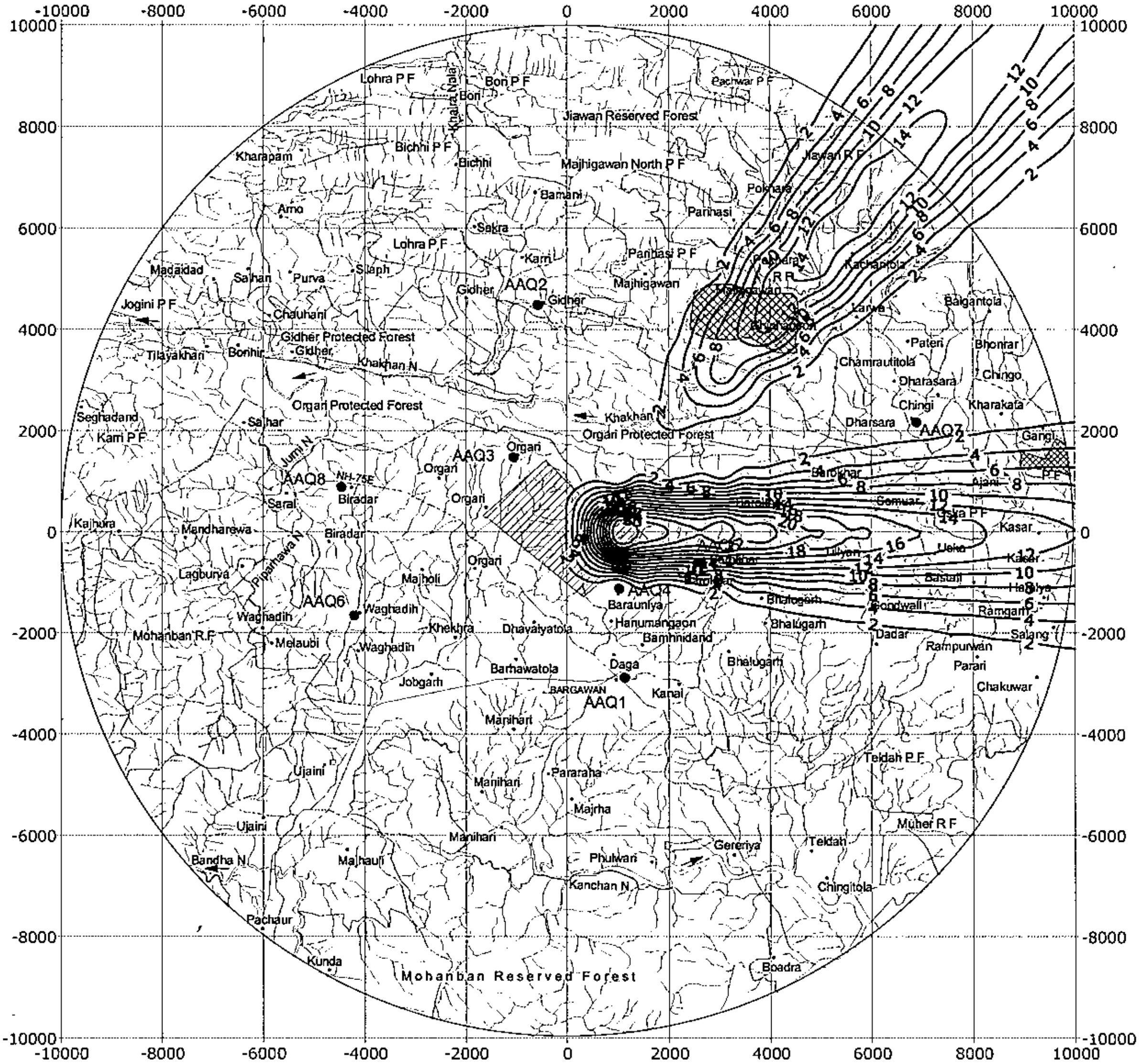



**FIGURE-3**
**SHORT TERM 24 HOURLY GLCs OF NOx (WINTER)**

# ANNEXURE-V
## LANDUSE PATTERN

| Sr. No. | Village Name | Forest land | Irrigated land | Un-Irrigated land | Cultivable Waste | Area unavailable for Cultivation | Total |
|---|---|---|---|---|---|---|---|
| **0-3 Km radius** | | | | | | | |
| 1 | Odagadi | 0.00 | 143.00 | 712.00 | 25.00 | 58.00 | 938.00 |
| 2 | Khekhada | 0.00 | 73.00 | 343.00 | 38.00 | 52.00 | 506.00 |
| 3 | Dhaudar | 0.00 | 60.00 | 400.00 | 1.00 | 126.00 | 587.00 |
| 4 | Barainia | 0.00 | 55.00 | 344.00 | 10.00 | 169.00 | 578.00 |
| 5 | Badokhar | 0.00 | 28.00 | 402.00 | 416.00 | 4.00 | 850.00 |
| 6 | Barhawatola | 0.00 | 38.00 | 293.00 | 200.00 | 114.00 | 645.00 |
| **3-7 Km radius** | | | | | | | |
| 7 | Betahadand | 0.00 | 7.00 | 16.00 | 187.00 | 128.00 | 338.00 |
| 8 | Baghadih | 0.00 | 12.00 | 799.00 | 123.00 | 315.00 | 1249.00 |
| 9 | Jobgarh | 0.00 | 12.00 | 214.00 | 131.00 | 100.00 | 457.00 |
| 10 | Bhalugarh | 0.00 | 44.00 | 650.00 | 19.00 | 44.00 | 757.00 |
| 11 | Godwali | 0.00 | 36.00 | 737.00 | 95.00 | 107.00 | 975.00 |
| 12 | Kanai | 0.00 | 12.00 | 200.00 | 120.00 | 180.00 | 512.00 |
| 13 | Bargawan | 628.00 | 0.00 | 532.00 | 801.00 | 16.00 | 1977.00 |
| 14 | Daga | 0.00 | 4.00 | 52.00 | 120.00 | 517.00 | 693.00 |
| 15 | Dadar | 0.00 | 18.00 | 267.00 | 67.00 | 3.00 | 355.00 |
| 16 | Gidher | 0.00 | 1.00 | 508.00 | 269.00 | 62.00 | 840.00 |
| 17 | Karri | 0.00 | 12.00 | 365.00 | 266.00 | 42.00 | 685.00 |
| 18 | Ghinhagaon | 0.00 | 39.00 | 276.00 | 58.00 | 5.00 | 378.00 |
| 19 | Majhigawan | 37.00 | 39.00 | 114.00 | 33.00 | 59.00 | 282.00 |
| **7-10 Km radius** | | | | | | | |
| 20 | Chhadna | 0.00 | 1.00 | 94.00 | 61.00 | 6.00 | 162.00 |
| 21 | Talwa | 0.00 | 8.00 | 308.00 | 218.00 | 57.00 | 591.00 |
| 22 | Ujjaini | 0.00 | 71.00 | 411.00 | 266.00 | 77.00 | 825.00 |
| 23 | Majhauli | 0.00 | 87.00 | 181.00 | 205.00 | 109.00 | 582.00 |
| 24 | Kunda | 0.00 | 21.00 | 61.00 | 30.00 | 19.00 | 131.00 |
| 25 | Manihari | 0.00 | 61.00 | 121.00 | 400.00 | 307.00 | 889.00 |
| 26 | Rampurwa | 864.00 | 0.00 | 448.00 | 987.00 | 26.00 | 2325.00 |
| 27 | Bodi | 0.00 | 16.00 | 106.00 | 21.00 | 41.00 | 184.00 |
| 28 | Birchhi | 0.00 | 3.00 | 69.00 | 22.00 | 13.00 | 107.00 |
| 29 | Parihasi | 0.00 | 5.00 | 201.00 | 79.00 | 65.00 | 350.00 |
| 30 | Pokhara | 0.00 | 78.00 | 426.00 | 40.00 | 2.00 | 546.00 |
| 31 | Silaph | 0.00 | 2.00 | 172.00 | 175.00 | 94.00 | 443.00 |
| 32 | Amo | 0.00 | 10.00 | 297.00 | 116.00 | 31.00 | 454.00 |
| 33 | Jharia | 0.00 | 0.00 | 53.00 | 16.00 | 17.00 | 86.00 |
| 34 | Purwa Jagir | 0.00 | 9.00 | 485.00 | 75.00 | 127.00 | 696.00 |
| 35 | Sajhar | 0.00 | 6.00 | 196.00 | 198.00 | 110.00 | 510.00 |
| 36 | Sarvo | 0.00 | 16.00 | 180.00 | 10.00 | 28.00 | 234.00 |
| 37 | Bastali Abad | 0.00 | 1.00 | 14.00 | 0.00 | 4.00 | 19.00 |
| 38 | Bastali Viran | 0.00 | 4.00 | 27.00 | 16.00 | 0.00 | 47.00 |
| 39 | Uska | 0.00 | 21.00 | 49.00 | 2.00 | 3.00 | 75.00 |
| 40 | Jamual | 0.00 | 10.00 | 27.00 | 1.00 | 9.00 | 47.00 |
| 41 | Semuar | 0.00 | 33.00 | 369.00 | 20.00 | 31.00 | 453.00 |
| 42 | Ajani | 0.00 | 40.00 | 78.00 | 6.00 | 9.00 | 133.00 |
| 43 | Pali | 0.00 | 52.00 | 83.00 | 7.00 | 16.00 | 158.00 |
| 44 | Dhasada | 0.00 | 30.00 | 45.00 | 392.00 | 37.00 | 504.00 |
| 45 | Sapaha | 0.00 | 5.00 | 75.00 | 0.00 | 9.00 | 89.00 |
| 46 | Pateri | 0.00 | 34.00 | 82.00 | 6.00 | 18.00 | 140.00 |
| 47 | Larwa | 0.00 | 98.00 | 12.00 | 32.00 | 0.00 | 142.00 |
| 48 | Kacharitola | 0.00 | 3.00 | 17.00 | 53.00 | 5.00 | 78.00 |
| 49 | Chingi | 0.00 | 18.00 | 37.00 | 6.00 | 0.00 | 61.00 |
| 50 | Chingo | 70.00 | 47.00 | 156.00 | 0.00 | 31.00 | 304.00 |
| 51 | Kharkata | 0.00 | 12.00 | 151.00 | 47.00 | 30.00 | 240.00 |
| **TOTAL** | | **1599.00** | **1435.00** | **12255.00** | **6486.00** | **3432.00** | **25207.00** |

# ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (WINTER SEASON)

| AAQ-1 Bargawan Village | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date of Monitoring | TSPM (µg/m3) | RPM (µg/m3) | SO2 (µg/m3) | Nox (µg/m3) | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | CO | | |
| 04.12.2007 | 137.2 | 37.3 | 7.7 | 9.1 | <0.1 | <0.01 | 385 | 393 | 382 |
| 05.12.2007 | 141.9 | 41.1 | 8.4 | 9.5 | <0.1 | <0.01 | 376 | 384 | 373 |
| 11.12.2007 | 138.2 | 38.6 | 9.1 | 9.1 | <0.1 | <0.01 | 365 | 373 | 363 |
| 12.12.2007 | 133.1 | 35.6 | 7.4 | 8.6 | <0.1 | <0.01 | 366 | 372 | 365 |
| 18.12.2007 | 128.5 | 37.5 | 8.3 | 8.9 | <0.1 | <0.01 | 392 | 396 | 389 |
| 19.12.2007 | 136.4 | 43.2 | 7.6 | 9.2 | <0.1 | <0.01 | 397 | 388 | 394 |
| 25.12.2007 | 129.2 | 36.8 | 8.3 | 9.5 | <0.1 | <0.01 | 381 | 389 | 378 |
| 26.12.2007 | 118.3 | 30.4 | 9.3 | 8.7 | <0.1 | <0.01 | 362 | 369 | 359 |
| 02.01.2008 | 122.8 | 29.7 | 9.1 | 8.1 | <0.1 | <0.01 | 375 | 383 | 378 |
| 03.01.2008 | 121.7 | 37.4 | 9.6 | 8.9 | <0.1 | <0.01 | 377 | 385 | 374 |
| 09.01.2008 | 116.6 | 33.7 | 7.8 | 8.4 | <0.1 | <0.01 | 384 | 392 | 381 |
| 10.01.2008 | 131.2 | 34.8 | 8.6 | 8.2 | <0.1 | <0.01 | 376 | 384 | 373 |
| 16.01.2008 | 127.5 | 40.8 | 7.8 | 9.6 | <0.1 | <0.01 | 374 | 381 | 371 |
| 17.01.2008 | 133.9 | 44.2 | 8.4 | 9.1 | <0.1 | <0.01 | 392 | 398 | 389 |
| 23.01.2008 | 123.1 | 32.3 | 9.6 | 8.9 | <0.1 | <0.01 | 391 | 391 | 388 |
| 24.01.2008 | 143.7 | 44.8 | 8.7 | 8.8 | <0.1 | <0.01 | 386 | 394 | 383 |
| 30.01.2008 | 139.4 | 38.6 | 9.2 | 8.2 | <0.1 | <0.01 | 388 | 396 | 385 |
| 31.01.2008 | 125.6 | 41.2 | 7.6 | 8.1 | <0.1 | <0.01 | 379 | 387 | 376 |
| 06.02.2008 | 127.8 | 37.4 | 8.1 | 8.5 | <0.1 | <0.01 | 371 | 378 | 368 |
| 07.02.2008 | 122.3 | 38.1 | 8.7 | 8.3 | <0.1 | <0.01 | 366 | 373 | 363 |
| 13.02.2008 | 117.9 | 32.7 | 9.2 | 8.3 | <0.1 | <0.01 | 364 | 371 | 361 |
| 14.02.2008 | 114.5 | 34.6 | 9.6 | 9.6 | <0.1 | <0.01 | 372 | 379 | 369 |
| 20.02.2008 | 126.7 | 37.2 | 9.3 | 8.3 | <0.1 | <0.01 | 377 | 385 | 374 |
| 21.02.2008 | 134.6 | 42.7 | 8.4 | 9.3 | <0.1 | <0.01 | 381 | 389 | 378 |
| 27.02.2008 | 127.8 | 38.2 | 9.3 | 9.9 | <0.1 | <0.01 | 392 | 385 | 389 |
| 28.02.2008 | 125.9 | 40.2 | 9.6 | 8.6 | <0.1 | <0.01 | 383 | 391 | 380 |
| | | | | | | | | | |
| **Max** | **143.7** | **44.8** | **9.6** | **9.9** | <0.1 | <0.01 | | **398.0** | |
| **Min** | **114.5** | **29.7** | **7.4** | **8.1** | <0.1 | <0.01 | | **369.0** | |
| **Average** | **128.7** | **37.7** | **8.6** | **8.8** | <0.1 | <0.01 | | **384.8** | |
| **98 % tile** | **142.8** | **44.5** | **9.6** | **9.8** | <0.1 | <0.01 | | **397.0** | |

**ANNEXURE-VI**
**AMBIENT AIR QUALITY LEVELS (WINTER SEASON)**

AAQ-2 Gidher Village

| Date of Monitoring | TSPM (µg/m3) | RPM (µg/m3) | SO2 (µg/m3) | Nox (µg/m3) | Fluoride (µg/m³) | PAH (µg/m³) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.12.2007 | 106.2 | 30.8 | 8.2 | 9.5 | <0.1 | <0.01 | 277 | 271 | 260 |
| 05.12.2007 | 109.9 | 31.9 | 8.5 | 8.9 | <0.1 | <0.01 | 271 | 265 | 254 |
| 11.12.2007 | 107.0 | 24.1 | 8.5 | 9.1 | <0.1 | <0.01 | 263 | 257 | 247 |
| 12.12.2007 | 103.1 | 28.9 | 8.9 | 9.2 | <0.1 | <0.01 | 264 | 259 | 248 |
| 18.12.2007 | 99.5 | 28.3 | 9.0 | 9.3 | <0.1 | <0.01 | 282 | 273 | 265 |
| 19.12.2007 | 105.6 | 23.7 | 8.1 | 9.1 | <0.1 | <0.01 | 286 | 268 | 268 |
| 25.12.2007 | 100.0 | 22.8 | 8.8 | 8.8 | <0.1 | <0.01 | 274 | 266 | 257 |
| 26.12.2007 | 91.6 | 26.6 | 7.6 | 8.5 | <0.1 | <0.01 | 261 | 255 | 251 |
| 02.01.2008 | 95.1 | 27.6 | 8.2 | 9.0 | <0.1 | <0.01 | 270 | 264 | 257 |
| 03.01.2008 | 94.2 | 24.9 | 8.1 | 8.4 | <0.1 | <0.01 | 271 | 265 | 254 |
| 09.01.2008 | 90.3 | 26.2 | 8.8 | 9.2 | <0.1 | <0.01 | 276 | 270 | 259 |
| 10.01.2008 | 101.6 | 29.4 | 8.9 | 8.6 | <0.1 | <0.01 | 272 | 263 | 253 |
| 16.01.2008 | 98.7 | 28.2 | 8.4 | 8.9 | <0.1 | <0.01 | 269 | 269 | 265 |
| 17.01.2008 | 103.7 | 30.2 | 9.2 | 8.5 | <0.1 | <0.01 | 283 | 275 | 269 |
| 23.01.2008 | 95.3 | 27.6 | 8.3 | 9.4 | <0.1 | <0.01 | 282 | 270 | 264 |
| 24.01.2008 | 111.3 | 22.3 | 8.7 | 9.2 | <0.1 | <0.01 | 278 | 272 | 271 |
| 30.01.2008 | 107.9 | 31.3 | 9.1 | 8.3 | <0.1 | <0.01 | 279 | 273 | 262 |
| 31.01.2008 | 97.3 | 28.2 | 8.1 | 8.9 | <0.1 | <0.01 | 273 | 267 | 256 |
| 06.02.2008 | 99.0 | 27.8 | 8.6 | 9.8 | <0.1 | <0.01 | 267 | 261 | 258 |
| 07.02.2008 | 94.7 | 25.7 | 9.2 | 9.1 | <0.1 | <0.01 | 264 | 257 | 253 |
| 13.02.2008 | 91.3 | 26.7 | 8.9 | 8.8 | <0.1 | <0.01 | 262 | 256 | 254 |
| 14.02.2008 | 88.7 | 21.6 | 8.4 | 9.3 | <0.1 | <0.01 | 268 | 262 | 261 |
| 20.02.2008 | 98.1 | 20.7 | 9.0 | 8.4 | <0.1 | <0.01 | 271 | 266 | 267 |
| 21.02.2008 | 104.2 | 30.2 | 8.8 | 9.2 | <0.1 | <0.01 | 274 | 268 | 263 |
| 27.02.2008 | 99.0 | 27.5 | 9.2 | 9.4 | <0.1 | <0.01 | 282 | 261 | 265 |
| 28.02.2008 | 97.5 | 28.7 | 7.9 | 9.0 | <0.1 | <0.01 | 276 | 270 | 259 |
| | | | | | | | | | |
| **Max** | **111.3** | **31.9** | **9.2** | **9.8** | <0.1 | <0.01 | | **286.0** | |
| **Min** | **88.7** | **20.7** | **7.6** | **8.3** | <0.1 | <0.01 | | **247.0** | |
| **Average** | **88.7** | **20.7** | **8.6** | **9.0** | <0.1 | <0.01 | | **265.9** | |
| **98 % tile** | **110.6** | **31.6** | **9.2** | **9.7** | <0.1 | <0.01 | | **282.5** | |

# ANNEXURE-VI
# AMBIENT AIR QUALITY LEVELS (WINTER SEASON)

**AAQ-3 Orgari Village**

| Date of Monitoring | TSPM (µg/m3) | RPM (µg/m3) | SO2 (µg/m3) | Nox (µg/m3) | Fluoride $(\mu g/m^3)$ | PAH $(\mu g/m^3)$ | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.12.2007 | 93.2 | 28.6 | 7.8 | 8.9 | <0.1 | <0.01 | 291 | 276 | 278 |
| 05.12.2007 | 84.9 | 31.4 | 8.3 | 9.5 | <0.1 | <0.01 | 285 | 270 | 272 |
| 11.12.2007 | 88.7 | 26.3 | 9.4 | 9.3 | <0.1 | <0.01 | 276 | 262 | 264 |
| 12.12.2007 | 92.1 | 24.3 | 8.3 | 9.1 | <0.1 | <0.01 | 277 | 264 | 265 |
| 18.12.2007 | 79.5 | 26.8 | 9.1 | 9.2 | <0.1 | <0.01 | 296 | 278 | 284 |
| 19.12.2007 | 75.2 | 22.3 | 7.7 | 8.4 | <0.1 | <0.01 | 300 | 273 | 287 |
| 25.12.2007 | 86.3 | 25.8 | 8.4 | 7.9 | <0.1 | <0.01 | 288 | 271 | 275 |
| 26.12.2007 | 91.3 | 31.2 | 9.1 | 8.3 | <0.1 | <0.01 | 274 | 260 | 269 |
| 02.01.2008 | 91.7 | 28.5 | 9.5 | 8.4 | <0.1 | <0.01 | 284 | 269 | 275 |
| 03.01.2008 | 83.2 | 25.6 | 9.1 | 9.4 | <0.1 | <0.01 | 285 | 270 | 272 |
| 09.01.2008 | 78.6 | 21.4 | 7.5 | 9.2 | <0.1 | <0.01 | 290 | 275 | 277 |
| 10.01.2008 | 89.5 | 27.3 | 8.2 | 8.6 | <0.1 | <0.01 | 286 | 268 | 271 |
| 16.01.2008 | 84.6 | 29.1 | 7.1 | 8.3 | <0.1 | <0.01 | 282 | 274 | 284 |
| 17.01.2008 | 72.9 | 21.5 | 8.3 | 8.0 | <0.1 | <0.01 | 297 | 281 | 288 |
| 23.01.2008 | 86.7 | 26.2 | 9.2 | 9.2 | <0.1 | <0.01 | 296 | 275 | 282 |
| 24.01.2008 | 85.8 | 28.3 | 8.4 | 7.9 | <0.1 | <0.01 | 292 | 277 | 290 |
| 30.01.2008 | 78.9 | 25.4 | 9.2 | 9.3 | <0.1 | <0.01 | 293 | 278 | 280 |
| 31.01.2008 | 81.5 | 29.1 | 7.2 | 9.6 | <0.1 | <0.01 | 287 | 272 | 274 |
| 06.02.2008 | 77.6 | 26.5 | 9.0 | 8.4 | <0.1 | <0.01 | 280 | 266 | 276 |
| 07.02.2008 | 84.7 | 28.3 | 8.3 | 7.9 | <0.1 | <0.01 | 277 | 262 | 271 |
| 13.02.2008 | 93.4 | 29.7 | 9.5 | 9.3 | <0.1 | <0.01 | 275 | 261 | 272 |
| 14.02.2008 | 88.5 | 28.9 | 9.1 | 9.4 | <0.1 | <0.01 | 281 | 267 | 276 |
| 20.02.2008 | 85.6 | 22.7 | 8.7 | 8.9 | <0.1 | <0.01 | 285 | 271 | 285 |
| 21.02.2008 | 73.8 | 24.2 | 8.4 | 9.3 | <0.1 | <0.01 | 288 | 273 | 281 |
| 27.02.2008 | 77.9 | 22.3 | 9.3 | 9.7 | <0.1 | <0.01 | 296 | 266 | 284 |
| 28.02.2008 | 81.2 | 28.6 | 8.9 | 8.6 | <0.1 | <0.01 | 290 | 275 | 277 |
| | | | | | | | | | |
| **Max** | **93.4** | **31.4** | **9.5** | **9.7** | <0.1 | <0.01 | | **300.0** | |
| **Min** | **72.9** | **21.4** | **7.1** | **7.9** | <0.1 | <0.01 | | **260.0** | |
| **Average** | **84.1** | **26.6** | **8.6** | **8.8** | <0.1 | <0.01 | | **278.1** | |
| **98 % tile** | **93.3** | **31.3** | **9.5** | **9.7** | <0.1 | <0.01 | | **296.5** | |

# ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (WINTER SEASON)

AAQ-4 Barauniya Village

| Date of Monitoring | TSPM (µg/m3) | RPM (µg/m3) | SO2 (µg/m3) | Nox (µg/m3) | Fluoride (µg/m³) | PAH (µg/m³) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.12.2007 | 98.5 | 28.1 | 7.3 | 9.6 | <0.1 | <0.01 | 308 | 289 | 318 |
| 05.12.2007 | 102.8 | 29.3 | 7.9 | 9.3 | <0.1 | <0.01 | 302 | 283 | 311 |
| 11.12.2007 | 95.3 | 27.5 | 8.3 | 8.5 | <0.1 | <0.01 | 293 | 275 | 302 |
| 12.12.2007 | 88.7 | 26.6 | 9.1 | 8.6 | <0.1 | <0.01 | 294 | 277 | 304 |
| 18.12.2007 | 76.5 | 23.4 | 7.2 | 9.1 | <0.1 | <0.01 | 314 | 291 | 316 |
| 19.12.2007 | 74.6 | 22.2 | 7.2 | 9.2 | <0.1 | <0.01 | 318 | 286 | 298 |
| 25.12.2007 | 89.7 | 26.9 | 7.2 | 9.0 | <0.1 | <0.01 | 305 | 284 | 312 |
| 26.12.2007 | 94.5 | 28.4 | 8.2 | 8.4 | <0.1 | <0.01 | 290 | 291 | 292 |
| 02.01.2008 | 101.2 | 31.4 | 7.5 | 8.6 | <0.1 | <0.01 | 301 | 282 | 310 |
| 03.01.2008 | 76.5 | 23.5 | 7.5 | 8.8 | <0.1 | <0.01 | 302 | 285 | 317 |
| 09.01.2008 | 87.8 | 26.7 | 7.9 | 9.2 | <0.1 | <0.01 | 307 | 288 | 287 |
| 10.01.2008 | 98.7 | 29.8 | 7.6 | 8.9 | <0.1 | <0.01 | 303 | 281 | 309 |
| 16.01.2008 | 99.2 | 28.9 | 8.3 | 9.5 | <0.1 | <0.01 | 299 | 287 | 316 |
| 17.01.2008 | 89.3 | 26.7 | 8.9 | 8.6 | <0.1 | <0.01 | 315 | 294 | 289 |
| 23.01.2008 | 96.7 | 29.3 | 7.1 | 9.0 | <0.1 | <0.01 | 314 | 289 | 317 |
| 24.01.2008 | 69.8 | 21.2 | 8.7 | 8.7 | <0.1 | <0.01 | 310 | 290 | 288 |
| 30.01.2008 | 73.4 | 22.5 | 8.6 | 8.5 | <0.1 | <0.01 | 311 | 297 | 320 |
| 31.01.2008 | 81.8 | 24.6 | 7.1 | 8.9 | <0.1 | <0.01 | 306 | 286 | 313 |
| 06.02.2008 | 85.9 | 25.8 | 8.7 | 9.6 | <0.1 | <0.01 | 297 | 279 | 307 |
| 07.02.2008 | 103.6 | 31.2 | 7.8 | 8.6 | <0.1 | <0.01 | 294 | 275 | 302 |
| 13.02.2008 | 94.8 | 24.8 | 8.5 | 9.4 | <0.1 | <0.01 | 292 | 277 | 301 |
| 14.02.2008 | 99.6 | 26.1 | 7.6 | 9.2 | <0.1 | <0.01 | 298 | 280 | 308 |
| 20.02.2008 | 101.5 | 30.8 | 9.2 | 8.7 | <0.1 | <0.01 | 302 | 284 | 315 |
| 21.02.2008 | 103.2 | 31.2 | 8.9 | 8.5 | <0.1 | <0.01 | 305 | 286 | 298 |
| 27.02.2008 | 92.4 | 28.9 | 7.8 | 9.6 | <0.1 | <0.01 | 314 | 279 | 296 |
| 28.02.2008 | 89.1 | 27.8 | 7.2 | 9.4 | <0.1 | <0.01 | 307 | 288 | 291 |
| | | | | | | | | | |
| **Max** | **103.6** | **31.4** | **9.2** | **9.6** | <0.1 | <0.01 | | **320.0** | |
| **Min** | **69.8** | **21.2** | **7.1** | **8.4** | <0.1 | <0.01 | | **275.0** | |
| **Average** | **91.0** | **27.1** | **8.0** | **9.0** | <0.1 | <0.01 | | **298.0** | |
| **98 % tile** | **103.4** | **31.3** | **9.2** | **9.6** | <0.1 | <0.01 | | **318.0** | |

## ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (WINTER SEASON)

**AAQ-5 Barokhar Village**

| Date of Monitoring | TSPM (μg/m3) | RPM (μg/m3) | SO2 (μg/m3) | Nox (μg/m3) | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.12.2007 | 99.6 | 30.3 | 7.3 | 9.1 | <0.1 | <0.01 | 302 | 299 | 301 |
| 05.12.2007 | 100.8 | 32.1 | 8.1 | 8.8 | <0.1 | <0.01 | 313 | 310 | 311 |
| 11.12.2007 | 95.2 | 29.1 | 7.2 | 8.6 | <0.1 | <0.01 | 318 | 315 | 316 |
| 12.12.2007 | 89.6 | 28.7 | 6.9 | 9.0 | <0.1 | <0.01 | 298 | 295 | 296 |
| 18.12.2007 | 87.3 | 27.6 | 7.5 | 9.1 | <0.1 | <0.01 | 303 | 300 | 301 |
| 19.12.2007 | 78.5 | 24.3 | 7.2 | 8.7 | <0.1 | <0.01 | 301 | 298 | 298 |
| 25.12.2007 | 79.4 | 26.4 | 8.1 | 8.9 | <0.1 | <0.01 | 317 | 314 | 315 |
| 26.12.2007 | 82.3 | 25.1 | 7.2 | 9.5 | <0.1 | <0.01 | 315 | 312 | 312 |
| 02.01.2008 | 81.6 | 23.5 | 8.3 | 9.1 | <0.1 | <0.01 | 293 | 290 | 292 |
| 03.01.2008 | 95.1 | 29.7 | 7.6 | 8.7 | <0.1 | <0.01 | 297 | 294 | 296 |
| 09.01.2008 | 88.2 | 27.8 | 8.2 | 9.5 | <0.1 | <0.01 | 299 | 296 | 297 |
| 10.01.2008 | 101.8 | 32.1 | 9.1 | 8.3 | <0.1 | <0.01 | 306 | 303 | 304 |
| 16.01.2008 | 97.3 | 31.2 | 9.5 | 9.9 | <0.1 | <0.01 | 314 | 311 | 312 |
| 17.01.2008 | 87.5 | 28.7 | 7.6 | 8.9 | <0.1 | <0.01 | 319 | 316 | 317 |
| 23.01.2008 | 94.6 | 29.1 | 7.1 | 8.1 | <0.1 | <0.01 | 325 | 322 | 323 |
| 24.01.2008 | 81.4 | 25.3 | 7.4 | 9.4 | <0.1 | <0.01 | 323 | 320 | 321 |
| 30.01.2008 | 88.7 | 27.2 | 8.9 | 9.3 | <0.1 | <0.01 | 305 | 302 | 303 |
| 31.01.2008 | 93.9 | 28.7 | 7.9 | 9.7 | <0.1 | <0.01 | 308 | 305 | 306 |
| 06.02.2008 | 84.5 | 26.8 | 7.3 | 7.9 | <0.1 | <0.01 | 296 | 293 | 295 |
| 07.02.2008 | 79.5 | 24.5 | 8.1 | 9.8 | <0.1 | <0.01 | 293 | 290 | 292 |
| 13.02.2008 | 68.4 | 22.1 | 7.8 | 9.9 | <0.1 | <0.01 | 318 | 315 | 316 |
| 14.02.2008 | 73.8 | 23.4 | 8.2 | 8.1 | <0.1 | <0.01 | 319 | 318 | 317 |
| 20.02.2008 | 67.7 | 22.5 | 7.3 | 8.9 | <0.1 | <0.01 | 307 | 304 | 305 |
| 21.02.2008 | 75.2 | 23.6 | 7.5 | 9.4 | <0.1 | <0.01 | 315 | 312 | 310 |
| 27.02.2008 | 83.5 | 25.7 | 8.1 | 9.3 | <0.1 | <0.01 | 319 | 319 | 317 |
| 28.02.2008 | 91.1 | 27.9 | 7.8 | 9.0 | <0.1 | <0.01 | 323 | 320 | 321 |
| | | | | | | | | | |
| **Max** | **101.8** | **32.1** | **9.5** | **9.9** | <0.1 | <0.01 | | **325.0** | |
| **Min** | **67.7** | **22.1** | **6.9** | **7.9** | <0.1 | <0.01 | | **290.0** | |
| **Average** | **86.4** | **27.1** | **7.8** | **9.0** | <0.1 | <0.01 | | **307.9** | |
| **98 % tile** | **101.3** | **32.1** | **9.3** | **9.9** | <0.1 | <0.01 | | **323.0** | |

# ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (WINTER SEASON)

**AAQ-6 Waghadih Village**

| Date of Monitoring | TSPM (µg/m3) | RPM (µg/m3) | SO2 (µg/m3) | Nox (µg/m3) | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.12.2007 | 78.5 | 23.4 | 6.5 | 8.5 | <0.1 | <0.01 | 291 | 279 | 274 |
| 05.12.2007 | 92.3 | 28.5 | 7.4 | 8.9 | <0.1 | <0.01 | 285 | 273 | 267 |
| 11.12.2007 | 97.6 | 26.5 | 7.8 | 7.9 | <0.1 | <0.01 | 276 | 265 | 265 |
| 12.12.2007 | 100.5 | 32.1 | 8.1 | 9.4 | <0.1 | <0.01 | 277 | 267 | 261 |
| 18.12.2007 | 88.6 | 27.5 | 7.9 | 9.2 | <0.1 | <0.01 | 296 | 281 | 276 |
| 19.12.2007 | 68.7 | 21.2 | 6.9 | 8.4 | <0.1 | <0.01 | 300 | 276 | 271 |
| 25.12.2007 | 79.4 | 23.6 | 6.6 | 7.8 | <0.1 | <0.01 | 288 | 274 | 269 |
| 26.12.2007 | 92.3 | 26.8 | 6.5 | 9.1 | <0.1 | <0.01 | 274 | 263 | 266 |
| 02.01.2008 | 84.5 | 25.4 | 7.3 | 8.4 | <0.1 | <0.01 | 284 | 272 | 268 |
| 03.01.2008 | 72.1 | 21.7 | 7.5 | 8.9 | <0.1 | <0.01 | 285 | 277 | 262 |
| 09.01.2008 | 85.2 | 24.6 | 7.8 | 8.2 | <0.1 | <0.01 | 290 | 281 | 273 |
| 10.01.2008 | 93.4 | 27.2 | 8.1 | 8.7 | <0.1 | <0.01 | 286 | 272 | 265 |
| 16.01.2008 | 86.5 | 25.3 | 8.0 | 9.1 | <0.1 | <0.01 | 282 | 277 | 272 |
| 17.01.2008 | 88.2 | 26.5 | 7.8 | 9.5 | <0.1 | <0.01 | 297 | 283 | 278 |
| 23.01.2008 | 83.7 | 24.3 | 6.8 | 8.4 | <0.1 | <0.01 | 293 | 278 | 273 |
| 24.01.2008 | 96.4 | 28.9 | 6.5 | 7.8 | <0.1 | <0.01 | 288 | 280 | 275 |
| 30.01.2008 | 91.5 | 26.7 | 6.1 | 9.3 | <0.1 | <0.01 | 293 | 281 | 282 |
| 31.01.2008 | 87.2 | 23.4 | 7.3 | 8.4 | <0.1 | <0.01 | 287 | 275 | 270 |
| 06.02.2008 | 78.5 | 22.8 | 7.4 | 9.1 | <0.1 | <0.01 | 280 | 269 | 263 |
| 07.02.2008 | 69.3 | 21.3 | 6.5 | 8.7 | <0.1 | <0.01 | 277 | 265 | 264 |
| 13.02.2008 | 62.4 | 24.2 | 8.2 | 9.2 | <0.1 | <0.01 | 275 | 264 | 268 |
| 14.02.2008 | 71.3 | 22.6 | 7.7 | 8.6 | <0.1 | <0.01 | 281 | 270 | 274 |
| 20.02.2008 | 77.6 | 25.2 | 6.4 | 7.3 | <0.1 | <0.01 | 285 | 274 | 269 |
| 21.02.2008 | 79.8 | 23.1 | 7.9 | 9.1 | <0.1 | <0.01 | 288 | 276 | 271 |
| 27.02.2008 | 85.4 | 24.7 | 6.2 | 7.9 | <0.1 | <0.01 | 296 | 269 | 267 |
| 28.02.2008 | 88.2 | 26.9 | 6.8 | 8.5 | <0.1 | <0.01 | 290 | 278 | 273 |
| | | | | | | | | | |
| **Max** | **100.5** | **32.1** | **8.2** | **9.5** | <0.1 | <0.01 | | **300.0** | |
| **Min** | **62.4** | **21.2** | **6.1** | **7.3** | <0.1 | <0.01 | | **261.0** | |
| **Average** | **83.8** | **25.2** | **7.2** | **8.6** | <0.1 | <0.01 | | **276.7** | |
| **98 % tile** | **99.1** | **30.5** | **8.2** | **9.5** | <0.1 | <0.01 | | **296.5** | |

## ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (WINTER SEASON)

**AAQ-7 Dharsara Village**

| Date of Monitoring | TSPM (µg/m3) | RPM (µg/m3) | SO2 (µg/m3) | Nox (µg/m3) | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.12.2007 | 102.3 | 34.2 | 8.1 | 8.5 | <0.1 | <0.01 | 273 | 277 | 305 |
| 05.12.2007 | 104.2 | 32.6 | 7.9 | 7.6 | <0.1 | <0.01 | 269 | 281 | 299 |
| 11.12.2007 | 98.6 | 31.5 | 8.5 | 7.2 | <0.1 | <0.01 | 261 | 261 | 290 |
| 12.12.2007 | 95.3 | 29.8 | 8.8 | 8.9 | <0.1 | <0.01 | 264 | 263 | 292 |
| 18.12.2007 | 89.7 | 28.2 | 7.7 | 7.6 | <0.1 | <0.01 | 279 | 276 | 303 |
| 19.12.2007 | 78.6 | 26.1 | 7.2 | 8.4 | <0.1 | <0.01 | 283 | 272 | 286 |
| 25.12.2007 | 68.9 | 24.7 | 7.6 | 9.6 | <0.1 | <0.01 | 271 | 281 | 300 |
| 26.12.2007 | 59.4 | 22.3 | 6.9 | 8.8 | <0.1 | <0.01 | 258 | 276 | 280 |
| 02.01.2008 | 66.3 | 26.5 | 7.5 | 8.6 | <0.1 | <0.01 | 268 | 268 | 298 |
| 03.01.2008 | 62.8 | 23.2 | 6.9 | 9.1 | <0.1 | <0.01 | 261 | 277 | 304 |
| 09.01.2008 | 89.5 | 27.1 | 7.6 | 9.5 | <0.1 | <0.01 | 273 | 274 | 276 |
| 10.01.2008 | 83.4 | 25.8 | 7.3 | 7.6 | <0.1 | <0.01 | 270 | 267 | 297 |
| 16.01.2008 | 67.6 | 23.2 | 6.8 | 9.2 | <0.1 | <0.01 | 266 | 273 | 303 |
| 17.01.2008 | 79.1 | 24.5 | 9.1 | 7.6 | <0.1 | <0.01 | 280 | 289 | 277 |
| 23.01.2008 | 101.5 | 32.1 | 8.9 | 8.4 | <0.1 | <0.01 | 279 | 275 | 304 |
| 24.01.2008 | 83.2 | 25.9 | 7.3 | 8.9 | <0.1 | <0.01 | 276 | 286 | 276 |
| 30.01.2008 | 93.4 | 33.2 | 9.1 | 8.3 | <0.1 | <0.01 | 287 | 282 | 307 |
| 31.01.2008 | 85.7 | 29.7 | 8.5 | 9.2 | <0.1 | <0.01 | 272 | 287 | 300 |
| 06.02.2008 | 64.5 | 25.6 | 7.4 | 7.8 | <0.1 | <0.01 | 264 | 265 | 295 |
| 07.02.2008 | 100.8 | 32.7 | 8.3 | 8.3 | <0.1 | <0.01 | 262 | 261 | 290 |
| 13.02.2008 | 75.4 | 24.3 | 6.9 | 9.0 | <0.1 | <0.01 | 260 | 263 | 289 |
| 14.02.2008 | 77.8 | 21.4 | 7.6 | 8.9 | <0.1 | <0.01 | 265 | 266 | 296 |
| 20.02.2008 | 81.3 | 25.8 | 7.4 | 8.4 | <0.1 | <0.01 | 269 | 271 | 302 |
| 21.02.2008 | 84.3 | 26.9 | 7.6 | 8.0 | <0.1 | <0.01 | 271 | 279 | 268 |
| 27.02.2008 | 97.2 | 34.5 | 8.5 | 7.9 | <0.1 | <0.01 | 279 | 266 | 284 |
| 28.02.2008 | 88.7 | 31.0 | 8.9 | 8.4 | <0.1 | <0.01 | 273 | 273 | 279 |
| | | | | | | | | | |
| **Max** | **104.2** | **34.5** | **9.1** | **9.6** | <0.1 | <0.01 | | **307.0** | |
| **Min** | **59.4** | **21.4** | **6.8** | **7.2** | <0.1 | <0.01 | | **258.0** | |
| **Average** | **83.8** | **27.8** | **7.9** | **8.5** | <0.1 | <0.01 | | **278.7** | |
| **98 % tile** | **103.3** | **34.4** | **9.1** | **9.6** | <0.1 | <0.01 | | **304.5** | |

## ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (WINTER SEASON)

**AAQ-8 Biradar Village**

| Date of Monitoring | TSPM (µg/m3) | RPM (µg/m3) | SO2 (µg/m3) | Nox (µg/m3) | Fluoride (µg/m³) | PAH (µg/m³) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.12.2007 | 121.3 | 39.8 | 8.9 | 9.5 | <0.1 | <0.01 | 361 | 363 | 391 |
| 05.12.2007 | 133.5 | 44.2 | 9.5 | 8.9 | <0.1 | <0.01 | 366 | 365 | 387 |
| 11.12.2007 | 117.9 | 38.7 | 9.9 | 10.2 | <0.1 | <0.01 | 387 | 377 | 376 |
| 12.12.2007 | 128.5 | 44.5 | 8.9 | 9.6 | <0.1 | <0.01 | 375 | 374 | 378 |
| 18.12.2007 | 134.6 | 41.1 | 10.2 | 9.7 | <0.1 | <0.01 | 362 | 365 | 398 |
| 19.12.2007 | 129.2 | 42.6 | 9.2 | 10.6 | <0.1 | <0.01 | 366 | 395 | 391 |
| 25.12.2007 | 131.1 | 43.5 | 8.9 | 9.6 | <0.1 | <0.01 | 373 | 369 | 388 |
| 26.12.2007 | 122.7 | 41.2 | 9.5 | 10.8 | <0.1 | <0.01 | 361 | 399 | 373 |
| 02.01.2008 | 136.4 | 44.7 | 9.6 | 9.2 | <0.1 | <0.01 | 372 | 391 | 385 |
| 03.01.2008 | 135.8 | 45.3 | 10.2 | 8.7 | <0.1 | <0.01 | 365 | 364 | 393 |
| 09.01.2008 | 128.5 | 42.4 | 9.4 | 8.9 | <0.1 | <0.01 | 362 | 368 | 398 |
| 10.01.2008 | 122.9 | 43.1 | 9.3 | 9.3 | <0.1 | <0.01 | 369 | 372 | 385 |
| 16.01.2008 | 118.2 | 41.4 | 9.7 | 9.8 | <0.1 | <0.01 | 378 | 363 | 391 |
| 17.01.2008 | 119.7 | 42.3 | 8.7 | 10.2 | <0.1 | <0.01 | 364 | 368 | 395 |
| 23.01.2008 | 120.1 | 42.5 | 8.9 | 9.1 | <0.1 | <0.01 | 385 | 361 | 385 |
| 24.01.2008 | 135.6 | 47.5 | 9.3 | 9.4 | <0.1 | <0.01 | 367 | 374 | 397 |
| 30.01.2008 | 127.6 | 44.8 | 9.9 | 9.3 | <0.1 | <0.01 | 362 | 379 | 398 |
| 31.01.2008 | 116.8 | 41.6 | 9.1 | 8.6 | <0.1 | <0.01 | 361 | 385 | 390 |
| 06.02.2008 | 129.2 | 42.5 | 8.8 | 8.9 | <0.1 | <0.01 | 377 | 380 | 381 |
| 07.02.2008 | 124.3 | 43.7 | 9.3 | 9.9 | <0.1 | <0.01 | 384 | 388 | 376 |
| 13.02.2008 | 133.4 | 46.8 | 9.7 | 9.3 | <0.1 | <0.01 | 381 | 396 | 374 |
| 14.02.2008 | 131.7 | 46.1 | 10.1 | 9.7 | <0.1 | <0.01 | 374 | 391 | 383 |
| 20.02.2008 | 115.9 | 33.9 | 9.4 | 9.3 | <0.1 | <0.01 | 366 | 365 | 388 |
| 21.02.2008 | 125.8 | 38.7 | 9.3 | 10.1 | <0.1 | <0.01 | 392 | 395 | 391 |
| 27.02.2008 | 129.8 | 37.6 | 9.7 | 9.3 | <0.1 | <0.01 | 386 | 388 | 381.173 |
| 28.02.2008 | 131.5 | 38.1 | 9.6 | 8.7 | <0.1 | <0.01 | 382 | 381 | 392 |
| | | | | | | | | | |
| **Max** | **136.4** | **47.5** | **10.2** | **10.8** | <0.1 | <0.01 | | **399.0** | |
| **Min** | **115.9** | **33.9** | **8.7** | **8.6** | <0.1 | <0.01 | | **361.0** | |
| **Average** | **127.0** | **42.3** | **9.4** | **9.5** | <0.1 | <0.01 | | **379.0** | |
| **98 % tile** | **136.1** | **47.2** | **10.2** | **10.7** | <0.1 | <0.01 | | **398.0** | |

## ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (PREMONSOON SEASON)

| AAQ-1 Bargawan Village | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date of Monitoring | TSPM (µg/m3) | RPM (µg/m3) | SO2 (µg/m3) | Nox (µg/m3) | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | CO | | |
| 04.03.2008 | 151.3 | 46.1 | 6.0 | 8.4 | <0.1 | <0.01 | 403 | 392 | 398 |
| 05.03.2008 | 147.6 | 46.3 | 6.7 | 8.8 | <0.1 | <0.01 | 394 | 383 | 389 |
| 11.03.2008 | 156.8 | 47.1 | 6.3 | 8.4 | <0.1 | <0.01 | 383 | 373 | 378 |
| 12.03.2008 | 142.8 | 44.6 | 5.7 | 7.9 | <0.1 | <0.01 | 382 | 375 | 379 |
| 18.03.2008 | 156.9 | 49.3 | 6.2 | 8.2 | <0.1 | <0.01 | 406 | 399 | 405 |
| 19.03.2008 | 147.5 | 45.1 | 5.9 | 8.5 | <0.1 | <0.01 | 398 | 404 | 410 |
| 25.03.2008 | 150.9 | 48.2 | 6.6 | 8.8 | <0.1 | <0.01 | 399 | 388 | 394 |
| 26.03.2008 | 148.7 | 43.5 | 6.0 | 8.0 | <0.1 | <0.01 | 379 | 369 | 375 |
| 01.04.2008 | 152.5 | 44.2 | 6.3 | 8.3 | <0.1 | <0.01 | 393 | 388 | 388 |
| 02.04.2008 | 159.1 | 49.3 | 6.3 | 8.6 | <0.1 | <0.01 | 395 | 384 | 390 |
| 08.04.2008 | 150.3 | 45.2 | 6.0 | 8.1 | <0.1 | <0.01 | 402 | 391 | 397 |
| 09.04.2008 | 158.7 | 46.8 | 6.4 | 8.2 | <0.1 | <0.01 | 394 | 383 | 389 |
| 15.04.2008 | 148.5 | 45.2 | 6.1 | 8.9 | <0.1 | <0.01 | 391 | 381 | 387 |
| 16.04.2008 | 125.8 | 39.2 | 5.9 | 8.4 | <0.1 | <0.01 | 408 | 399 | 405 |
| 22.04.2008 | 155.4 | 47.4 | 6.1 | 8.2 | <0.1 | <0.01 | 401 | 398 | 404 |
| 23.04.2008 | 137.6 | 41.9 | 6.2 | 8.3 | <0.1 | <0.01 | 404 | 393 | 399 |
| 29.04.2008 | 149.6 | 48.1 | 6.0 | 8.2 | <0.1 | <0.01 | 406 | 395 | 401 |
| 30.04.2008 | 160.1 | 46.3 | 5.9 | 8.3 | <0.1 | <0.01 | 397 | 386 | 392 |
| 06.05.2008 | 148.4 | 48.0 | 6.2 | 8.3 | <0.1 | <0.01 | 388 | 378 | 384 |
| 07.05.2008 | 157.6 | 49.6 | 6.1 | 8.2 | <0.1 | <0.01 | 383 | 373 | 379 |
| 13.05.2008 | 150.6 | 44.3 | 6.3 | 8.5 | <0.1 | <0.01 | 381 | 371 | 377 |
| 14.05.2008 | 149.1 | 45.6 | 6.4 | 8.9 | <0.1 | <0.01 | 389 | 379 | 385 |
| 20.05.2008 | 139.4 | 42.6 | 6.6 | 8.2 | <0.1 | <0.01 | 395 | 384 | 390 |
| 21.05.2008 | 142.5 | 45.2 | 6.1 | 8.6 | <0.1 | <0.01 | 399 | 388 | 394 |
| 27.05.2008 | 120.6 | 37.2 | 6.3 | 9.2 | <0.1 | <0.01 | 395 | 399 | 405 |
| 28.05.2008 | 148.7 | 47.2 | 6.4 | 8.3 | <0.1 | <0.01 | 401 | 390 | 396 |
| | | | | | | | | | |
| **Max** | **160.1** | **49.6** | **6.7** | **9.2** | <0.1 | <0.01 | | **404.1** | |
| **Min** | **120.6** | **37.2** | **5.7** | **7.9** | <0.1 | <0.01 | | **369.1** | |
| **Average** | **148.3** | **45.5** | **6.2** | **8.4** | <0.1 | <0.01 | | **386.4** | |
| **98 % tile** | **159.6** | **49.5** | **6.7** | **9.1** | <0.1 | <0.01 | | **401.6** | |

## ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (PREMONSOON SEASON)

AAQ-2 Gidher Village

| Date of Monitoring | TSPM (μg/m3) | RPM (μg/m3) | SO2 (μg/m3) | Nox (μg/m3) | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.03.2008 | 114.6 | 39.6 | 6.2 | 8.5 | <0.1 | <0.01 | 270 | 290 | 283 |
| 05.03.2008 | 119.0 | 41.4 | 6.1 | 8.1 | <0.1 | <0.01 | 264 | 284 | 277 |
| 11.03.2008 | 117.4 | 34.9 | 6.2 | 8.1 | <0.1 | <0.01 | 257 | 276 | 269 |
| 12.03.2008 | 112.9 | 39.1 | 6.9 | 8.5 | <0.1 | <0.01 | 258 | 277 | 271 |
| 18.03.2008 | 109.4 | 38.6 | 7.0 | 8.6 | <0.1 | <0.01 | 275 | 295 | 285 |
| 19.03.2008 | 116.4 | 34.9 | 6.1 | 8.1 | <0.1 | <0.01 | 278 | 299 | 280 |
| 25.03.2008 | 109.8 | 33.0 | 6.8 | 8.9 | <0.1 | <0.01 | 267 | 287 | 278 |
| 26.03.2008 | 102.6 | 38.0 | 5.8 | 7.5 | <0.1 | <0.01 | 261 | 274 | 267 |
| 01.04.2008 | 104.5 | 37.4 | 6.2 | 8.0 | <0.1 | <0.01 | 267 | 283 | 276 |
| 02.04.2008 | 103.1 | 34.2 | 6.1 | 7.4 | <0.1 | <0.01 | 264 | 284 | 277 |
| 08.04.2008 | 99.4 | 35.7 | 6.8 | 8.2 | <0.1 | <0.01 | 269 | 289 | 282 |
| 09.04.2008 | 111.1 | 39.3 | 6.3 | 8.1 | <0.1 | <0.01 | 263 | 285 | 275 |
| 15.04.2008 | 108.7 | 38.6 | 6.4 | 8.6 | <0.1 | <0.01 | 275 | 282 | 281 |
| 16.04.2008 | 114.1 | 41.0 | 6.5 | 8.7 | <0.1 | <0.01 | 279 | 296 | 287 |
| 22.04.2008 | 104.6 | 37.3 | 6.3 | 8.4 | <0.1 | <0.01 | 274 | 295 | 282 |
| 23.04.2008 | 120.9 | 32.3 | 6.7 | 8.9 | <0.1 | <0.01 | 281 | 291 | 284 |
| 29.04.2008 | 117.4 | 41.2 | 5.8 | 8.3 | <0.1 | <0.01 | 272 | 292 | 285 |
| 30.04.2008 | 106.1 | 37.4 | 6.1 | 8.9 | <0.1 | <0.01 | 266 | 286 | 279 |
| 06.05.2008 | 108.1 | 37.3 | 6.6 | 8.8 | <0.1 | <0.01 | 268 | 280 | 273 |
| 07.05.2008 | 104.8 | 36.2 | 7.4 | 9.6 | <0.1 | <0.01 | 263 | 277 | 269 |
| 13.05.2008 | 100.8 | 36.6 | 6.9 | 8.9 | <0.1 | <0.01 | 264 | 275 | 268 |
| 14.05.2008 | 98.6 | 31.9 | 6.4 | 9.0 | <0.1 | <0.01 | 271 | 281 | 274 |
| 20.05.2008 | 107.6 | 30.6 | 7.0 | 9.6 | <0.1 | <0.01 | 277 | 284 | 278 |
| 21.05.2008 | 114.5 | 40.9 | 6.8 | 9.3 | <0.1 | <0.01 | 273 | 287 | 280 |
| 27.05.2008 | 108.5 | 37.4 | 6.9 | 9.5 | <0.1 | <0.01 | 275 | 295 | 273 |
| 28.05.2008 | 106.4 | 38.0 | 5.9 | 8.0 | <0.1 | <0.01 | 269 | 289 | 282 |
| | | | | | | | | | |
| **Max** | **120.9** | **41.4** | **7.4** | **9.6** | <0.1 | <0.01 | | **299.4** | |
| **Min** | **98.6** | **30.6** | **5.8** | **7.4** | <0.1 | <0.01 | | **257.1** | |
| **Average** | **98.6** | **30.6** | **6.5** | **8.6** | <0.1 | <0.01 | | **277.5** | |
| **98 % tile** | **119.9** | **41.3** | **7.2** | **9.6** | <0.1 | <0.01 | | **295.9** | |

## ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (PREMONSOON SEASON)

**AAQ-3 Orgari Village**

| Date of Monitoring | TSPM (µg/m3) | RPM (µg/m3) | SO2 (µg/m3) | Nox (µg/m3) | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.03.2008 | 102.9 | 32.7 | 5.2 | 7.3 | <0.1 | <0.01 | 304 | 288 | 289 |
| 05.03.2008 | 94.0 | 24.3 | 6.3 | 8.5 | <0.1 | <0.01 | 298 | 282 | 283 |
| 11.03.2008 | 99.1 | 31.9 | 6.4 | 8.3 | <0.1 | <0.01 | 289 | 274 | 275 |
| 12.03.2008 | 101.9 | 29.3 | 6.3 | 8.1 | <0.1 | <0.01 | 290 | 276 | 276 |
| 18.03.2008 | 89.4 | 29.9 | 7.1 | 8.2 | <0.1 | <0.01 | 309 | 290 | 295 |
| 19.03.2008 | 86.0 | 28.3 | 5.7 | 7.4 | <0.1 | <0.01 | 314 | 285 | 298 |
| 25.03.2008 | 96.1 | 30.8 | 6.4 | 8.3 | <0.1 | <0.01 | 301 | 283 | 286 |
| 26.03.2008 | 102.3 | 33.4 | 6.2 | 8.6 | <0.1 | <0.01 | 287 | 274 | 280 |
| 01.04.2008 | 101.1 | 33.1 | 6.1 | 8.3 | <0.1 | <0.01 | 297 | 281 | 286 |
| 02.04.2008 | 92.1 | 29.7 | 6.4 | 8.4 | <0.1 | <0.01 | 298 | 282 | 283 |
| 08.04.2008 | 87.7 | 25.7 | 5.5 | 8.2 | <0.1 | <0.01 | 303 | 287 | 288 |
| 09.04.2008 | 99.0 | 25.0 | 6.2 | 7.6 | <0.1 | <0.01 | 299 | 280 | 282 |
| 15.04.2008 | 94.6 | 24.9 | 5.4 | 7.3 | <0.1 | <0.01 | 295 | 286 | 295 |
| 16.04.2008 | 83.3 | 21.3 | 6.3 | 8.3 | <0.1 | <0.01 | 310 | 293 | 299 |
| 22.04.2008 | 96.0 | 30.7 | 7.2 | 8.2 | <0.1 | <0.01 | 309 | 287 | 293 |
| 23.04.2008 | 95.4 | 25.0 | 6.4 | 8.6 | <0.1 | <0.01 | 305 | 289 | 301 |
| 29.04.2008 | 88.4 | 30.1 | 7.2 | 8.3 | <0.1 | <0.01 | 306 | 290 | 291 |
| 30.04.2008 | 90.3 | 28.6 | 5.2 | 8.6 | <0.1 | <0.01 | 300 | 284 | 285 |
| 06.05.2008 | 86.7 | 24.4 | 7.0 | 8.4 | <0.1 | <0.01 | 293 | 278 | 287 |
| 07.05.2008 | 94.8 | 25.0 | 6.3 | 8.8 | <0.1 | <0.01 | 290 | 274 | 282 |
| 13.05.2008 | 102.9 | 30.9 | 7.3 | 8.6 | <0.1 | <0.01 | 288 | 273 | 283 |
| 14.05.2008 | 98.4 | 25.0 | 7.1 | 8.4 | <0.1 | <0.01 | 294 | 279 | 287 |
| 20.05.2008 | 95.1 | 27.4 | 6.7 | 8.8 | <0.1 | <0.01 | 298 | 283 | 296 |
| 21.05.2008 | 84.1 | 23.4 | 6.4 | 8.6 | <0.1 | <0.01 | 301 | 285 | 292 |
| 27.05.2008 | 87.4 | 27.0 | 6.2 | 8.7 | <0.1 | <0.01 | 309 | 278 | 295 |
| 28.05.2008 | 90.1 | 24.9 | 6.9 | 8.6 | <0.1 | <0.01 | 303 | 287 | 288 |
| | | | | | | | | | |
| **Max** | **102.9** | **33.4** | **7.3** | **8.8** | <0.1 | <0.01 | | **314** | |
| **Min** | **83.3** | **21.3** | **5.2** | **7.3** | <0.1 | <0.01 | | **273** | |
| **Average** | **93.8** | **27.8** | **6.4** | **8.3** | <0.1 | <0.01 | | **290** | |
| **98 % tile** | **102.9** | **33.3** | **7.3** | **8.8** | <0.1 | <0.01 | | **310** | |

## ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (PREMONSOON SEASON)

**AAQ-4 Barauniya Village**

| Date of Monitoring | TSPM (µg/m3) | RPM (µg/m3) | SO2 (µg/m3) | Nox (µg/m3) | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.03.2008 | 107.1 | 30.6 | 5.7 | 8.0 | <0.1 | <0.01 | 319 | 299 | 328 |
| 05.03.2008 | 111.9 | 33.6 | 5.9 | 8.3 | <0.1 | <0.01 | 313 | 293 | 321 |
| 11.03.2008 | 105.7 | 33.1 | 6.3 | 8.5 | <0.1 | <0.01 | 304 | 285 | 312 |
| 12.03.2008 | 98.5 | 31.6 | 6.1 | 8.6 | <0.1 | <0.01 | 305 | 287 | 314 |
| 18.03.2008 | 86.4 | 28.5 | 5.2 | 8.1 | <0.1 | <0.01 | 325 | 301 | 326 |
| 19.03.2008 | 85.4 | 28.2 | 5.2 | 8.2 | <0.1 | <0.01 | 329 | 296 | 308 |
| 25.03.2008 | 99.5 | 31.9 | 5.2 | 8.0 | <0.1 | <0.01 | 316 | 294 | 322 |
| 26.03.2008 | 105.5 | 34.6 | 6.2 | 8.2 | <0.1 | <0.01 | 301 | 301 | 302 |
| 01.04.2008 | 110.6 | 36.0 | 5.5 | 7.6 | <0.1 | <0.01 | 312 | 292 | 320 |
| 02.04.2008 | 85.4 | 27.6 | 5.5 | 7.8 | <0.1 | <0.01 | 313 | 295 | 327 |
| 08.04.2008 | 96.9 | 31.0 | 5.9 | 8.2 | <0.1 | <0.01 | 318 | 298 | 297 |
| 09.04.2008 | 108.2 | 34.5 | 5.6 | 7.9 | <0.1 | <0.01 | 314 | 291 | 319 |
| 15.04.2008 | 109.2 | 34.1 | 6.3 | 8.5 | <0.1 | <0.01 | 310 | 297 | 326 |
| 16.04.2008 | 99.7 | 32.3 | 6.9 | 8.6 | <0.1 | <0.01 | 326 | 304 | 299 |
| 22.04.2008 | 106 | 33.8 | 5.1 | 8.0 | <0.1 | <0.01 | 325 | 299 | 327 |
| 23.04.2008 | 79.4 | 26.0 | 6.7 | 7.7 | <0.1 | <0.01 | 321 | 300 | 298 |
| 29.04.2008 | 82.9 | 27.2 | 6.6 | 8.6 | <0.1 | <0.01 | 322 | 307 | 330 |
| 30.04.2008 | 90.6 | 28.6 | 5.1 | 7.9 | <0.1 | <0.01 | 317 | 296 | 323 |
| 06.05.2008 | 95 | 30.1 | 6.7 | 8.6 | <0.1 | <0.01 | 308 | 289 | 317 |
| 07.05.2008 | 113.7 | 36.5 | 5.8 | 7.6 | <0.1 | <0.01 | 305 | 285 | 312 |
| 13.05.2008 | 104.3 | 29.5 | 6.5 | 8.4 | <0.1 | <0.01 | 303 | 287 | 311 |
| 14.05.2008 | 109.5 | 31.2 | 5.6 | 8.2 | <0.1 | <0.01 | 309 | 290 | 318 |
| 20.05.2008 | 111 | 35.5 | 6.5 | 8.5 | <0.1 | <0.01 | 313 | 294 | 325 |
| 21.05.2008 | 113.5 | 36.7 | 6.9 | 8.3 | <0.1 | <0.01 | 316 | 296 | 308 |
| 27.05.2008 | 101.9 | 33.6 | 5.8 | 8.6 | <0.1 | <0.01 | 325 | 289 | 306 |
| 28.05.2008 | 98 | 31.9 | 5.2 | 8.4 | <0.1 | <0.01 | 318 | 298 | 301 |
| | | | | | | | | | |
| **Max** | **113.7** | **36.7** | **6.9** | **8.6** | <0.1 | <0.01 | | **330.1** | |
| **Min** | **79.4** | **26.0** | **5.1** | **7.6** | <0.1 | <0.01 | | **285.4** | |
| **Average** | **100.6** | **31.9** | **5.9** | **8.2** | <0.1 | <0.01 | | **308.6** | |
| **98 % tile** | **113.6** | **36.6** | **6.9** | **8.6** | <0.1 | <0.01 | | **328.7** | |

## ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (PREMONSOON SEASON)

**AAQ-5 Barokhar Village**

| Date of Monitoring | TSPM (µg/m3) | RPM (µg/m3) | SO2 (µg/m3) | Nox (µg/m3) | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.03.2008 | 108.8 | 33.3 | 4.7 | 7.5 | <0.1 | <0.01 | 309 | 311 | 315 |
| 05.03.2008 | 109.9 | 35.3 | 6.1 | 8.1 | <0.1 | <0.01 | 320 | 321 | 326 |
| 11.03.2008 | 105.6 | 33.6 | 5.2 | 7.6 | <0.1 | <0.01 | 325 | 326 | 331 |
| 12.03.2008 | 99.4 | 32.6 | 5.1 | 8.0 | <0.1 | <0.01 | 305 | 306 | 311 |
| 18.03.2008 | 97.2 | 31.6 | 5.5 | 8.1 | <0.1 | <0.01 | 310 | 311 | 316 |
| 19.03.2008 | 89.3 | 29.2 | 5.2 | 7.7 | <0.1 | <0.01 | 308 | 308 | 314 |
| 25.03.2008 | 89.2 | 30.3 | 6.1 | 8.2 | <0.1 | <0.01 | 324 | 325 | 330 |
| 26.03.2008 | 93.3 | 30.2 | 5.2 | 8.5 | <0.1 | <0.01 | 322 | 322 | 328 |
| 01.04.2008 | 91 | 27.0 | 6.3 | 8.1 | <0.1 | <0.01 | 300 | 302 | 306 |
| 02.04.2008 | 104 | 32.7 | 5.6 | 7.7 | <0.1 | <0.01 | 304 | 306 | 310 |
| 08.04.2008 | 97.3 | 31.0 | 6.2 | 8.5 | <0.1 | <0.01 | 306 | 307 | 312 |
| 09.04.2008 | 111.3 | 35.7 | 6.6 | 8.6 | <0.1 | <0.01 | 313 | 314 | 319 |
| 15.04.2008 | 107.3 | 35.3 | 7.2 | 8.7 | <0.1 | <0.01 | 321 | 322 | 327 |
| 16.04.2008 | 97.9 | 33.2 | 5.6 | 7.9 | <0.1 | <0.01 | 326 | 327 | 332 |
| 22.04.2008 | 103.9 | 32.5 | 5.1 | 7.1 | <0.1 | <0.01 | 332 | 333 | 338 |
| 23.04.2008 | 91 | 29.0 | 5.4 | 8.4 | <0.1 | <0.01 | 330 | 331 | 336 |
| 29.04.2008 | 98.2 | 30.8 | 6.9 | 8.7 | <0.1 | <0.01 | 312 | 313 | 318 |
| 30.04.2008 | 102.7 | 31.6 | 5.9 | 8.7 | <0.1 | <0.01 | 315 | 316 | 321 |
| 06.05.2008 | 93.6 | 30.0 | 5.3 | 7.8 | <0.1 | <0.01 | 303 | 305 | 309 |
| 07.05.2008 | 89.6 | 28.7 | 6.1 | 8.4 | <0.1 | <0.01 | 300 | 302 | 306 |
| 13.05.2008 | 77.9 | 25.7 | 5.8 | 8.7 | <0.1 | <0.01 | 325 | 326 | 331 |
| 14.05.2008 | 83.7 | 27.4 | 6.2 | 8.6 | <0.1 | <0.01 | 328 | 327 | 332 |
| 20.05.2008 | 77.2 | 26.1 | 5.3 | 7.9 | <0.1 | <0.01 | 314 | 315 | 320 |
| 21.05.2008 | 85.5 | 28.0 | 5.5 | 8.4 | <0.1 | <0.01 | 322 | 320 | 328 |
| 27.05.2008 | 93 | 29.3 | 6.1 | 8.3 | <0.1 | <0.01 | 329 | 327 | 332 |
| 28.05.2008 | 100 | 30.9 | 5.8 | 8.0 | <0.1 | <0.01 | 330 | 331 | 336 |
| | | | | | | | | | |
| **Max** | **111.3** | **35.7** | **7.2** | **8.7** | <0.1 | <0.01 | | **338.4** | |
| **Min** | **77.2** | **25.7** | **4.7** | **7.1** | <0.1 | <0.01 | | **300.4** | |
| **Average** | **96.1** | **30.8** | **5.8** | **8.2** | <0.1 | <0.01 | | **319.2** | |
| **98 % tile** | **110.6** | **35.5** | **7.1** | **8.7** | <0.1 | <0.01 | | **336.4** | |

## ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (PREMONSOON SEASON)

AAQ-6 Waghadih Village

| Date of Monitoring | TSPM (µg/m3) | RPM (µg/m3) | SO2 (µg/m3) | Nox (µg/m3) | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.03.2008 | 87.4 | 25.7 | 4 | 7 | <0.1 | <0.01 | 304 | 291 | 285 |
| 05.03.2008 | 101.4 | 31.2 | 5.4 | 7.9 | <0.1 | <0.01 | 298 | 285 | 278 |
| 11.03.2008 | 108 | 30.5 | 5.8 | 7.9 | <0.1 | <0.01 | 289 | 277 | 276 |
| 12.03.2008 | 110.3 | 35.5 | 6.1 | 8.4 | <0.1 | <0.01 | 290 | 279 | 272 |
| 18.03.2008 | 98.5 | 31 | 5.9 | 8.2 | <0.1 | <0.01 | 309 | 293 | 287 |
| 19.03.2008 | 79.5 | 25.6 | 4.9 | 7.4 | <0.1 | <0.01 | 313 | 288 | 282 |
| 25.03.2008 | 89.2 | 27 | 4.6 | 6.8 | <0.1 | <0.01 | 301 | 286 | 280 |
| 26.03.2008 | 103.3 | 31.4 | 4.5 | 8.1 | <0.1 | <0.01 | 287 | 275 | 277 |
| 01.04.2008 | 93.9 | 28.4 | 5.3 | 7.4 | <0.1 | <0.01 | 297 | 284 | 279 |
| 02.04.2008 | 81 | 24.2 | 5.5 | 7.9 | <0.1 | <0.01 | 298 | 289 | 273 |
| 08.04.2008 | 94.3 | 27.3 | 5.8 | 7.8 | <0.1 | <0.01 | 303 | 293 | 284 |
| 09.04.2008 | 102.9 | 30.3 | 6.1 | 7.9 | <0.1 | <0.01 | 299 | 284 | 276 |
| 15.04.2008 | 96.5 | 28.9 | 6 | 8.1 | <0.1 | <0.01 | 295 | 289 | 283 |
| 16.04.2008 | 98.6 | 30.5 | 5.8 | 8.5 | <0.1 | <0.01 | 310 | 295 | 289 |
| 22.04.2008 | 93 | 27.2 | 4.8 | 7.4 | <0.1 | <0.01 | 306 | 290 | 284 |
| 23.04.2008 | 106 | 32.1 | 4.5 | 6.8 | <0.1 | <0.01 | 301 | 292 | 286 |
| 29.04.2008 | 101 | 29.8 | 4.1 | 7.3 | <0.1 | <0.01 | 306 | 293 | 293 |
| 30.04.2008 | 96 | 25.8 | 5.3 | 7.4 | <0.1 | <0.01 | 300 | 287 | 281 |
| 06.05.2008 | 87.6 | 25.5 | 5.4 | 8.1 | <0.1 | <0.01 | 293 | 281 | 274 |
| 07.05.2008 | 79.4 | 25 | 4.5 | 7.7 | <0.1 | <0.01 | 290 | 277 | 275 |
| 13.05.2008 | 71.9 | 27.3 | 6.2 | 8.2 | <0.1 | <0.01 | 288 | 276 | 279 |
| 14.05.2008 | 81.2 | 26.1 | 5.7 | 7.9 | <0.1 | <0.01 | 294 | 282 | 285 |
| 20.05.2008 | 87.1 | 28.3 | 4.4 | 7.1 | <0.1 | <0.01 | 298 | 286 | 280 |
| 21.05.2008 | 90.1 | 27 | 5.9 | 8.1 | <0.1 | <0.01 | 301 | 288 | 282 |
| 27.05.2008 | 94.9 | 27.8 | 4.2 | 6.9 | <0.1 | <0.01 | 309 | 281 | 278 |
| 28.05.2008 | 97.1 | 29.4 | 4.8 | 7.5 | <0.1 | <0.01 | 303 | 290 | 284 |
| | | | | | | | | | |
| **Max** | **110.3** | **35.5** | **6.2** | **8.5** | <0.1 | <0.01 | | **313.4** | |
| **Min** | **71.9** | **24.2** | **4.0** | **6.8** | <0.1 | <0.01 | | **272.0** | |
| **Average** | **93.5** | **28.4** | **5.2** | **7.7** | <0.1 | <0.01 | | **288.6** | |
| **98 % tile** | **109.2** | **33.8** | **6.2** | **8.5** | <0.1 | <0.01 | | **309.9** | |

## ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (PREMONSOON SEASON)

**AAQ-7 Dharsara Village**

| Date of Monitoring | TSPM (μg/m3) | RPM (μg/m3) | SO2 (μg/m3) | Nox (μg/m3) | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.03.2008 | 110.8 | 41.2 | 4.9 | 6.3 | <0.1 | <0.01 | 284 | 287 | 315 |
| 05.03.2008 | 113.3 | 40.8 | 5.9 | 8.6 | <0.1 | <0.01 | 280 | 291 | 309 |
| 11.03.2008 | 109 | 41.0 | 6.5 | 8.2 | <0.1 | <0.01 | 272 | 271 | 300 |
| 12.03.2008 | 105.1 | 38.7 | 6.8 | 8.3 | <0.1 | <0.01 | 275 | 273 | 302 |
| 18.03.2008 | 99.6 | 37.2 | 5.7 | 8.5 | <0.1 | <0.01 | 290 | 286 | 313 |
| 19.03.2008 | 89.4 | 36.0 | 5.2 | 7.4 | <0.1 | <0.01 | 294 | 282 | 296 |
| 25.03.2008 | 78.7 | 33.6 | 5.6 | 8.6 | <0.1 | <0.01 | 282 | 291 | 310 |
| 26.03.2008 | 70.4 | 32.4 | 4.9 | 7.8 | <0.1 | <0.01 | 269 | 286 | 290 |
| 01.04.2008 | 75.7 | 35.0 | 5.5 | 7.6 | <0.1 | <0.01 | 279 | 278 | 308 |
| 02.04.2008 | 71.7 | 31.2 | 4.9 | 8.1 | <0.1 | <0.01 | 272 | 287 | 314 |
| 08.04.2008 | 98.6 | 35.3 | 5.6 | 8.5 | <0.1 | <0.01 | 284 | 284 | 286 |
| 09.04.2008 | 92.9 | 34.4 | 5.3 | 6.6 | <0.1 | <0.01 | 281 | 277 | 307 |
| 15.04.2008 | 77.6 | 32.3 | 4.8 | 8.2 | <0.1 | <0.01 | 277 | 283 | 313 |
| 16.04.2008 | 89.5 | 34.0 | 7.1 | 8.6 | <0.1 | <0.01 | 291 | 299 | 287 |
| 22.04.2008 | 110.8 | 40.5 | 6.9 | 8.4 | <0.1 | <0.01 | 290 | 285 | 314 |
| 23.04.2008 | 92.8 | 34.6 | 5.3 | 7.9 | <0.1 | <0.01 | 287 | 296 | 286 |
| 29.04.2008 | 102.9 | 41.8 | 7.1 | 8.9 | <0.1 | <0.01 | 298 | 292 | 317 |
| 30.04.2008 | 94.5 | 37.6 | 6.5 | 8.2 | <0.1 | <0.01 | 283 | 297 | 310 |
| 06.05.2008 | 73.6 | 33.8 | 5.4 | 6.8 | <0.1 | <0.01 | 275 | 275 | 305 |
| 07.05.2008 | 110.9 | 41.9 | 6.3 | 8.3 | <0.1 | <0.01 | 273 | 271 | 300 |
| 13.05.2008 | 84.9 | 32.9 | 4.9 | 8.0 | <0.1 | <0.01 | 271 | 273 | 299 |
| 14.05.2008 | 87.7 | 30.4 | 5.6 | 7.9 | <0.1 | <0.01 | 276 | 276 | 306 |
| 20.05.2008 | 90.8 | 34.4 | 5.4 | 7.4 | <0.1 | <0.01 | 280 | 281 | 312 |
| 21.05.2008 | 94.6 | 36.3 | 5.6 | 7.0 | <0.1 | <0.01 | 282 | 289 | 278 |
| 27.05.2008 | 106.7 | 43.1 | 6.5 | 8.9 | <0.1 | <0.01 | 290 | 276 | 294 |
| 28.05.2008 | 97.6 | 39.0 | 6.9 | 8.4 | <0.1 | <0.01 | 284 | 283 | 289 |
| | | | | | | | | | |
| **Max** | **113.3** | **43.1** | **7.1** | **8.9** | <0.1 | <0.01 | | **317.1** | |
| **Min** | **70.4** | **30.4** | **4.8** | **6.3** | <0.1 | <0.01 | | **269.3** | |
| **Average** | **93.5** | **36.5** | **5.8** | **8.0** | <0.1 | <0.01 | | **289.3** | |
| **98 % tile** | **112.1** | **42.5** | **7.1** | **8.9** | <0.1 | <0.01 | | **314.6** | |

## ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (PREMONSOON SEASON)

**AAQ-8 Biradar Village**

| Date of Monitoring | TSPM (µg/m3) | RPM (µg/m3) | SO2 (µg/m3) | Nox (µg/m3) | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.03.2008 | 130.6 | 50.3 | 5.6 | 8.2 | <0.1 | <0.01 | 373 | 401 | 374 |
| 05.03.2008 | 142.6 | 54.8 | 7.5 | 8.9 | <0.1 | <0.01 | 375 | 397 | 379 |
| 11.03.2008 | 128.3 | 50.6 | 7.9 | 9.8 | <0.1 | <0.01 | 387 | 386 | 400 |
| 12.03.2008 | 138.3 | 55.8 | 6.9 | 8.6 | <0.1 | <0.01 | 384 | 388 | 388 |
| 18.03.2008 | 144.5 | 52.5 | 8.2 | 10.1 | <0.1 | <0.01 | 375 | 408 | 375 |
| 19.03.2008 | 140 | 54.9 | 7.2 | 9.6 | <0.1 | <0.01 | 405 | 401 | 379 |
| 25.03.2008 | 140.9 | 54.8 | 6.9 | 8.6 | <0.1 | <0.01 | 379 | 398 | 386 |
| 26.03.2008 | 133.7 | 53.7 | 7.5 | 9.8 | <0.1 | <0.01 | 409 | 383 | 374 |
| 01.04.2008 | 145.8 | 55.6 | 7.6 | 9.9 | <0.1 | <0.01 | 401 | 395 | 385 |
| 02.04.2008 | 144.7 | 55.7 | 8.2 | 10.5 | <0.1 | <0.01 | 374 | 403 | 378 |
| 08.04.2008 | 137.6 | 53 | 7.4 | 10.6 | <0.1 | <0.01 | 378 | 408 | 375 |
| 09.04.2008 | 132.4 | 54.1 | 7.3 | 10.1 | <0.1 | <0.01 | 382 | 395 | 382 |
| 15.04.2008 | 128.2 | 52.9 | 7.7 | 10.5 | <0.1 | <0.01 | 373 | 401 | 391 |
| 16.04.2008 | 130.1 | 54.2 | 6.7 | 9.2 | <0.1 | <0.01 | 378 | 405 | 377 |
| 22.04.2008 | 129.4 | 53.3 | 6.9 | 9.6 | <0.1 | <0.01 | 371 | 395 | 398 |
| 23.04.2008 | 145.2 | 58.6 | 7.3 | 9.6 | <0.1 | <0.01 | 384 | 407 | 380 |
| 29.04.2008 | 137.1 | 55.8 | 7.9 | 9.7 | <0.1 | <0.01 | 389 | 408 | 375 |
| 30.04.2008 | 125.6 | 51.9 | 7.1 | 9.9 | <0.1 | <0.01 | 395 | 400 | 374 |
| 06.05.2008 | 138.3 | 53.1 | 6.8 | 9.6 | <0.1 | <0.01 | 390 | 391 | 390 |
| 07.05.2008 | 134.4 | 55.3 | 7.3 | 9.9 | <0.1 | <0.01 | 398 | 386 | 397 |
| 13.05.2008 | 142.9 | 57.8 | 7.7 | 9.6 | <0.1 | <0.01 | 406 | 384 | 394 |
| 14.05.2008 | 141.6 | 57.5 | 8.1 | 10.7 | <0.1 | <0.01 | 401 | 393 | 387 |
| 20.05.2008 | 125.4 | 44.9 | 7.4 | 9.5 | <0.1 | <0.01 | 375 | 398 | 379 |
| 21.05.2008 | 136.1 | 50.5 | 7.3 | 9.6 | <0.1 | <0.01 | 405 | 401 | 405 |
| 27.05.2008 | 139.3 | 48.6 | 7.7 | 9.6 | <0.1 | <0.01 | 398 | 391 | 399 |
| 28.05.2008 | 140.4 | 48.5 | 7.6 | 9.9 | <0.1 | <0.01 | 391 | 402 | 395 |
| | | | | | | | | | |
| **Max** | **145.8** | **58.6** | **8.2** | **10.7** | <0.1 | <0.01 | | **409.4** | |
| **Min** | **125.4** | **44.9** | **5.6** | **8.2** | <0.1 | <0.01 | | **371.4** | |
| **Average** | **136.7** | **53.4** | **7.4** | **9.7** | <0.1 | <0.01 | | **390.3** | |
| **98 % tile** | **145.5** | **58.2** | **8.2** | **10.7** | <0.1 | <0.01 | | **408.1** | |

**ANNEXURE-VI**

**AMBIENT AIR QUALITY LEVELS (POST MONSOON SEASON)**

| AAQ-1 Bargawan Village | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Date of Monitoring** | **TSPM (mg/m3)** | **RPM (mg/m3)** | **SO2 (mg/m3)** | **Nox (mg/m3)** | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | **CO** | | |
| 04.09.2008 | 125.0 | 35.8 | 7.6 | 9.2 | <0.1 | <0.01 | 403 | 394 | 383 |
| 05.09.2008 | 133.5 | 40.6 | 7.1 | 8.8 | <0.1 | <0.01 | 392 | 383 | 373 |
| 11.09.2008 | 127.3 | 37.2 | 6.4 | 7.3 | <0.1 | <0.01 | 398 | 389 | 378 |
| 12.09.2008 | 119.2 | 34.9 | 5.9 | 7.2 | <0.1 | <0.01 | 270 | 264 | 257 |
| 18.09.2008 | 116.5 | 38.1 | 7.2 | 9.3 | <0.1 | <0.01 | 290 | 284 | 276 |
| 19.09.2008 | 130.1 | 43.1 | 6.4 | 8.7 | <0.1 | <0.01 | 283 | 277 | 269 |
| 25.09.2008 | 116.5 | 35.4 | 5.4 | 7.7 | <0.1 | <0.01 | 304 | 298 | 289 |
| 26.09.2008 | 99.2 | 30.7 | 5.3 | 8.0 | <0.1 | <0.01 | 288 | 282 | 274 |
| 02.10.2008 | 103.0 | 28.6 | 6.7 | 8.4 | <0.1 | <0.01 | 289 | 283 | 275 |
| 03.10.2008 | 109.6 | 36.5 | 6.4 | 8.0 | <0.1 | <0.01 | 319 | 313 | 304 |
| 09.10.2008 | 100.8 | 32.4 | 5.5 | 6.9 | <0.1 | <0.01 | 299 | 293 | 285 |
| 10.10.2008 | 116.5 | 34.3 | 5.6 | 7.1 | <0.1 | <0.01 | 328 | 321 | 312 |
| 16.10.2008 | 118.8 | 42.1 | 6.1 | 7.9 | <0.1 | <0.01 | 326 | 332 | 330 |
| 17.10.2008 | 128.6 | 44.8 | 5.2 | 6.7 | <0.1 | <0.01 | 327 | 333 | 331 |
| 23.10.2008 | 105.9 | 34.6 | 6.2 | 7.2 | <0.1 | <0.01 | 332 | 338 | 336 |
| 24.10.2008 | 139.0 | 45.6 | 7.2 | 9.3 | <0.1 | <0.01 | 310 | 306 | 301 |
| 30.10.2008 | 128.5 | 38.5 | 7.2 | 9.2 | <0.1 | <0.01 | 295 | 290 | 292 |
| 31.10.2008 | 117.3 | 39.7 | 6.9 | 8.6 | <0.1 | <0.01 | 289 | 284 | 286 |
| 06.11.2008 | 115.7 | 36.2 | 5.8 | 7.6 | <0.1 | <0.01 | 291 | 290 | 287 |
| 07.11.2008 | 110.9 | 36.8 | 6.7 | 8.2 | <0.1 | <0.01 | 299 | 285 | 296 |
| 13.11.2008 | 101.1 | 30.6 | 6.4 | 8.4 | <0.1 | <0.01 | 287 | 314 | 286 |
| 14.11.2008 | 99.6 | 32.8 | 5.6 | 7.2 | <0.1 | <0.01 | 378 | 371 | 384 |
| 20.11.2008 | 114.4 | 34.6 | 5.7 | 7.8 | <0.1 | <0.01 | 405 | 395 | 407 |
| 21.11.2008 | 127.8 | 41.2 | 8.1 | 10.0 | <0.1 | <0.01 | 377 | 398 | 380 |
| 27.11.2008 | 116.5 | 36.9 | 5.9 | 6.6 | <0.1 | <0.01 | 401 | 390 | 396 |
| 28.11.2008 | 116.6 | 38.9 | 7.6 | 9.5 | <0.1 | <0.01 | 395 | 399 | 405 |
| 04.12.2008 | 115.4 | 35.8 | 6.7 | 7.3 | <0.1 | <0.01 | 384 | 359 | 336 |
| 05.12.2008 | 117.9 | 37.3 | 5.8 | 7.8 | <0.1 | <0.01 | 397 | 384 | 366 |
| 11.12.2008 | 123.2 | 37.4 | 7.1 | 6.9 | <0.1 | <0.01 | 385 | 369 | 342 |
| 12.12.2008 | 108.7 | 35.4 | 7.4 | 6.7 | <0.1 | <0.01 | 372 | 361 | 358 |
| 18.12.2008 | 114.4 | 36.2 | 7.9 | 8.7 | <0.1 | <0.01 | 367 | 358 | 342 |
| 19.12.2008 | 119.5 | 37.9 | 5.5 | 8.1 | <0.1 | <0.01 | 358 | 342 | 338 |
| 25.12.2008 | 117.2 | 37.2 | 6.4 | 9.2 | <0.1 | <0.01 | 342 | 335 | 329 |
| 26.12.2008 | 113.2 | 36.1 | 6.7 | 9.6 | <0.1 | <0.01 | 348 | 335 | 328 |
| **Max** | **139.0** | **45.6** | **8.1** | **10.0** | <0.1 | <0.01 | | **399** | |
| **Min** | **99.2** | **28.6** | **5.2** | **6.6** | <0.1 | <0.01 | | **264** | |
| **Average** | **116.8** | **36.9** | **6.5** | **8.1** | <0.1 | <0.01 | | **334** | |
| **98 % tile** | **136.3** | **45.2** | **7.9** | **9.8** | <0.1 | <0.01 | | **399** | |

**ANNEXURE-VI**

**AMBIENT AIR QUALITY LEVELS (POST MONSOON SEASON)**

**AAQ-2 Gidher Village**

| Date of Monitoring | TSPM (mg/m3) | RPM (mg/m3) | SO2 (mg/m3) | Nox (mg/m3) | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.09.2008 | 105.1 | 35.3 | 6.6 | 8.3 | <0.1 | <0.01 | 382 | 406 | 398 |
| 05.09.2008 | 109.5 | 37.1 | 6.4 | 8.2 | <0.1 | <0.01 | 375 | 399 | 404 |
| 11.09.2008 | 107.9 | 30.6 | 6.1 | 8.3 | <0.1 | <0.01 | 379 | 405 | 410 |
| 12.09.2008 | 103.4 | 34.8 | 5.6 | 8.0 | <0.1 | <0.01 | 258 | 275 | 278 |
| 18.09.2008 | 99.9 | 34.3 | 7.9 | 10.3 | <0.1 | <0.01 | 277 | 295 | 299 |
| 19.09.2008 | 106.9 | 30.6 | 7.2 | 9.6 | <0.1 | <0.01 | 271 | 285 | 280 |
| 25.09.2008 | 100.3 | 28.7 | 5.1 | 7.5 | <0.1 | <0.01 | 290 | 309 | 313 |
| 26.09.2008 | 93.1 | 33.7 | 6.9 | 9.7 | <0.1 | <0.01 | 276 | 290 | 285 |
| 02.10.2008 | 94.9 | 33.1 | 7.6 | 9.4 | <0.1 | <0.01 | 276 | 295 | 298 |
| 03.10.2008 | 93.6 | 29.9 | 6.7 | 8.4 | <0.1 | <0.01 | 305 | 325 | 329 |
| 09.10.2008 | 89.9 | 31.4 | 5.3 | 6.8 | <0.1 | <0.01 | 287 | 301 | 296 |
| 10.10.2008 | 101.6 | 35.0 | 5.4 | 7.0 | <0.1 | <0.01 | 314 | 326 | 308 |
| 16.10.2008 | 99.2 | 34.3 | 7.0 | 8.9 | <0.1 | <0.01 | 312 | 315 | 303 |
| 17.10.2008 | 104.6 | 36.7 | 5.2 | 6.8 | <0.1 | <0.01 | 313 | 316 | 305 |
| 23.10.2008 | 95.1 | 33.0 | 5.9 | 8.3 | <0.1 | <0.01 | 318 | 321 | 309 |
| 24.10.2008 | 111.4 | 28.0 | 8.2 | 10.4 | <0.1 | <0.01 | 306 | 300 | 293 |
| 30.10.2008 | 107.9 | 36.9 | 6.4 | 8.5 | <0.1 | <0.01 | 293 | 287 | 281 |
| 31.10.2008 | 96.6 | 33.1 | 6.3 | 8.1 | <0.1 | <0.01 | 293 | 281 | 274 |
| 06.11.2008 | 98.6 | 33.0 | 6.0 | 7.9 | <0.1 | <0.01 | 298 | 283 | 275 |
| 07.11.2008 | 95.3 | 31.9 | 7.7 | 9.3 | <0.1 | <0.01 | 292 | 297 | 275 |
| 13.11.2008 | 91.3 | 32.3 | 6.9 | 9.0 | <0.1 | <0.01 | 317 | 310 | 305 |
| 14.11.2008 | 89.1 | 27.6 | 6.5 | 8.2 | <0.1 | <0.01 | 389 | 395 | 390 |
| 20.11.2008 | 98.1 | 26.3 | 6.2 | 8.4 | <0.1 | <0.01 | 408 | 400 | 391 |
| 21.11.2008 | 105.2 | 36.6 | 7.7 | 9.7 | <0.1 | <0.01 | 375 | 374 | 390 |
| 27.11.2008 | 98.9 | 33.1 | 5.2 | 6.1 | <0.1 | <0.01 | 269 | 289 | 282 |
| 28.11.2008 | 96.9 | 33.7 | 7.7 | 9.7 | <0.1 | <0.01 | 275 | 295 | 273 |
| 04.12.2008 | 95.3 | 32.5 | 5.6 | 6.8 | <0.1 | <0.01 | 285 | 274 | 261 |
| 05.12.2008 | 101.5 | 32.8 | 5.8 | 7.2 | <0.1 | <0.01 | 273 | 269 | 258 |
| 11.12.2008 | 108.4 | 36.5 | 6.3 | 8.6 | <0.1 | <0.01 | 289 | 275 | 269 |
| 12.12.2008 | 110.5 | 36.3 | 6.6 | 7.9 | <0.1 | <0.01 | 275 | 271 | 265 |
| 18.12.2008 | 108.4 | 36.2 | 7.1 | 8.3 | <0.1 | <0.01 | 264 | 258 | 241 |
| 19.12.2008 | 104.5 | 34.2 | 7.4 | 9.1 | <0.1 | <0.01 | 252 | 249 | 242 |
| 25.12.2008 | 95.8 | 31.6 | 6.5 | 9.4 | <0.1 | <0.01 | 298 | 287 | 274 |
| 26.12.2008 | 94.9 | 31.8 | 5.9 | 9.2 | <0.1 | <0.01 | 269 | 258 | 257 |
| | | | | | | | | | |
| **Max** | **111.4** | **37.1** | **8.2** | **10.4** | <0.1 | <0.01 | | **410** | |
| **Min** | **89.1** | **26.3** | **5.1** | **6.1** | <0.1 | <0.01 | | **258** | |
| **Average** | **89.1** | **26.3** | **6.5** | **8.5** | <0.1 | <0.01 | | **318** | |
| **98 % tile** | **110.8** | **37.0** | **8.1** | **10.4** | <0.1 | <0.01 | | **407** | |

## ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (POST MONSOON SEASON)

| AAQ-3 Orgari Village | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Date of Monitoring** | **TSPM (mg/m3)** | **RPM (mg/m3)** | **SO2 (mg/m3)** | **Nox (mg/m3)** | **Fluoride ($\mu g/m^3$)** | **PAH ($\mu g/m^3$)** | **CO** | | |
| 04.09.2008 | 93.4 | 30.0 | 5.9 | 7.8 | <0.1 | <0.01 | 399 | 379 | 393 |
| 05.09.2008 | 84.5 | 21.6 | 5.7 | 7.7 | <0.1 | <0.01 | 388 | 369 | 388 |
| 11.09.2008 | 89.6 | 29.2 | 5.3 | 7.6 | <0.1 | <0.01 | 394 | 375 | 388 |
| 12.09.2008 | 92.4 | 26.6 | 5.8 | 7.8 | <0.1 | <0.01 | 267 | 261 | 267 |
| 18.09.2008 | 79.9 | 27.2 | 6.7 | 9.3 | <0.1 | <0.01 | 287 | 274 | 283 |
| 19.09.2008 | 76.5 | 25.6 | 6.3 | 8.9 | <0.1 | <0.01 | 278 | 267 | 276 |
| 25.09.2008 | 86.6 | 28.1 | 5.6 | 8.2 | <0.1 | <0.01 | 301 | 287 | 297 |
| 26.09.2008 | 92.8 | 30.7 | 7.1 | 10.1 | <0.1 | <0.01 | 283 | 272 | 281 |
| 02.10.2008 | 91.6 | 30.4 | 7.9 | 9.9 | <0.1 | <0.01 | 286 | 280 | 286 |
| 03.10.2008 | 82.6 | 27.0 | 7.1 | 9.0 | <0.1 | <0.01 | 316 | 301 | 312 |
| 09.10.2008 | 78.2 | 23.0 | 6.2 | 7.9 | <0.1 | <0.01 | 294 | 301 | 292 |
| 10.10.2008 | 89.5 | 22.3 | 5.6 | 7.4 | <0.1 | <0.01 | 322 | 302 | 320 |
| 16.10.2008 | 85.1 | 22.2 | 6.9 | 9.0 | <0.1 | <0.01 | 300 | 325 | 328 |
| 17.10.2008 | 73.8 | 18.6 | 7.1 | 8.9 | <0.1 | <0.01 | 302 | 326 | 327 |
| 23.10.2008 | 86.5 | 28.0 | 6.1 | 8.7 | <0.1 | <0.01 | 306 | 331 | 332 |
| 24.10.2008 | 85.9 | 22.3 | 6.9 | 9.3 | <0.1 | <0.01 | 290 | 288 | 294 |
| 30.10.2008 | 78.9 | 27.4 | 6.9 | 9.2 | <0.1 | <0.01 | 277 | 276 | 282 |
| 31.10.2008 | 80.8 | 25.9 | 5.6 | 7.6 | <0.1 | <0.01 | 275 | 279 | 285 |
| 06.11.2008 | 77.2 | 21.7 | 6.1 | 8.2 | <0.1 | <0.01 | 273 | 271 | 276 |
| 07.11.2008 | 85.3 | 22.3 | 7.3 | 9.1 | <0.1 | <0.01 | 271 | 273 | 276 |
| 13.11.2008 | 93.4 | 28.2 | 7.2 | 9.5 | <0.1 | <0.01 | 300 | 299 | 306 |
| 14.11.2008 | 88.9 | 22.3 | 5.8 | 7.7 | <0.1 | <0.01 | 398 | 406 | 401 |
| 20.11.2008 | 85.6 | 24.7 | 5.5 | 6.9 | <0.1 | <0.01 | 386 | 384 | 393 |
| 21.11.2008 | 74.6 | 20.7 | 7.3 | 9.5 | <0.1 | <0.01 | 397 | 394 | 387 |
| 27.11.2008 | 77.9 | 24.3 | 5.9 | 8.0 | <0.1 | <0.01 | 303 | 287 | 288 |
| 28.11.2008 | 80.6 | 22.2 | 7.3 | 9.5 | <0.1 | <0.01 | 309 | 278 | 295 |
| 04.12.2008 | 78.2 | 24.5 | 5.8 | 7.2 | <0.1 | <0.01 | 342 | 329 | 313 |
| 05.12.2008 | 83.2 | 28.2 | 6.1 | 7.5 | <0.1 | <0.01 | 356 | 341 | 329 |
| 11.12.2008 | 92.6 | 29.6 | 6.9 | 7.9 | <0.1 | <0.01 | 375 | 364 | 355 |
| 12.12.2008 | 87.4 | 28.5 | 7.2 | 8.4 | <0.1 | <0.01 | 398 | 375 | 361 |
| 18.12.2008 | 91.3 | 31.2 | 7.6 | 6.8 | <0.1 | <0.01 | 385 | 371 | 354 |
| 19.12.2008 | 85.6 | 28.1 | 7.7 | 8.3 | <0.1 | <0.01 | 354 | 341 | 322 |
| 25.12.2008 | 93.1 | 29.4 | 8.2 | 9.3 | <0.1 | <0.01 | 395 | 388 | 365 |
| 26.12.2008 | 87.2 | 28.9 | 8.4 | 8.5 | <0.1 | <0.01 | 344 | 328 | 321 |
| | | | | | | | | | |
| **Max** | **93.4** | **31.2** | **8.4** | **10.1** | <0.1 | <0.01 | | **406** | |
| **Min** | **73.8** | **18.6** | **5.3** | **6.8** | <0.1 | <0.01 | | **261** | |
| **Average** | **85.0** | **25.9** | **6.6** | **8.4** | <0.1 | <0.01 | | **315** | |
| **98 % tile** | **93.4** | **30.6** | **7.6** | **10.0** | <0.1 | <0.01 | | **400** | |

## ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (POST MONSOON SEASON)

| AAQ-4 Barauniya Village | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date of Monitoring | TSPM (mg/m3) | RPM (mg/m3) | SO2 (mg/m3) | Nox (mg/m3) | Fluoride (µg/m³) | PAH (µg/m³) | CO | | |
| 04.09.2008 | 97.6 | 26.0 | 6.6 | 8.6 | <0.1 | <0.01 | 395 | 402 | 394 |
| 05.09.2008 | 102.4 | 29.0 | 7.1 | 9.2 | <0.1 | <0.01 | 384 | 391 | 383 |
| 11.09.2008 | 96.2 | 28.5 | 5.5 | 8.0 | <0.1 | <0.01 | 390 | 397 | 389 |
| 12.09.2008 | 89.0 | 27.0 | 5.7 | 8.4 | <0.1 | <0.01 | 264 | 269 | 263 |
| 18.09.2008 | 76.9 | 23.9 | 6.1 | 8.8 | <0.1 | <0.01 | 284 | 289 | 285 |
| 19.09.2008 | 75.9 | 23.6 | 5.1 | 7.8 | <0.1 | <0.01 | 277 | 282 | 275 |
| 25.09.2008 | 90.0 | 27.3 | 7.5 | 10.2 | <0.1 | <0.01 | 298 | 303 | 299 |
| 26.09.2008 | 96.0 | 30.0 | 5.8 | 7.9 | <0.1 | <0.01 | 282 | 287 | 280 |
| 02.10.2008 | 101.1 | 31.4 | 7.5 | 9.6 | <0.1 | <0.01 | 283 | 288 | 282 |
| 03.10.2008 | 75.9 | 23.0 | 7.5 | 9.5 | <0.1 | <0.01 | 313 | 318 | 314 |
| 09.10.2008 | 87.4 | 26.4 | 5.8 | 7.6 | <0.1 | <0.01 | 295 | 298 | 291 |
| 10.10.2008 | 98.7 | 29.9 | 6.9 | 6.8 | <0.1 | <0.01 | 327 | 297 | 319 |
| 16.10.2008 | 99.7 | 29.5 | 6.5 | 8.7 | <0.1 | <0.01 | 314 | 322 | 329 |
| 17.10.2008 | 90.2 | 27.7 | 6.3 | 8.2 | <0.1 | <0.01 | 315 | 320 | 327 |
| 23.10.2008 | 96.5 | 29.2 | 6.2 | 8.5 | <0.1 | <0.01 | 320 | 328 | 332 |
| 24.10.2008 | 69.9 | 21.4 | 7.9 | 10.4 | <0.1 | <0.01 | 298 | 301 | 309 |
| 30.10.2008 | 73.4 | 22.6 | 6.8 | 9.2 | <0.1 | <0.01 | 286 | 288 | 281 |
| 31.10.2008 | 81.1 | 24.0 | 5.9 | 8.0 | <0.1 | <0.01 | 280 | 282 | 278 |
| 06.11.2008 | 85.5 | 25.5 | 5.8 | 8.0 | <0.1 | <0.01 | 280 | 282 | 290 |
| 07.11.2008 | 104.2 | 31.9 | 7.4 | 9.3 | <0.1 | <0.01 | 281 | 289 | 276 |
| 13.11.2008 | 94.8 | 24.9 | 6.6 | 9.0 | <0.1 | <0.01 | 312 | 278 | 294 |
| 14.11.2008 | 100.0 | 26.6 | 6.7 | 8.7 | <0.1 | <0.01 | 375 | 405 | 398 |
| 20.11.2008 | 101.5 | 30.9 | 5.4 | 7.9 | <0.1 | <0.01 | 398 | 401 | 391 |
| 21.11.2008 | 104.0 | 32.1 | 6.8 | 9.1 | <0.1 | <0.01 | 379 | 405 | 399 |
| 27.11.2008 | 92.4 | 29.0 | 5.4 | 6.6 | <0.1 | <0.01 | 318 | 298 | 301 |
| 28.11.2008 | 88.5 | 27.3 | 7.4 | 9.7 | <0.1 | <0.01 | 325 | 289 | 306 |
| 04.12.2008 | 72.5 | 25.6 | 5.6 | 6.9 | <0.1 | <0.01 | 328 | 312 | 286 |
| 05.12.2008 | 78.9 | 25.8 | 5.8 | 7.1 | <0.1 | <0.01 | 386 | 379 | 361 |
| 11.12.2008 | 86.5 | 27.6 | 6.2 | 7.8 | <0.1 | <0.01 | 375 | 369 | 356 |
| 12.12.2008 | 87.2 | 29.7 | 6.4 | 8.9 | <0.1 | <0.01 | 386 | 371 | 355 |
| 18.12.2008 | 93.4 | 31.5 | 6.9 | 7.7 | <0.1 | <0.01 | 379 | 368 | 325 |
| 19.12.2008 | 97.6 | 32.6 | 7.2 | 8.2 | <0.1 | <0.01 | 398 | 342 | 325 |
| 25.12.2008 | 79.6 | 27.9 | 8.3 | 9.3 | <0.1 | <0.01 | 326 | 318 | 298 |
| 26.12.2008 | 74.6 | 27.2 | 8.4 | 8.8 | <0.1 | <0.01 | 312 | 318 | 283 |
| | | | | | | | | | |
| **Max** | **104.2** | **32.6** | **8.4** | **10.4** | <0.1 | <0.01 | | **405** | |
| **Min** | **69.9** | **21.4** | **5.1** | **6.6** | <0.1 | <0.01 | | **263** | |
| **Average** | **89.4** | **27.5** | **6.6** | **8.5** | <0.1 | <0.01 | | **319** | |
| **98 % tile** | **104.1** | **32.0** | **7.7** | **10.3** | <0.1 | <0.01 | | **404** | |

## ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (POST MONSOON SEASON)

| AAQ-5 Barokhar Village | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date of Monitoring | TSPM (mg/m3) | RPM (mg/m3) | SO2 (mg/m3) | Nox (mg/m3) | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | CO | | |
| 04.09.2008 | 99.3 | 27.7 | 5.7 | 7.4 | <0.1 | <0.01 | 391 | 408 | 401 |
| 05.09.2008 | 100.4 | 29.7 | 6.3 | 8.1 | <0.1 | <0.01 | 381 | 399 | 398 |
| 11.09.2008 | 96.1 | 28.1 | 5.9 | 7.1 | <0.1 | <0.01 | 387 | 405 | 404 |
| 12.09.2008 | 89.9 | 27.2 | 6.8 | 9.2 | <0.1 | <0.01 | 275 | 279 | 274 |
| 18.09.2008 | 87.7 | 26.8 | 6.9 | 9.3 | <0.1 | <0.01 | 282 | 296 | 295 |
| 19.09.2008 | 79.8 | 23.6 | 6.2 | 8.6 | <0.1 | <0.01 | 281 | 287 | 282 |
| 25.09.2008 | 79.7 | 24.7 | 7.1 | 9.5 | <0.1 | <0.01 | 295 | 310 | 309 |
| 26.09.2008 | 83.8 | 24.6 | 5.3 | 8.1 | <0.1 | <0.01 | 286 | 293 | 287 |
| 02.10.2008 | 81.5 | 21.4 | 7.0 | 8.8 | <0.1 | <0.01 | 295 | 299 | 293 |
| 03.10.2008 | 94.5 | 27.1 | 6.3 | 8.0 | <0.1 | <0.01 | 310 | 326 | 325 |
| 09.10.2008 | 87.8 | 25.4 | 6.1 | 7.6 | <0.1 | <0.01 | 297 | 304 | 299 |
| 10.10.2008 | 101.8 | 30.1 | 6.3 | 7.9 | <0.1 | <0.01 | 326 | 299 | 327 |
| 16.10.2008 | 97.8 | 29.7 | 6.5 | 8.4 | <0.1 | <0.01 | 330 | 309 | 320 |
| 17.10.2008 | 88.4 | 27.6 | 5.9 | 7.5 | <0.1 | <0.01 | 331 | 311 | 321 |
| 23.10.2008 | 94.4 | 26.9 | 5.4 | 7.8 | <0.1 | <0.01 | 336 | 315 | 326 |
| 24.10.2008 | 81.5 | 23.4 | 7.5 | 9.7 | <0.1 | <0.01 | 303 | 304 | 298 |
| 30.10.2008 | 88.7 | 25.2 | 6.1 | 8.2 | <0.1 | <0.01 | 290 | 291 | 285 |
| 31.10.2008 | 93.2 | 26.6 | 5.5 | 7.3 | <0.1 | <0.01 | 284 | 285 | 278 |
| 06.11.2008 | 84.1 | 24.4 | 5.5 | 7.4 | <0.1 | <0.01 | 284 | 284 | 280 |
| 07.11.2008 | 80.1 | 23.1 | 8.2 | 9.8 | <0.1 | <0.01 | 283 | 287 | 291 |
| 13.11.2008 | 68.4 | 20.1 | 6.1 | 8.2 | <0.1 | <0.01 | 289 | 315 | 309 |
| 14.11.2008 | 74.2 | 21.8 | 5.7 | 6.8 | <0.1 | <0.01 | 391 | 373 | 375 |
| 20.11.2008 | 67.7 | 20.5 | 5.3 | 7.5 | <0.1 | <0.01 | 402 | 401 | 397 |
| 21.11.2008 | 76.4 | 22.4 | 7.1 | 9.1 | <0.1 | <0.01 | 395 | 374 | 379 |
| 27.11.2008 | 83.5 | 23.7 | 5.9 | 7.8 | <0.1 | <0.01 | 321 | 322 | 327 |
| 28.11.2008 | 90.5 | 25.3 | 5.4 | 7.2 | <0.1 | <0.01 | 313 | 314 | 319 |
| 04.12.2008 | 68.5 | 24.6 | 5.5 | 7.1 | <0.1 | <0.01 | 324 | 315 | 308 |
| 05.12.2008 | 75.2 | 26.4 | 6.3 | 8.2 | <0.1 | <0.01 | 389 | 375 | 365 |
| 11.12.2008 | 89.4 | 31.5 | 7.5 | 9.5 | <0.1 | <0.01 | 358 | 356 | 342 |
| 12.12.2008 | 82.1 | 29.8 | 8.4 | 9.2 | <0.1 | <0.01 | 342 | 333 | 326 |
| 18.12.2008 | 89.4 | 31.6 | 9.4 | 7.4 | <0.1 | <0.01 | 355 | 341 | 339 |
| 19.12.2008 | 88.2 | 32.6 | 8.8 | 9.4 | <0.1 | <0.01 | 346 | 338 | 327 |
| 25.12.2008 | 79.6 | 28.9 | 8.7 | 7.2 | <0.1 | <0.01 | 329 | 325 | 321 |
| 26.12.2008 | 75.2 | 25.4 | 8.6 | 8.2 | <0.1 | <0.01 | 375 | 364 | 324 |
| | | | | | | | | | |
| **Max** | **101.8** | **32.6** | **9.4** | **9.8** | <0.1 | <0.01 | | **408** | |
| **Min** | **67.7** | **20.1** | **5.3** | **6.8** | <0.1 | <0.01 | | **274** | |
| **Average** | **85.3** | **26.1** | **6.6** | **8.2** | <0.1 | <0.01 | | **323** | |
| **98 % tile** | **101.1** | **29.9** | **7.9** | **9.8** | <0.1 | <0.01 | | **405** | |

**ANNEXURE-VI**
**AMBIENT AIR QUALITY LEVELS (POST MONSOON SEASON)**

**AAQ-6 Waghadih Village**

| Date of Monitoring | TSPM (mg/m3) | RPM (mg/m3) | SO2 (mg/m3) | Nox (mg/m3) | Fluoride (µg/m³) | PAH (µg/m³) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.09.2008 | 77.9 | 23.1 | 7.4 | 9.5 | <0.1 | <0.01 | 404 | 406 | 397 |
| 05.09.2008 | 91.9 | 28.6 | 7.4 | 9.6 | <0.1 | <0.01 | 393 | 395 | 386 |
| 11.09.2008 | 98.5 | 27.9 | 5.2 | 7.8 | <0.1 | <0.01 | 399 | 401 | 392 |
| 12.09.2008 | 100.8 | 32.9 | 6.5 | 9.3 | <0.1 | <0.01 | 281 | 272 | 266 |
| 18.09.2008 | 89.0 | 28.4 | 6.1 | 8.9 | <0.1 | <0.01 | 291 | 292 | 286 |
| 19.09.2008 | 70.0 | 23 | 5.5 | 8.3 | <0.1 | <0.01 | 284 | 285 | 279 |
| 25.09.2008 | 79.7 | 24.4 | 6.2 | 9.5 | <0.1 | <0.01 | 305 | 306 | 300 |
| 26.09.2008 | 93.8 | 28.8 | 5.6 | 8.8 | <0.1 | <0.01 | 289 | 290 | 284 |
| 02.10.2008 | 84.4 | 25.8 | 6.4 | 8.6 | <0.1 | <0.01 | 301 | 291 | 285 |
| 03.10.2008 | 71.5 | 21.6 | 7.2 | 9.1 | <0.1 | <0.01 | 321 | 322 | 317 |
| 09.10.2008 | 84.8 | 24.7 | 5.3 | 7.2 | <0.1 | <0.01 | 300 | 307 | 296 |
| 10.10.2008 | 93.4 | 27.7 | 5.4 | 7.4 | <0.1 | <0.01 | 298 | 330 | 323 |
| 16.10.2008 | 87.0 | 26.3 | 6.2 | 8.5 | <0.1 | <0.01 | 325 | 305 | 310 |
| 17.10.2008 | 89.1 | 27.9 | 5.7 | 6.7 | <0.1 | <0.01 | 326 | 306 | 311 |
| 23.10.2008 | 83.5 | 24.6 | 5.9 | 6.8 | <0.1 | <0.01 | 331 | 311 | 316 |
| 24.10.2008 | 96.5 | 29.5 | 5.6 | 8.2 | <0.1 | <0.01 | 289 | 290 | 309 |
| 30.10.2008 | 91.5 | 27.2 | 6.2 | 8.7 | <0.1 | <0.01 | 277 | 279 | 293 |
| 31.10.2008 | 86.5 | 23.2 | 5.5 | 7.7 | <0.1 | <0.01 | 276 | 272 | 287 |
| 06.11.2008 | 78.1 | 22.9 | 5.3 | 7.6 | <0.1 | <0.01 | 272 | 275 | 290 |
| 07.11.2008 | 69.9 | 22.4 | 7.6 | 9.6 | <0.1 | <0.01 | 271 | 273 | 286 |
| 13.11.2008 | 62.4 | 24.7 | 7.1 | 9.6 | <0.1 | <0.01 | 300 | 302 | 313 |
| 14.11.2008 | 71.7 | 23.5 | 6.6 | 8.7 | <0.1 | <0.01 | 387 | 384 | 375 |
| 20.11.2008 | 77.6 | 25.7 | 6.2 | 6.7 | <0.1 | <0.01 | 386 | 388 | 410 |
| 21.11.2008 | 80.6 | 24.4 | 7.9 | 10.3 | <0.1 | <0.01 | 400 | 388 | 375 |
| 27.11.2008 | 85.4 | 25.2 | 7.2 | 9.5 | <0.1 | <0.01 | 295 | 289 | 283 |
| 28.11.2008 | 87.6 | 26.8 | 5.8 | 8.2 | <0.1 | <0.01 | 299 | 284 | 276 |
| 04.12.2008 | 73.5 | 24.5 | 6.2 | 6.9 | <0.1 | <0.01 | 289 | 274 | 233 |
| 05.12.2008 | 84.1 | 28.3 | 6.4 | 8.4 | <0.1 | <0.01 | 312 | 410 | 277 |
| 11.12.2008 | 93.6 | 32.6 | 5.9 | 7.6 | <0.1 | <0.01 | 354 | 346 | 333 |
| 12.12.2008 | 74.5 | 26.5 | 7.1 | 8.4 | <0.1 | <0.01 | 361 | 348 | 335 |
| 18.12.2008 | 69.5 | 23.6 | 7.3 | 9.3 | <0.1 | <0.01 | 325 | 316 | 308 |
| 19.12.2008 | 85.7 | 28.7 | 6.9 | 10.1 | <0.1 | <0.01 | 329 | 314 | 304 |
| 25.12.2008 | 78.4 | 26.9 | 6.6 | 9.5 | <0.1 | <0.01 | 305 | 285 | 274 |
| 26.12.2008 | 93.2 | 31.1 | 5.7 | 7.5 | <0.1 | <0.01 | 294 | 286 | 244 |
| | | | | | | | | | |
| **Max** | **100.8** | **32.9** | **7.9** | **10.3** | <0.1 | <0.01 | | **410** | |
| **Min** | **62.4** | **21.6** | **5.2** | **6.7** | <0.1 | <0.01 | | **266** | |
| **Average** | **83.4** | **26.3** | **6.3** | **8.5** | <0.1 | <0.01 | | **318** | |
| **98 % tile** | **99.7** | **31.2** | **7.8** | **10.0** | <0.1 | <0.01 | | **405** | |

## ANNEXURE-VI
## AMBIENT AIR QUALITY LEVELS (POST MONSOON SEASON)

AAQ-7 Dharsara Village

| Date of Monitoring | TSPM (mg/m3) | RPM (mg/m3) | SO2 (mg/m3) | Nox (mg/m3) | Fluoride ($\mu g/m^3$) | PAH ($\mu g/m^3$) | CO | | |
|---|---|---|---|---|---|---|---|---|---|
| 04.09.2008 | 101.3 | 31.8 | 6.7 | 8.5 | <0.1 | <0.01 | 388 | 383 | 381 |
| 05.09.2008 | 103.8 | 31.4 | 6.3 | 8.2 | <0.1 | <0.01 | 378 | 373 | 371 |
| 11.09.2008 | 99.5 | 31.6 | 6.1 | 8.4 | <0.1 | <0.01 | 384 | 379 | 377 |
| 12.09.2008 | 95.6 | 29.3 | 5.9 | 8.4 | <0.1 | <0.01 | 268 | 263 | 264 |
| 18.09.2008 | 90.1 | 27.8 | 7.9 | 10.4 | <0.1 | <0.01 | 280 | 277 | 275 |
| 19.09.2008 | 79.9 | 26.6 | 7.1 | 9.6 | <0.1 | <0.01 | 273 | 269 | 268 |
| 25.09.2008 | 69.2 | 24.2 | 5.6 | 8.1 | <0.1 | <0.01 | 293 | 290 | 288 |
| 26.09.2008 | 60.9 | 23.0 | 5.9 | 7.8 | <0.1 | <0.01 | 278 | 274 | 273 |
| 02.10.2008 | 66.2 | 25.6 | 6.1 | 7.8 | <0.1 | <0.01 | 287 | 282 | 283 |
| 03.10.2008 | 62.2 | 21.8 | 5.2 | 7.0 | <0.1 | <0.01 | 308 | 305 | 303 |
| 09.10.2008 | 89.1 | 25.9 | 5.9 | 7.5 | <0.1 | <0.01 | 289 | 285 | 287 |
| 10.10.2008 | 83.4 | 25.0 | 6.5 | 8.2 | <0.1 | <0.01 | 317 | 312 | 311 |
| 16.10.2008 | 68.1 | 22.9 | 7.9 | 9.9 | <0.1 | <0.01 | 308 | 324 | 322 |
| 17.10.2008 | 80.0 | 24.6 | 6.9 | 8.6 | <0.1 | <0.01 | 308 | 325 | 322 |
| 23.10.2008 | 101.3 | 31.1 | 5.8 | 8.3 | <0.1 | <0.01 | 314 | 330 | 328 |
| 24.10.2008 | 83.3 | 25.2 | 6.9 | 9.2 | <0.1 | <0.01 | 313 | 301 | 287 |
| 30.10.2008 | 93.4 | 32.4 | 5.6 | 7.8 | <0.1 | <0.01 | 288 | 286 | 275 |
| 31.10.2008 | 85.0 | 28.2 | 6.2 | 8.1 | <0.1 | <0.01 | 282 | 280 | 277 |
| 06.11.2008 | 64.1 | 24.4 | 5.8 | 6.5 | <0.1 | <0.01 | 294 | 282 | 269 |
| 07.11.2008 | 101.4 | 32.5 | 7.5 | 9.2 | <0.1 | <0.01 | 282 | 291 | 286 |
| 13.11.2008 | 75.4 | 23.5 | 6.7 | 8.9 | <0.1 | <0.01 | 296 | 310 | 290 |
| 14.11.2008 | 78.2 | 21.0 | 6.6 | 8.5 | <0.1 | <0.01 | 403 | 379 | 402 |
| 20.11.2008 | 81.3 | 25.0 | 7.4 | 6.8 | <0.1 | <0.01 | 401 | 398 | 383 |
| 21.11.2008 | 85.1 | 26.9 | 7.3 | 9.4 | <0.1 | <0.01 | 379 | 386 | 374 |
| 27.11.2008 | 97.2 | 33.7 | 6.8 | 8.8 | <0.1 | <0.01 | 277 | 283 | 313 |
| 28.11.2008 | 88.1 | 29.6 | 6.9 | 9.2 | <0.1 | <0.01 | 281 | 277 | 307 |
| 04.12.2008 | 72.6 | 24.3 | 6.3 | 8.3 | <0.1 | <0.01 | 309 | 313 | 316 |
| 05.12.2008 | 84.5 | 27.5 | 7.1 | 7.4 | <0.1 | <0.01 | 314 | 304 | 285 |
| 11.12.2008 | 81.2 | 26.4 | 8.2 | 7.6 | <0.1 | <0.01 | 326 | 319 | 304 |
| 12.12.2008 | 76.8 | 25.4 | 7.9 | 8.9 | <0.1 | <0.01 | 317 | 305 | 285 |
| 18.12.2008 | 79.4 | 26.8 | 7.4 | 7.1 | <0.1 | <0.01 | 332 | 328 | 316 |
| 19.12.2008 | 74.2 | 25.6 | 7.1 | 6.8 | <0.1 | <0.01 | 384 | 359 | 341 |
| 25.12.2008 | 85.2 | 29.7 | 8.1 | 10.2 | <0.1 | <0.01 | 369 | 342 | 328 |
| 26.12.2008 | 63.5 | 21.2 | 5.9 | 9.2 | <0.1 | <0.01 | 355 | 347 | 312 |
| | | | | | | | | | |
| **Max** | **103.8** | **33.7** | **8.2** | **10.4** | <0.1 | <0.01 | | **403** | |
| **Min** | **60.9** | **21.0** | **5.2** | **6.5** | <0.1 | <0.01 | | **263** | |
| **Average** | **82.4** | **26.8** | **6.7** | **8.4** | <0.1 | <0.01 | | **313** | |
| **98 % tile** | **102.6** | **33.1** | **7.9** | **10.2** | <0.1 | <0.01 | | **402** | |

**ANNEXURE-VI**
**AMBIENT AIR QUALITY LEVELS (POST MONSOON SEASON)**

| AAQ-8 Biradar Village | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date of Monitoring | TSPM (mg/m3) | RPM (mg/m3) | SO2 (mg/m3) | Nox (mg/m3) | Fluoride (μg/m³) | PAH (μg/m³) | CO | | |
| 04.09.2008 | 121.1 | 38.1 | 6 | 7.9 | <0.1 | <0.01 | 389 | 395 | 399 |
| 05.09.2008 | 133.1 | 40.3 | 5.2 | 7.2 | <0.1 | <0.01 | 379 | 384 | 388 |
| 11.09.2008 | 118.8 | 38.2 | 5.5 | 7.1 | <0.1 | <0.01 | 385 | 390 | 394 |
| 12.09.2008 | 128.8 | 42.1 | 6.1 | 7.5 | <0.1 | <0.01 | 271 | 277 | 273 |
| 18.09.2008 | 135.0 | 43.3 | 7.4 | 10 | <0.1 | <0.01 | 281 | 284 | 287 |
| 19.09.2008 | 130.5 | 41.9 | 7.5 | 10.1 | <0.1 | <0.01 | 274 | 278 | 280 |
| 25.09.2008 | 131.4 | 39.2 | 6.3 | 8.9 | <0.1 | <0.01 | 294 | 298 | 301 |
| 26.09.2008 | 124.2 | 38.2 | 5.5 | 8.5 | <0.1 | <0.01 | 279 | 283 | 285 |
| 02.10.2008 | 136.3 | 42.3 | 7.5 | 9.5 | <0.1 | <0.01 | 287 | 296 | 292 |
| 03.10.2008 | 135.2 | 40.1 | 7.2 | 9.1 | <0.1 | <0.01 | 309 | 313 | 316 |
| 09.10.2008 | 128.1 | 40.4 | 6.9 | 8.6 | <0.1 | <0.01 | 290 | 294 | 296 |
| 10.10.2008 | 122.9 | 41.5 | 7.1 | 8.9 | <0.1 | <0.01 | 318 | 325 | 308 |
| 16.10.2008 | 118.7 | 40.3 | 7.6 | 9.7 | <0.1 | <0.01 | 300 | 304 | 306 |
| 17.10.2008 | 120.6 | 41.6 | 7.3 | 9.1 | <0.1 | <0.01 | 302 | 306 | 307 |
| 23.10.2008 | 119.9 | 40.7 | 6.1 | 8.7 | <0.1 | <0.01 | 306 | 310 | 312 |
| 24.10.2008 | 135.7 | 46 | 6.5 | 8.9 | <0.1 | <0.01 | 297 | 298 | 303 |
| 30.10.2008 | 127.6 | 43.2 | 6.8 | 9.1 | <0.1 | <0.01 | 284 | 289 | 293 |
| 31.10.2008 | 116.1 | 39.3 | 5.2 | 7.2 | <0.1 | <0.01 | 279 | 273 | 284 |
| 06.11.2008 | 128.8 | 40.5 | 5.3 | 6.7 | <0.1 | <0.01 | 279 | 272 | 284 |
| 07.11.2008 | 124.9 | 42.7 | 6.9 | 8.7 | <0.1 | <0.01 | 278 | 287 | 284 |
| 13.11.2008 | 133.4 | 45.2 | 6.3 | 8.6 | <0.1 | <0.01 | 308 | 314 | 286 |
| 14.11.2008 | 132.1 | 44.9 | 5.1 | 7.6 | <0.1 | <0.01 | 401 | 374 | 378 |
| 20.11.2008 | 115.9 | 32.3 | 5.8 | 7.2 | <0.1 | <0.01 | 395 | 403 | 408 |
| 21.11.2008 | 126.6 | 37.9 | 6.9 | 9.1 | <0.1 | <0.01 | 385 | 378 | 375 |
| 27.11.2008 | 129.8 | 36 | 7.2 | 9.1 | <0.1 | <0.01 | 373 | 401 | 391 |
| 28.11.2008 | 130.9 | 35.9 | 7.2 | 9.4 | <0.1 | <0.01 | 382 | 395 | 382 |
| 04.12.2008 | 121.3 | 37.6 | 7.3 | 8.9 | <0.1 | <0.01 | 356 | 342 | 333 |
| 05.12.2008 | 136.5 | 42.3 | 7.6 | 9.2 | <0.1 | <0.01 | 329 | 315 | 308 |
| 11.12.2008 | 118.9 | 36.9 | 7.4 | 8.4 | <0.1 | <0.01 | 378 | 369 | 346 |
| 12.12.2008 | 122.3 | 38.4 | 7.8 | 7.6 | <0.1 | <0.01 | 328 | 316 | 311 |
| 18.12.2008 | 119.4 | 37.5 | 6.5 | 9.4 | <0.1 | <0.01 | 412 | 397 | 358 |
| 19.12.2008 | 118.7 | 36.4 | 5.7 | 7.8 | <0.1 | <0.01 | 369 | 357 | 324 |
| 25.12.2008 | 131.5 | 41.5 | 5.6 | 8.4 | <0.1 | <0.01 | 398 | 365 | 321 |
| 26.12.2008 | 116.4 | 36.4 | 6.6 | 6.4 | <0.1 | <0.01 | 297 | 264 | 286 |
| | | | | | | | | | |
| **Max** | **136.5** | **46.0** | **7.8** | **10.1** | <0.1 | <0.01 | | **408** | |
| **Min** | **115.9** | **32.3** | **5.1** | **6.7** | <0.1 | <0.01 | | **271** | |
| **Average** | **126.2** | **40.0** | **6.6** | **8.6** | <0.1 | <0.01 | | **323** | |
| **98 % tile** | **136.0** | **45.6** | **7.6** | **10.1** | <0.1 | <0.01 | | **402** | |

## ANNEXURE-VII
## ECOLOGICAL DETAILS

### TABLE-1
### PLANT SPECIES RECORDED IN STUDY AREA ( CORE ZONE)

| Sr.No | Technical Name | Family | Life form |
|---|---|---|---|
| **I. Agricultural crops** | | | |
| 1. | *Hordium vulgare* | Poaceae | Hemicryptophyte |
| 2. | *Sorghum vulgare* | Poaceae | Hemicryptophyte |
| 3. | *Triticum vulgare* | Poaceae | Hemicryptophyte |
| 4. | *Zea mays* | Poaceae | Hemicryptophyte |
| 5. | *Oryza sativa* | Poaceae | Hemicryptophyte |
| 6. | *Pennisetum typhoideum* | Poaceae | Hemicryptophyte |
| 7. | *Sacharum officinarum* | Poaceae | Hemicryptophyte |
| **II** | **Commercial crops( including vegetables)** | | |
| 8. | *Abelomoschus indicus* | Malvaceae | Therophyte |
| 9. | *Allium cepa* | Liliaceae | Geophyte |
| 10. | *Allium sativum* | Liliaceae | Geophyte |
| 11. | *Annona squamosa* | Annonaceae | Phanerophyte |
| 12. | *Arachis hypogia* | Fabaceae | Geophyte |
| 13. | *Beta vulgaris* | Chenopodiaceae | Geophyte |
| 14. | *Brassica oleracea var botrydis* | Cruciferae | Therophyte |
| 15. | *Brassica oleracea* var capitata | Cruciferae | Therophyte |
| 16. | *Cajanus cajan* | Fabaceae | Therophyte |
| 17. | *Carica papaya* | Caricaceae | Therophyte |
| 18. | *Catharanthes pusillus* | Compositae | Therophyte |
| 19. | *Cicer arietinum* | Fabaceae | Hemicryptophyte |
| 20. | *Citrus lemon* | Ruataceae | Therophyte |
| 21. | *Colacasia esculenta* | Areaceae | Geophyte |
| 22. | *Coreandrum sativum* | Umbelliferae | Hemicryptophyte |
| 23. | *Daucus carota* | Umbelliferae | Geophyte |
| 24. | *Gossypium sp* | Malvaceae | Therophyte |
| 25. | *Lycopersicum esculentus* | Solanaceae | Therophyte |
| 26. | *Mangifera indica* | Anacardiaceae | Phanerophyte |
| 27. | *Memordia charantia* | Cucurbitaceae | Therophyte |
| 28. | *Pepaver somneferrum* | Pepavaraceae | Hemicrptophyte |
| 29. | *Pisum sativum* | Fabaceae | Therophyte |
| 30. | *Psidium guava* | Myrtaceae | Phanerophyte |
| 31. | *Raphanus sativa* | Cruciferae | Geophyte |
| 32. | *Solanum tuberosum* | Solanaceae | Geophyte |
| 33. | *Trichosanthes anguina* | Cucurbitaceae | Therophyte |
| **III. Plantations** | | | |
| 34. | *Acacia nilotica* | Mimosaceae | Phanerophyte |
| 35. | *Albizia lebbeck* | Mimosaceae | Phanerophyte |
| 36. | *Albizia odorattissima* | Mimosaceae | Phanerophyte |
| 37. | *Albizia procera* | Mimosaceae | Phanerophyte |
| 38. | *Azadirachta indica* | Meliaceae | Phanerophyte |
| 39. | *Bauhinia variegate* | Caesalpinaceae | Phanerophyte |
| 40. | *Bauhinia purpuria* | Caesalpinaceae | Phanerophyte |
| 41. | *Bambusa arundanaceae* | Poaceae | Phanerophyte |
| 42. | *Butea superba* | Caesalpinaceae | Phanerophyte |
| 43. | *Butea frondosa* | Caesalpinaceae | Phanerophyte |
| 44. | *Delonix regia* | Caesalpinaceae | Phanerophyte |
| 45. | *Leucena leucophloe* | Caesalpinaceae | Phanerophyte |
| 46. | *Eucalyptus sp* | Myrtaceae | Phanerophyte |
| | **Natural Vegetation/Forest Tyepe** | | |
| 47. | *Abrus precatorius* | Fabaceae | Therophyte |
| 48. | *Abutilon indicum* | Malvaceae | Phanerophyte |
| 49. | *Acacia Arabica* | Mimosaceae | Phanerophyte |
| 50. | *Acacia auriculiformis* | Mimosaceae | Phanerophyte |
| 51. | *Acacia fernacea* | Mimosaceae | Phanerophyte |
| 52. | *Acacia leucophloe* | Mimosaceae | Phanerophyte |
| 53. | *Acacia Senegal* | Mimosaceae | Phanerophyte |
| 54. | *Achyranthes aspera* | Amaranthaceae | Therophyte |
| 55. | *Adathoda vasica* | Acanthaceae | Therophyte |

**ANNEXURE-VII**
**ECOLOGICAL DETAILS**

| Sr.No | Technical Name | Family | Life form |
|---|---|---|---|
| 56. | *Adina cordifolia* | Rubiaceae | Phanerophyte |
| 57. | *Aegle marmelos* | Rutaceae | Phanerophyte |
| 58. | *Aerva lanata* | Compositae | Phanerophyte |
| 59. | *Agave wightii* | Agavaceae | Phanerophyte |
| 60. | *Ageratum conyzoides* | Compositae | Therophyte |
| 61. | *Ailanthes excela* | Simaroubaceae | Phanerophyte |
| 62. | *Alangium salivus* | Alangiceae | Phanerophyte |
| 63. | *Aloe barbedensis* | Agavaceae | Geophyte |
| 64. | *Alstonia scholaris* | Apocyanaceae | Phanerophyte |
| 65. | *Alternanthera sessilis* | Amaranthaceae | Therophyte |
| 66. | *Alysicarpus hamosus* | Fabaceae | Therophyte |
| 67. | *Alysicarpus monilifer* | Fabaceae | Therophyte |
| 68. | *Andrographis paniculata* | Acanthaceae | Hemicryptophyte |
| 69. | *Anoegeissus latifolia* | Combretaceae | Phanerophyte |
| 70. | *Anogeissus latifolia* | Combretaceae | Phanerophyte |
| 71. | *Anogeissus serica* | Combretaceae | Phanerophyte |
| 72. | *Asparagaus racemosus* | Liliaceae | Therophyte |
| 73. | *Atalantia monophylla* | Rutaceae | Therophyte |
| 74. | *Barleria prionoites* | Acanthaceae | Therophyte |
| 75. | *Bidens biternata* | Compositae | Therophyte |
| 76. | *Blepharis asperima* | Acanthaceae | Phanerophyte |
| 77. | *Blepharis madaraspatens* | Acanthaceae | Therophyte |
| 78. | *Blumea lacera* | Compositae | Therophyte |
| 79. | *Boerheavia chinensis* | Nycataginaceae | Therophyte |
| 80. | *Boerheavia diffusa* | Nyctaginaceae | Therophyte |
| 81. | *Bombax ceiba* | Bombacaceae | Phanerophyte |
| 82. | *Borreria hispida* | Rubiaceae | Therophyte |
| 83. | *Borreria stricta* | Rubiaceae | Therophyte |
| 84. | *Boswellia serrata* | Burseraceae | Phanerophyte |
| 85. | *Brassica camprestris* | Cruciferae | Therophyte |
| 86. | *Bridelia retusa* | Euphorbiaceae | Phanerophyte |
| 87. | *Bridelia superba* | Euphorbiaceae | Phanerophyte |
| 88. | *Caesalpina pulcherima* | Caesalpinaceae | Phanerophyte |
| 89. | *Calotropis procera* | Asclipiadaceae | Phanerophyte |
| 90. | *Canna indica* | Cannaceae | Therophyte |
| 91. | *Cannabis sativa* | Cannabinaceae | Hemicryptophyte |
| 92. | *Canthium didynum* | Rubiaceae | Phanerophyte |
| 93. | *Capparis aphylla* | Capparidaceae | Therophyte |
| 94. | *Capparis deciduas* | Capparidaceae | Phanerophyte |
| 95. | *Capsicum annulatum* | Solanaceae | Therophyte |
| 96. | *Careya arborea* | Palmae | Phanerophyte |
| 97. | *Carissa carandus* | Apocyanaceae | Phanerophyte |
| 98. | *Carissa spinarium* | Apocyanaceae | Phanerophyte |
| 99. | *Casearia graveolens* | Samydiaceae | Phanerophyte |
| 100 | *Cassia absus* | Caesalpinaceae | Therophyte |
| 101 | *Cassia auriculata* | Caesalpinaceae | Therophyte |
| 102 | *Cassia pumella* | Caesalpinaceae | Therophyte |
| 103 | *Cassia tora* | Caesalpinaceae | Phanerophyte |
| 104 | *Ceiba pentandra* | Bombacaceae | Phanerophyte |
| 105 | *Cestrum diurnum* | Rubiaceae | Theophyte |
| 106 | *Cestrum noctrunum* | Rubiaceae | Therophyte |
| 107 | *Chrysanthemum sp* | Compositae | Therophyte |
| 108 | *Cissus quadrangularis* | Vitaceae | Therophyte |
| 109 | *Citrus liminoites* | Rutaceae | Phanerophyte |
| 110 | *Cleome gynandra* | Capparidaceae | Therophyte |
| 111 | *Cleome viscose* | Capparidaceae | Therophyte |
| 112 | *Clitoria ternate* | Fabaceae | Therophyte |
| 113 | *Cocculus villosa* | Cucurbiataceae | Phanerophyte |
| 114 | *Combretum ovalifolium* | Rubiaceae | Phanerophyte |
| 115 | *Commelina benghalensis* | Commelinaceae | Therophyte |
| 116 | *Cordia dichotoma* | Rubiaceae | Phanerophyte |
| 117 | *Cordia myxa* | Rubiaceae | Phanerophyte |

## ANNEXURE-VII
## ECOLOGICAL DETAILS

| Sr.No | Technical Name | Family | Life form |
|---|---|---|---|
| 118 | *Cordia rothri* | Rubiaceae | Phanerophyte |
| 119 | *Crataeva adsoni* | Capparidaceae | Phanerophyte |
| 120 | *Crotalaria burhia* | Fabaceae | Therophyte |
| 121 | *Crotalaria medicagenia* | Fabaceae | Therophyte |
| 122 | *Croton bonplandinum* | Amaryllidaceae | Therophyte |
| 123 | *Cuscuta reflexa* | Cuscutaceae | Epiphyte |
| 124 | *Daemia extensa* | Fabaceae | Therophyte |
| 125 | *Dalbergia paniculata* | Fabaceae | Phanerophyte |
| 126 | *Datura alba* | Solanaceae | Therophyte |
| 127 | *Datura fastulosa* | Solanaceae | Therophyte |
| 128 | *Datura metal* | Solanaceae | Therophyte |
| 129 | *Delphinium ajacus* | Ranunculaceae | Phanerophyte |
| 130 | *Dendrophthe falcate* | Loranthaceae | Hemicryptophyte |
| 131 | *Desmodium triflorum* | Asclepiadaceae | Therophyte |
| 132 | *Diospyros melanoxylon* | Lythraceae | Phanerophyte |
| 133 | *Diospyros Montana* | Lythraceae | Phanerophyte |
| 134 | *Echinops echinatus* | Compositae | Therophyte |
| 135 | *Eclipta alba* | Compositae | Therophyte |
| 136 | *Eclipta prostrate* | Compositae | Hemicryptophyte |
| 137 | *Emblica officinale* | Euphorbiaceae | Phanerophyte |
| 138 | *Emilia lajerium* | Compositae | Hemicryptophyte |
| 139 | *Erythrina indica* | Papillionaceae | Phanerophyte |
| 140 | *Euphorbia geniculata* | Euphorbiaceae | Therophyte |
| 141 | *Euphorbia hirta* | Euphorbiaceae | Therophyte |
| 142 | *Euphorbia hyperocifolia* | Euphorbiaceae | Therophyte |
| 143 | *Euphorbia nerifolia* | Euphorbiaceae | Phanerophyte |
| 144 | *Euphorbia neruri* | Euphorbiaceae | Therophyte |
| 145 | *Euphorbia nivula* | Euphorbiaceae | Therophyte |
| 146 | *Euphorbia piluliflora* | Euphorbiaceae | Hemicryptophyte |
| 147 | *Euphorbia thymiflora* | Euphorbiaceae | Phanerophyte |
| 148 | *Euphorbia tricauli* | Euphorbiaceae | Hemicryptophyte |
| 149 | *Evolvulus alsinoides* | Convolvulaceae | Therophyte |
| 150 | *Evolvulus numalaris* | Convolvulaceae | Therophyte |
| 151 | *Fagonia cretica* | Zygophyllaceae | Phanerophyte |
| 152 | *Feronia elephantum* | Rutaceae | Phanerophyte |
| 153 | *Ficus benghalensis* | Moraceae | Phanerophyte |
| 154 | *Ficus carica* | Moraceae | Phanerophyte |
| 155 | *Ficus glomerata* | Moraceae | Phanerophyte |
| 156 | *Ficus hispida* | Moraceae | Phanerophyte |
| 157 | *Ficus racemosus* | Moraceae | Phanerophyte |
| 158 | *Ficus relisiosa* | Moraceae | Phanerophyte |
| 159 | *Ficvus gibbosa* | Moraceae | Phanerophyte |
| 160 | *Flacourtia indica* | Flacourtiaceae | Phanerophyte |
| 161 | *Flacourtia latifolia* | Flacourtiaceae | Phanerophyte |
| 162 | *Fumaria indica* | Papillionaceae | Hemicryptophyte |
| 163 | *Gardenia latifolia* | Rubiaceae | Phanerophyte |
| 164 | *Gardenia lucida* | Rubiaceae | Phanerophyte |
| 165 | *Garuga pinnata* | Burseraceae | Phanerophyte |
| 166 | *Glossocardia bosvellia* | Compositae | Hemicryptophyte |
| 167 | *Gmelina arborea* | Rubiaceae | Phanerophyte |
| 168 | *Grewia abutifolia* | Tiliaceae | Phanerophyte |
| 169 | *Grewia salivifolia* | Tiliaceae | Phanerophyte |
| 170 | *Grewia subinaqualis* | Tiliaceae | Phanerophyte |
| 171 | *Haplanthus tentaculatus* | Acanthaceae | Therophyte |
| 172 | *Haplanthus verticillatus* | Acanthaceae | Therophyte |
| 173 | *Helictris isora* | Rubiaceae | Phanerophyte |
| 174 | *Heliotropium indicum* | Rubiaceae | Hemicryptophyte |
| 175 | *Helitropium ovalifolium* | Rubiaceae | Hemicryptophyte |
| 176 | *Hemidesmus indicus* | Asclepiadaceae | Phanerophyte |
| 177 | *Hibiscus gibbosa* | Malvaceae | Therophyte |
| 178 | *Hibiscus micronthus* | Malvaceae | Therophyte |
| 179 | *Hibiscus ovalifolia* | Malvaceae | Therophyte |

## ANNEXURE-VII
## ECOLOGICAL DETAILS

| Sr.No | Technical Name | Family | Life form |
|---|---|---|---|
| 180 | *Hibiscus rosa-cianensis* | Malvaceae | Therophyte |
| 181 | *Hibsicus caesus* | Malvaceae | Hemicryptophyte |
| 182 | *Holarrhena antidycenterica* | Asclepiadaceae | Phanerophyte |
| 183 | *Holostemma annularia* | Aslepiadaceae | Phanerophyte |
| 184 | *Hygrophylla auriculata* | Acanthaceae | Hemicryptophyte |
| 185 | *Hyptis suavalens* | Labiatae | Therophyte |
| 186 | *Ichnocarpus frutens* | Poaceae | Hemicryptophyte |
| 187 | *Impatiens balasamania* | Balsaminaceae | Therophyte |
| 188 | *Indigofera cordifolia* | Caesalpinaceae | Therophyte |
| 189 | *Indigofera tinctoria* | Caesalpinaceae | Therophyte |
| 190 | *Ipomea aquatica* | Convolvulaceae | Hydrophyte |
| 191 | *Ipomea carnea* | Convolvulaceae | Phanerophyte |
| 192 | *Ipomea coccinea* | Convolvulaceae | Therophyte |
| 193 | *Ipomea tuba* | Convolvulaceae | Hemicryptophyte |
| 194 | *Ixora arborea* | Rubiaceae | Phanerophyte |
| 195 | *Ixora parviflora* | Rubiaceae | Phanerophyte |
| 196 | *Ixora singapuriens* | Rubiaceae | Phanerophyte |
| 197 | *Jacarandra jacquimontii* | Bignoniaceae | Therophyte |
| 198 | *Jasmimum arborens* | Oleaceae | Phanerophyte |
| 199 | *Jatropha gossypifolia* | Euphorbiaceae | Therophyte |
| 200 | *Justia simplex* | Acanthaceae | Therophyte |
| 201 | *Jussiaea suffraticosa* | Onagraceae | Hydrophyte |
| 202 | *Justia diffusa* | Acanthaceae | Therophyte |
| 203 | *Justicia diffusa* | Acanthaceae | Therophyte |
| 204 | *Kyllinga trceps* | Cyperaceae | Hemicryptophyte |
| 205 | *Lactuca punctata* | Compositae | Therophyte |
| 206 | *Lagestromia indica* | Lythraceae | Therophyte |
| 207 | *Lannea asplenifolia* | Anacardiaceae | Therophyte |
| 208 | *Lannea coramandalica* | Anacardiaceae | Phanerophyte |
| 209 | *Lannea grandis* | Anacardiaceae | Phanerophyte |
| 210 | *Lannea procumbens* | Anacardiaceae | Therophyte |
| 211 | *Lantana camara* | Verbinacaee | Phanerophyte |
| 212 | *Lathyrus sativus* | Papillionaceae | Hemicryptophyte |
| 213 | *Lawsonia inermis* | Lythraceae | Phanerophyte |
| 214 | *Leptodenia pyrotechnica* | Asclepiadaceae | Phanerophyte |
| 215 | *Leptodenia reticulate* | Asclepiadaceae | Phanerophyte |
| 216 | *Leucas aspera* | Labiatae | Therophyte |
| 217 | *Leucas longifolia* | Labiatae | Therophyte |
| 218 | *Leucas stelligera* | Labiatae | Therophyte |
| 219 | *Linderbergia indica* | Scrophulariaceae | Therophyte |
| 220 | *Lindernbergia ciliate* | Scrophulariaceae | Therophyte |
| 221 | *Lophophora tridinatus* | Scrophulariaceae | Geophyte |
| 222 | *Loranthus sp* | Loranthaceae | Epiphyte |
| 223 | *Lycopersicum esculentus* | Solanaceae | Therophyte |
| 224 | *Lygodium flexosum* | Schiaceae | Therophyte |
| 225 | *Madhuca latifolia* | Sapotaceae | Phanerophyte |
| 226 | *Madhuca latifolia* | Sapotaceae | Phanerophyte |
| 227 | *Mallotus philippinus* | Euphorbiaceae | Phanerophyte |
| 228 | *Malvastrum coramandalicum* | Malvaceae | Therophyte |
| 229 | *Marselia quadrifolia* | Marseliaceae | Phanerophyte |
| 230 | *Medicago indica* | Papillionaceae | Phanerophyte |
| 231 | *Medicago polymorpha* | Papillionaceae | Therophyte |
| 232 | *Melia azadirachta* | Meliaceae | Phanerophyte |
| 233 | *Memycelon edule* | Melastonellaceae | Phanerophyte |
| 234 | *Mentha piperata* | Labiatae | Hemicryptophyte |
| 235 | *Merremia emerginata* | Convolvulaceae | Therophyte |
| 236 | *Mesua ferrea* | Guttiferae | Phanerophyte |
| 237 | *Michaelia champaca* | Annonaceae | Phanerophyte |
| 238 | *Millingtonia hartensis* | Bignoniaceae | Phanerophyte |
| 239 | *Mimosa hamata* | Mimosaceae | Therophyte |
| 240 | *Mitragyna parviflora* | Rubiaceae | Phanerophyte |
| 241 | *Mitrgyna parviflora* | Rubiaceae | Phanerophyte |

# ANNEXURE-VII
# ECOLOGICAL DETAILS

| Sr.No | Technical Name | Family | Life form |
|---|---|---|---|
| 242 | *Mollugo cerviana* | Aizoaceae | Therophyte |
| 243 | *Mollugo hirta* | Aizoaceae | Therophyte |
| 244 | *Moringa oleifera* | Moringaceae | Phanerophyte |
| 245 | *Moringa olerifera* | Moringaeae | Phanrophyte |
| 246 | *Morus alba* | Moraceae | Phanerophyte |
| 247 | *Mucuna prurita* | Papillionaceae | Hemicryptophyte |
| 248 | *Murraya exotica* | Rutaceae | Phanerophyte |
| 249 | *Murraya koenigii* | Rutaceae | Phanerophyte |
| 250 | *Musa paradisica* | Musaceae | Therophyte |
| 251 | *Nerium indicum* | Apocyanaceae | Phanerophyte |
| 252 | *Nicotiana plubigera* | Solanaceae | Hemicryptophyte |
| 253 | *Nymphia sp* | Magnoliaceae | Hydrophyte |
| 254 | *Ocimum americanum* | Labiatae | Therophyte |
| 255 | *Ocimum basillum* | Labiatae | Therophyte |
| 256 | *Ocimum canum* | Labiatae | Therophyte |
| 257 | *Ocimum sanctum* | Labiatae | Therophyte |
| 258 | *Oldenlandia umbellate* | Convolvulaceae | Therophyte |
| 259 | *Oldenlandiua corymbosa* | Rubiaceae | Therophyte |
| 260 | *Oogeinia oojensis* | Papillionaceae | Phanerophyte |
| 261 | *Opuntia dillinii* | Opuntiaceae | Therophyte |
| 262 | *Opuntia elator* | Cacataceae | Therophyteq |
| 263 | *Oxalis corniculata* | Oxalidaceae | Therophyte |
| 264 | *Panicum notatum* | Poaceae | Hemicryptophyte |
| 265 | *Papaver somniferum* | Papaveraceae | Hemicryptophyte |
| 266 | *Parkinsonia aculata* | Mimosaceae | Phanerophyte |
| 267 | *Parthenium hysterophorus* | Compositae | Therophyte |
| 268 | *Paspalum strobilanthus* | Passifloraceae | Hemicryptophyte |
| 269 | *Passiflora foetida* | Passifloraceae | Phanerophyte |
| 270 | *Pavonia zeylanica* | Malvaceae | Phanerophyte |
| 271 | *Peltophorum ferrusinum* | Caesalpinaceae | Phanerophyte |
| 272 | *Peristrophe bicalculata* | Acanthaceae | Therophyte |
| 273 | *Phoenix aculis* | Palmae | Phanerophyte |
| 274 | *Phyllanthes asperulatus* | Euphorbiaceae | Phanerophyte |
| 275 | *Phyllanthes emblica* | Euphorbiaceae | Phanerophyte |
| 276 | *Phyllanthes nirurii* | Euphorbiaceae | Therophyte |
| 277 | *Phyllanthes reticulates* | Euphorbiaceae | Therophyte |
| 278 | *Physalis minima* | Solanaceae | Therophyte |
| 279 | *Pithocolobium dulce* | Mimosaceae | Phanerophyte |
| 280 | *Polyalthia longifolia* | Annonaceae | Phanerophyte |
| 281 | *Polygala ererptera* | Polygalaceae | Therophyte |
| 282 | *Pongamia pinnata* | Fabaceae | Phanerophyte |
| 283 | *Portulaca oleracea* | Portulaccaceae | Therophyte |
| 284 | *Prosopis cineraria* | Mimosaceae | Phanerophyte |
| 285 | *Prosopis spicegera* | Mimosaceae | Phanerophyte |
| 286 | *Punica granulatum* | Puniaceae | Therophyte |
| 287 | *Randia dumatorum* | Rubiaceae | Phanerophyte |
| 288 | *Raphanus sativus* | Cruciferae | Therophyte |
| 289 | *Rosa indica* | Rosaceae | Therophyte |
| 290 | *Rosa machata* | Rosaceae | Therophyte |
| 291 | *Salmalia malabarica* | Salmaliaceae | Phanerophyte |
| 292 | *Sapindus emerginatus* | Sapindaceae | Phanerophyte |
| 293 | *Sapindus emerginatus* | Sapindaceae | Phanerophyte |
| 294 | *Scherebera sweitenoides* | Sapindaceae | Phanerophyte |
| 295 | *Schleichera oleosa* | Sapindaceae | Phanerophyte |
| 296 | *Sesamum indicum* | Pedaliaceae | Hemicryptophyte |
| 297 | *Shorea robusta* | Dipterocarpaceae | Phanerophyte |
| 298 | *Sida cordifolia* | Malvaceae | Phanerophyte |
| 299 | *Sida orientalis* | Malvaceae | Phanerophyte |
| 300 | *Sida vernanifolia* | Malvaceae | Hemicryptophyte |
| 301 | *Solanum nigrum* | Solanaceae | Therophyte |
| 302 | *Solanum suratensis* | Solanaceae | Phanerophyte |
| 303 | *Solanum xanthocarpum* | Solanaceae | Therophyte |

# ANNEXURE-VII
# ECOLOGICAL DETAILS

| Sr.No | Technical Name | Family | Life form |
|---|---|---|---|
| 304 | *Sterculia villosa* | Tiliaceae | Therophyte |
| 305 | *Stereospermum chelinoides* | Bignoniaceae | Phanerophyte |
| 306 | *Sygygium cumini* | Myrtaceae | Phanerophyte |
| 307 | *Symplocos racemosa* | Styraceae | Phanerophyte |
| 308 | *Tagetus sp* | Compositae | Therophyte |
| 309 | *Tamarindus indica* | Caesalpinaceae | Phanerophyte |
| 310 | *Tecomella undulate* | Bignoniaceae | Therophyte |
| 311 | *Tectona grandis* | Verbinaceae | Phanreophyte |
| 312 | *Tephrosia purpuria* | Fabaceae | Therophyte |
| 313 | *Terminalia bellarica* | Combretaceae | Phanerophyte |
| 314 | *Terminalia chebula* | Combretaceae | Phanerophyte |
| 315 | *Terminalia paniculata* | Combretaceae | Phanerophyte |
| 316 | *Terminalia tomentosa* | Combretaceae | Phanerophyte |
| 317 | *Thespesia populanea* | Malvaceae | Phanrophyte |
| 318 | *Thespesia lampas* | Malvaceae | Phanerophyte |
| 319 | *Tinospora cordifolia* | Rhamnaceae | Therophyte |
| 320 | *Tragus biflorus* | Poaceae | Hemicryptophyte |
| 321 | *Trapa bispinosa* | Trapaceae | Hydrophyte |
| 322 | *Trapa natans* | Trapaceae | Hemicryptophyte |
| 323 | *Tribulus terrestris* | Zygophyllaceae | Therophyte |
| 324 | *Tridax procumbens* | Compositae | Therophyte |
| 325 | *Tripogon jacquimontii* | Poaceae | Hemicryptophyte |
| 326 | *Triumferta pilosa* | Tiliaceae | |
| 327 | *Vernonia cinera* | Compositae | Therophyte |
| 328 | *Vicoa indica* | Compositae | Phanerophyte |
| 329 | *Vitex negungo* | Verbinaceae | Therophyte |
| 330 | *Vitis vermifera* | Vitaceae | Therophyte |
| 331 | *Vivevera zizanoides* | Poaceae | Therophyte |
| 332 | *Wrightia tomentosa* | Apocyanaceae | Phanerophyte |
| 333 | *Xanthium strumariumk* | Compositae | Therophyte |
| 334 | *Yucca gloriosa* | Agavaceae | Therophyte |
| 335 | *Zizyphus jujube* | Rhamnaceae | Phanerophyte |
| 336 | *Zizyphus mauritiana* | Rhamanaceae | Phanrophyte |
| 337 | *Zizyphus oenoplica* | Rhamnaceae | Therophyte |
| 338 | *Zornia gobbosa* | Compositae | Therophyte |
| | **Grasslands** | | |
| 339 | *Cenchurus ciliaris* | Poaceae | Hemicryptophyte |
| 340 | *Apluda mutica* | Poaceae | Hemicryptophyte |
| 341 | *Chloris dolichosta* | Poaceae | Hemicryptophyte |
| 342 | *Cyanodactylon sp* | Poaceae | Geophyte |
| 343 | *Dichanthium annulatum* | Poaceae | Hemicryptophyte |
| 344 | *Inpurta cylendrica* | Poaceae | Hemicryptophyte |
| 345 | *Cenchrus setifgera* | Poaceae | Therophyte |
| 346 | *Cymbopogon jwarancusa* | Cyperaceae | Hemicrptophyte |
| 347 | *Cyperus aristatus* | Cyperaceae | Therophyte |
| 348 | *Cyperus triceps* | Cyperaceae | Therophyte |
| 349 | *Dactylectinium annualatum* | Poaceae | Therophyte |
| 350 | *Digetaria bicornis* | Poaceae | Hemicryptophyte |
| 351 | *Digetaria Segetaria* | Poaceae | Hemicryptophyte |
| 352 | *Digetaria adscendens* | Poaceae | Hemicryptophyte |
| 353 | *Eragrostis biferia* | Poaceae | Therophyte |
| 354 | *Fibrystylis dichotoma* | Poaceae | Hemicryptophyte |
| 355 | *Ischaemum rugosum* | Poaceae | Hemicryptophyte |
| | **Endemic species** | **No endemic species recorded/reported as per BSI records** | |
| | **Endangered plants** | **No endangered plant species observed during study period and also from records of Botanical Survey of India( Red data of Books of Indian Plants)** | |

## ANNEXURE-VII
## ECOLOGICAL DETAILS

### TABLE-2
### PLANT SPECIES RECORDED IN STUDY AREA

| Sr.No | Technical Name | Family | Life form |
|---|---|---|---|
| **I. Agricultural crops** | | | |
| 1. | *Hordium vulgare* | Poaceae | Hemicryptophyte |
| 2. | *Sorghum vulgare* | Poaceae | Hemicryptophyte |
| 3. | *Triticum vulgare* | Poaceae | Hemicryptophyte |
| 4. | *Zea mays* | Poaceae | Hemicryptophyte |
| 5. | *Oryza sativa* | Poaceae | Hemicryptophyte |
| 6. | *Pennisetum typhoideum* | Poaceae | Hemicryptophyte |
| II | **Commercial crops( including vegetables)** | | |
| 7. | *Abelomoschus indicus* | Malvaceae | Therophyte |
| 8. | *Allium cepa* | Liliaceae | Geophyte |
| 9. | *Brassica oleracea* var capitata | Cruciferae | Therophyte |
| 10. | *Cajanus cajan* | Fabaceae | Therophyte |
| 11. | *Carica papaya* | Caricaceae | Therophyte |
| 12. | *Catharanthes pusillus* | Compositae | Therophyte |
| 13. | *Cicer arietinum* | Fabaceae | Hemicryptophyte |
| 14. | *Coreandrum sativum* | Umbelliferae | Hemicryptophyte |
| 15. | *Daucus carota* | Umbelliferae | Geophyte |
| 16. | *Lycopersicum esculentus* | Solanaceae | Therophyte |
| 17. | *Mangifera indica* | Anacardiaceae | Phanerophyte |
| 18. | *Memordia charantia* | Cucurbitaceae | Therophyte |
| 19. | *Pepaver somneferrum* | Pepavaraceae | Hemicrptophyte |
| 20. | *Pisum sativum* | Fabaceae | Therophyte |
| 21. | *Psidium guava* | Myrtaceae | Phanerophyte |
| 22. | *Raphanus sativa* | Cruciferae | Geophyte |
| 23. | *Solanum tuberosum* | Solanaceae | Geophyte |
| **III. Plantations** | | | |
| 24. | *Acacia nilotica* | Mimosaceae | Phanerophyte |
| 25. | *Albizia lebbeck* | Mimosaceae | Phanerophyte |
| 26. | *Albizia odorattissima* | Mimosaceae | Phanerophyte |
| 27. | *Albizia procera* | Mimosaceae | Phanerophyte |
| 28. | *Azadirachta indica* | Meliaceae | Phanerophyte |
| 29. | *Bambusa arundanaceae* | Poaceae | Phanerophyte |
| 30. | *Butea superba* | Caesalpinaceae | Phanerophyte |
| 31. | *Butea frondosa* | Caesalpinaceae | Phanerophyte |
| 32. | *Delonix regia* | Caesalpinaceae | Phanerophyte |
| | **Natural Vegetation/Forest Tyepe** | | |
| 33. | *Abrus precatorius* | Fabaceae | Therophyte |
| 34. | *Abutilon indicum* | Malvaceae | Phanerophyte |
| 35. | *Acacia Arabica* | Mimosaceae | Phanerophyte |
| 36. | *Acacia auriculiformis* | Mimosaceae | Phanerophyte |
| 37. | *Acacia fernacea* | Mimosaceae | Phanerophyte |
| 38. | *Acacia leucophloe* | Mimosaceae | Phanerophyte |
| 39. | *Acacia Senegal* | Mimosaceae | Phanerophyte |
| 40. | *Adathoda vasica* | Acanthaceae | Therophyte |
| 41. | *Adina cordifolia* | Rubiaceae | Phanerophyte |
| 42. | *Aegle marmelos* | Rutaceae | Phanerophyte |
| 43. | *Aerva lanata* | Compositae | Phanerophyte |
| 44. | *Agave wightii* | Agavaceae | Phanerophyte |
| 45. | *Ageratum conyzoides* | Compositae | Therophyte |
| 46. | *Ailanthes excela* | Simaroubaceae | Phanerophyte |
| 47. | *Alangium salivus* | Alangiceae | Phanerophyte |
| 48. | *Alstonia scholaris* | Apocyanaceae | Phanerophyte |
| 49. | *Andrographis paniculata* | Acanthaceae | Hemicryptophyte |
| 50. | *Anogeissus latifolia* | Combretaceae | Phanerophyte |
| 51. | *Anogeissus serica* | Combretaceae | Phanerophyte |
| 52. | *Asparagaus racemosus* | Liliaceae | Therophyte |
| 53. | *Atalantia monophylla* | Rutaceae | Therophyte |
| 54. | *Barleria prionoites* | Acanthaceae | Therophyte |
| 55. | *Blepharis asperima* | Acanthaceae | Phanerophyte |

## ANNEXURE-VII
## ECOLOGICAL DETAILS

| Sr.No | Technical Name | Family | Life form |
|---|---|---|---|
| 56. | *Boerheavia chinensis* | Nycataginaceae | Therophyte |
| 57. | *Boerheavia diffusa* | Nyctaginaceae | Therophyte |
| 58. | *Bombax ceiba* | Bombacaceae | Phanerophyte |
| 59. | *Borreria hispida* | Rubiaceae | Therophyte |
| 60. | *Borreria stricta* | Rubiaceae | Therophyte |
| 61. | *Boswellia serrata* | Burseraceae | Phanerophyte |
| 62. | *Brassica camprestris* | Cruciferae | Therophyte |
| 63. | *Bridelia retusa* | Euphorbiaceae | Phanerophyte |
| 64. | *Bridelia superba* | Euphorbiaceae | Phanerophyte |
| 65. | *Caesalpina pulcherima* | Caesalpinaceae | Phanerophyte |
| 66. | *Calotropis procera* | Asclipiadaceae | Phanerophyte |
| 67. | *Canna indica* | Cannaceae | Therophyte |
| 68. | *Cannabis sativa* | Cannabinaceae | Hemicryptophyte |
| 69. | *Canthium didynum* | Rubiaceae | Phanerophyte |
| 70. | *Capparis deciduas* | Capparidaceae | Phanerophyte |
| 71. | *Careya arborea* | Palmae | Phanerophyte |
| 72. | *Carissa carandus* | Apocyanaceae | Phanerophyte |
| 73. | *Carissa spinarium* | Apocyanaceae | Phanerophyte |
| 74. | *Casearia graveolens* | Samydiaceae | Phanerophyte |
| 75. | *Cassia absus* | Caesalpinaceae | Therophyte |
| 76. | *Cassia auriculata* | Caesalpinaceae | Therophyte |
| 77. | *Cassia pumella* | Caesalpinaceae | Therophyte |
| 78. | *Cassia tora* | Caesalpinaceae | Phanerophyte |
| 79. | *Ceiba pentandra* | Bombacaceae | Phanerophyte |
| 80. | *Cestrum diurnum* | Rubiaceae | Theophyte |
| 81. | *Cestrum noctrunum* | Rubiaceae | Therophyte |
| 82. | *Chrysanthemum sp* | Compositae | Therophyte |
| 83. | *Cissus quadrangularis* | Vitaceae | Therophyte |
| 84. | *Cleome gynandra* | Capparidaceae | Therophyte |
| 85. | *Cleome viscose* | Capparidaceae | Therophyte |
| 86. | *Combretum ovalifolium* | Rubiaceae | Phanerophyte |
| 87. | *Commelina benghalensis* | Commelinaceae | Therophyte |
| 88. | *Cordia dichotoma* | Rubiaceae | Phanerophyte |
| 89. | *Cordia myxa* | Rubiaceae | Phanerophyte |
| 90. | *Cordia rothri* | Rubiaceae | Phanerophyte |
| 91. | *Crataeva adsoni* | Capparidaceae | Phanerophyte |
| 92. | *Crotalaria burhia* | Fabaceae | Therophyte |
| 93. | *Crotalaria medicagenia* | Fabaceae | Therophyte |
| 94. | *Croton bonplandinum* | Amaryllidaceae | Therophyte |
| 95. | *Cuscuta reflexa* | Cuscutaceae | Epiphyte |
| 96. | *Daemia extensa* | Fabaceae | Therophyte |
| 97. | *Dalbergia paniculata* | Fabaceae | Phanerophyte |
| 98. | *Datura alba* | Solanaceae | Therophyte |
| 99. | *Datura fastulosa* | Solanaceae | Therophyte |
| 100 | *Datura metal* | Solanaceae | Therophyte. |
| 101 | *Delphinium ajacus* | Ranunculaceae | Phanerophyte |
| 102 | *Dendrophthe falcate* | Loranthaceae | Hemicryptophyte |
| 103 | *Desmodium triflorum* | Asclepiadaceae | Therophyte |
| 104 | *Diospyros melanoxylon* | Lythraceae | Phanerophyte |
| 105 | *Diospyros Montana* | Lythraceae | Phanerophyte |
| 106 | *Echinops echinatus* | Compositae | Therophyte |
| 107 | *Eclipta alba* | Compositae | Therophyte |
| 108 | *Eclipta prostrate* | Compositae | Hemicryptophyte |
| 109 | *Emblica officinale* | Euphorbiaceae | Phanerophyte |
| 110 | *Emilia lajerium* | Compositae | Hemicryptophyte |
| 111 | *Erythrina indica* | Papillionaceae | Phanerophyte |
| 112 | *Euphorbia geniculata* | Euphorbiaceae | Therophyte |
| 113 | *Euphorbia hirta* | Euphorbiaceae | Therophyte |
| 114 | *Euphorbia hyperocifolia* | Euphorbiaceae | Therophyte |
| 115 | *Euphorbia nerifolia* | Euphorbiaceae | Phanerophyte |
| 116 | *Euphorbia neruri* | Euphorbiaceae | Therophyte |
| 117 | *Euphorbia nivula* | Euphorbiaceae | Therophyte |

## ANNEXURE-VII
## ECOLOGICAL DETAILS

| Sr.No | Technical Name | Family | Life form |
|---|---|---|---|
| 118 | *Euphorbia piluliflora* | Euphorbiaceae | Hemicryptophyte |
| 119 | *Euphorbia thymiflora* | Euphorbiaceae | Phanerophyte |
| 120 | *Euphorbia tricauli* | Euphorbiaceae | Hemicryptophyte |
| 121 | *Evolvulus alsinoides* | Convolvulaceae | Therophyte |
| 122 | *Evolvulus numalaris* | Convolvulaceae | Therophyte |
| 123 | *Fagonia cretica* | Zygophyllaceae | Phanerophyte |
| 124 | *Feronia elephantum* | Rutaceae | Phanerophyte |
| 125 | *Ficus glomerata* | Moraceae | Phanerophyte |
| 126 | *Ficus hispida* | Moraceae | Phanerophyte |
| 127 | *Ficus racemosus* | Moraceae | Phanerophyte |
| 128 | *Ficus relisiosa* | Moraceae | Phanerophyte |
| 129 | *Ficvus gibbosa* | Moraceae | Phanerophyte |
| 130 | *Flacourtia latifolia* | Flacourtiaceae | Phanerophyte |
| 131 | *Gardenia latifolia* | Rubiaceae | Phanerophyte |
| 132 | *Gardenia lucida* | Rubiaceae | Phanerophyte |
| 133 | *Garuga pinnata* | Burseraceae | Phanerophyte |
| 134 | *Glossocardia bosvellia* | Compositae | Hemicryptophyte |
| 135 | *Gmelina arborea* | Rubiaceae | Phanerophyte |
| 136 | *Grewia abutifolia* | Tiliaceae | Phanerophyte |
| 137 | *Grewia salivifolia* | Tiliaceae | Phanerophyte |
| 138 | *Grewia subinaqualis* | Tiliaceae | Phanerophyte |
| 139 | *Haplanthus tentaculatus* | Acanthaceae | Therophyte |
| 140 | *Haplanthus verticillatus* | Acanthaceae | Therophyte |
| 141 | *Helictris isora* | Rubiaceae | Phanerophyte |
| 142 | *Heliotropium indicum* | Rubiaceae | Hemicryptophyte |
| 143 | *Helitropium ovalifolium* | Rubiaceae | Hemicryptophyte |
| 144 | *Hemidesmus indicus* | Asclepiadaceae | Phanerophyte |
| 145 | *Hibiscus gibbosa* | Malvaceae | Therophyte |
| 146 | *Hibiscus micronthus* | Malvaceae | Therophyte |
| 147 | *Hibiscus ovalifolia* | Malvaceae | Therophyte |
| 148 | *Hibiscus rosa-cianensis* | Malvaceae | Therophyte |
| 149 | *Hibsicus caesus* | Malvaceae | Hemicryptophyte |
| 150 | *Holarrhena antidycenterica* | Asclepiadaceae | Phanerophyte |
| 151 | *Holostemma annularia* | Aslepiadaceae | Phanerophyte |
| 152 | *Hygrophylla auriculata* | Acanthaceae | Hemicryptophyte |
| 153 | *Hyptis suavalens* | Labiatae | Therophyte |
| 154 | *Ichnocarpus frutens* | Poaceae | Hemicryptophyte |
| 155 | *Impatiens balasamania* | Balsaminaceae | Therophyte |
| 156 | *Indigofera cordifolia* | Caesalpinaceae | Therophyte |
| 157 | *Indigofera tinctoria* | Caesalpinaceae | Therophyte |
| 158 | *Ipomea aquatica* | Convolvulaceae | Hydrophyte |
| 159 | *Ipomea carnea* | Convolvulaceae | Phanerophyte |
| 160 | *Ipomea coccinea* | Convolvulaceae | Therophyte |
| 161 | *Ipomea tuba* | Convolvulaceae | Hemicryptophyte |
| 162 | *Ixora arborea* | Rubiaceae | Phanerophyte |
| 163 | *Ixora parviflora* | Rubiaceae | Phanerophyte |
| 164 | *Ixora singapuriens* | Rubiaceae | Phanerophyte |
| 165 | *Jacarandra jacquimontii* | Bignoniaceae | Therophyte |
| 166 | *Jasmimum arborens* | Oleaceae | Phanerophyte |
| 167 | *Jatropha gossypifolia* | Euphorbiaceae | Therophyte |
| 168 | *Justia simplex* | Acanthaceae | Therophyte |
| 169 | *Jussiaea suffraticosa* | Onagraceae | Hydrophyte |
| 170 | *Justia diffusa* | Acanthaceae | Therophyte |
| 171 | *Justicia diffusa* | Acanthaceae | Therophyte |
| 172 | *Kyllinga trceps* | Cyperaceae | Hemicryptophyte |
| 173 | *Lactuca punctata* | Compositae | Therophyte |
| 174 | *Lagestromia indica* | Lythraceae | Therophyte |
| 175 | *Lannea asplenifolia* | Anacardiaceae | Therophyte |
| 176 | *Lannea coramandalica* | Anacardiaceae | Phanerophyte |
| 177 | *Lannea grandis* | Anacardiaceae | Phanerophyte |
| 178 | *Lannea procumbens* | Anacardiaceae | Therophyte |
| 179 | *Lantana camara* | Verbinacaee | Phanerophyte |

# ANNEXURE-VII
# ECOLOGICAL DETAILS

| Sr.No | Technical Name | Family | Life form |
|---|---|---|---|
| 180 | *Lathyrus sativus* | Papillionaceae | Hemicryptophyte |
| 181 | *Lawsonia inermis* | Lythraceae | Phanerophyte |
| 182 | *Leptodenia pyrotechnica* | Asclepiadaceae | Phanerophyte |
| 183 | *Leptodenia reticulate* | Asclepiadaceae | Phanerophyte |
| 184 | *Leucas aspera* | Labiatae | Therophyte |
| 185 | *Leucas longifolia* | Labiatae | Therophyte |
| 186 | *Leucas stelligera* | Labiatae | Therophyte |
| 187 | *Linderbergia indica* | Scrophulariaceae | Therophyte |
| 188 | *Lindernbergia ciliate* | Scrophulariaceae | Therophyte |
| 189 | *Lophophora tridinatus* | Scrophulariaceae | Geophyte |
| 190 | *Loranthus sp* | Loranthaceae | Epiphyte |
| 191 | *Lycopersicum esculentus* | Solanaceae | Therophyte |
| 192 | *Lygodium flexosum* | Schiaceae | Therophyte |
| 193 | *Madhuca latifolia* | Sapotaceae | Phanerophyte |
| 194 | *Madhuca latifolia* | Sapotaceae | Phanerophyte |
| 195 | *Mallotus philippinus* | Euphorbiaceae | Phanerophyte |
| 196 | *Malvastrum coramandalicum* | Malvaceae | Therophyte |
| 197 | *Marselia quadrifolia* | Marseliaceae | Phanerophyte |
| 198 | *Medicago indica* | Papillionaceae | Phanerophyte |
| 199 | *Medicago polymorpha* | Papillionaceae | Therophyte |
| 200 | *Melia azadirachta* | Meliaceae | Phanerophyte |
| 201 | *Memycelon edule* | Melastonellaceae | Phanerophyte |
| 202 | *Mentha piperata* | Labiatae | Hemicryptophyte |
| 203 | *Merremia emerginata* | Convolvulaceae | Therophyte |
| 204 | *Mesua ferrea* | Guttiferae | Phanerophyte |
| 205 | *Michaelia champaca* | Annonaceae | Phanerophyte |
| 206 | *Millingtonia hartensis* | Bignoniaceae | Phanerophyte |
| 207 | *Mimosa hamata* | Mimosaceae | Therophyte |
| 208 | *Mitragyna parviflora* | Rubiaceae | Phanerophyte |
| 209 | *Mitrgyna parviflora* | Rubiaceae | Phanerophyte |
| 210 | *Mollugo cerviana* | Aizoaceae | Therophyte |
| 211 | *Mollugo hirta* | Aizoaceae | Therophyte |
| 212 | *Moringa oleifera* | Moringaceae | Phanerophyte |
| 213 | *Moringa olerifera* | Moringaeae | Phanrophyte |
| 214 | *Morus alba* | Moraceae | Phanerophyte |
| 215 | *Mucuna prurita* | Papillionaceae | Hemicryptophyte |
| 216 | *Murraya exotica* | Rutaceae | Phanerophyte |
| 217 | *Murraya koenigii* | Rutaceae | Phanerophyte |
| 218 | *Musa paradisica* | Musaceae | Therophyte |
| 219 | *Nicotiana plubigera* | Solanaceae | Hemicryptophyte |
| 220 | *Ocimum americanum* | Labiatae | Therophyte |
| 221 | *Ocimum basillum* | Labiatae | Therophyte |
| 222 | *Ocimum canum* | Labiatae | Therophyte |
| 223 | *Ocimum sanctum* | Labiatae | Therophyte |
| 224 | *Oldenlandia umbellate* | Convolvulaceae | Therophyte |
| 225 | *Oogeinia oojensis* | Papillionaceae | Phanerophyte |
| 226 | *Opuntia elator* | Cacataceae | Therophyteq |
| 227 | *Panicum notatum* | Poaceae | Hemicryptophyte |
| 228 | *Papaver somniferum* | Papaveraceae | Hemicryptophyte |
| 229 | *Parkinsonia aculata* | Mimosaceae | Phanerophyte |
| 230 | *Parthenium hysterophorus* | Compositae | Therophyte |
| 231 | *Paspalum strobilanthus* | Passifloraceae | Hemicryptophyte |
| 232 | *Passiflora foetida* | Passifloraceae | Phanerophyte |
| 233 | *Pavonia zeylanica* | Malvaceae | Phanerophyte |
| 234 | *Peltophorum ferrusinum* | Caesalpinaceae | Phanerophyte |
| 235 | *Peristrophe bicalculata* | Acanthaceae | Therophyte |
| 236 | *Phyllanthes asperulatus* | Euphorbiaceae | Phanerophyte |
| 237 | *Phyllanthes emblica* | Euphorbiaceae | Phanerophyte |
| 238 | *Phyllanthes nirurii* | Euphorbiaceae | Therophyte |
| 239 | *Phyllanthes reticulates* | Euphorbiaceae | Therophyte |
| 240 | *Physalis minima* | Solanaceae | Therophyte |
| 241 | *Pithocolobium dulce* | Mimosaceae | Phanerophyte |

## ANNEXURE-VII
## ECOLOGICAL DETAILS

| Sr.No | Technical Name | Family | Life form |
|---|---|---|---|
| 242 | *Polyalthia longifolia* | Annonaceae | Phanerophyte |
| 243 | *Polygala ererptera* | Polygalaceae | Therophyte |
| 244 | *Pongamia pinnata* | Fabaceae | Phanerophyte |
| 245 | *Portulaca oleracea* | Portulaccaceae | Therophyte |
| 246 | *Prosopis cineraria* | Mimosaceae | Phanerophyte |
| 247 | *Prosopis spicegera* | Mimosaceae | Phanerophyte |
| 248 | *Punica granulatum* | Puniaceae | Therophyte |
| 249 | *Randia dumatorum* | Rubiaceae | Phanerophyte |
| 250 | *Raphanus sativus* | Cruciferae | Therophyte |
| 251 | *Rosa indica* | Rosaceae | Therophyte |
| 252 | *Rosa machata* | Rosaceae | Therophyte |
| 253 | *Salmalia malabarica* | Salmaliaceae | Phanerophyte |
| 254 | *Sapindus emerginatus* | Sapindaceae | Phanerophyte |
| 255 | *Sapindus emerginatus* | Sapindaceae | Phanerophyte |
| 256 | *Scherebera sweitenoides* | Sapindaceae | Phanerophyte |
| 257 | *Schleichera oleosa* | Sapindaceae | Phanerophyte |
| 258 | *Sesamum indicum* | Pedaliaceae | Hemicryptophyte |
| 259 | *Shorea robusta* | Dipterocarpaceae | Phanerophyte |
| 260 | *Sida cordifolia* | Malvaceae | Phanerophyte |
| 261 | *Sida orientalis* | Malvaceae | Phanerophyte |
| 262 | *Sida vernanifolia* | Malvaceae | Hemicryptophyte |
| 263 | *Solanum nigrum* | Solanaceae | Therophyte |
| 264 | *Solanum suratensis* | Solanaceae | Phanerophyte |
| 265 | *Solanum xanthocarpum* | Solanaceae | Therophyte |
| 266 | *Sterculia villosa* | Tiliaceae | Therophyte |
| 267 | *Stereospermum chelinoides* | Bignoniaceae | Phanerophyte |
| 268 | *Sygygium cumini* | Myrtaceae | Phanerophyte |
| 269 | *Symplocos racemosa* | Styraceae | Phanerophyte |
| 270 | *Tagetus sp* | Compositae | Therophyte |
| 271 | *Tamarindus indica* | Caesalpinaceae | Phanerophyte |
| 272 | *Tecomella undulate* | Bignoniaceae | Therophyte |
| 273 | *Tectona grandis* | Verbinaceae | Phanreophyte |
| 274 | *Tephrosia purpuria* | Fabaceae | Therophyte |
| 275 | *Terminalia bellarica* | Combretaceae | Phanerophyte |
| 276 | *Terminalia chebula* | Combretaceae | Phanerophyte |
| 277 | *Terminalia paniculata* | Combretaceae | Phanerophyte |
| 278 | *Terminalia tomentosa* | Combretaceae | Phanerophyte |
| 279 | *Thespesia populanea* | Malvaceae | Phanrophyte |
| 280 | *Thespesia lampas* | Malvaceae | Phanerophyte |
| 281 | *Tinospora cordifolia* | Rhamnaceae | Therophyte |
| 282 | *Tragus biflorus* | Poaceae | Hemicryptophyte |
| 283 | *Trapa bispinosa* | Trapaceae | Hydrophyte |
| 284 | *Trapa natans* | Trapaceae | Hemicryptophyte |
| 285 | *Tribulus terrestris* | Zygophyllaceae | Therophyte |
| 286 | *Tridax procumbens* | Compositae | Therophyte |
| 287 | *Tripogon jacquimontii* | Poaceae | Hemicryptophyte |
| 288 | *Triumferta pilosa* | Tiliaceae | |
| 289 | *Vernonia cinera* | Compositae | Therophyte |
| 290 | *Vicoa indica* | Compositae | Phanerophyte |
| 291 | *Vitex negungo* | Verbinaceae | Therophyte |
| 292 | *Vitis vermifera* | Vitaceae | Therophyte |
| 293 | *Vivevera zizanoides* | Poaceae | Therophyte |
| 294 | *Wrightia tomentosa* | Apocyanaceae | Phanerophyte |
| 295 | *Xanthium strumariumk* | Compositae | Therophyte |
| 296 | *Yucca gloriosa* | Agavaceae | Therophyte |
| 297 | *Zizyphus jujube* | Rhamnaceae | Phanerophyte |
| 298 | *Zizyphus mauritiana* | Rhamanaceae | Phanrophyte |
| 299 | *Zizyphus oenoplica* | Rhamnaceae | Therophyte |
| 300 | *Zornia gobbosa* | Compositae | Therophyte |
| | **Grasslands** | | |
| 301 | *Cenchurus ciliaris* | Poaceae | Hemicryptophyte |
| 302 | *Apluda mutica* | Poaceae | Hemicryptophyte |

## ANNEXURE-VII
## ECOLOGICAL DETAILS

| Sr.No | Technical Name | Family | Life form |
|---|---|---|---|
| 303 | *Cyanodactylon sp* | Poaceae | Geophyte |
| 304 | *Dichanthium annulatum* | Poaceae | Hemicryptophyte |
| 305 | *Inpurta cylendrica* | Poaceae | Hemicryptophyte |
| 306 | *Cyperus aristatus* | Cyperaceae | Therophyte |
| 307 | *Dactylectinium annualatum* | Poaceae | Therophyte |
| 308 | *Digetaria bicornis* | Poaceae | Hemicryptophyte |
| 309 | *Digetaria Segetaria* | Poaceae | Hemicryptophyte |
| 310 | *Eragrostis biferia* | Poaceae | Therophyte |
| | **Endemic species** | **No endemic species recorded/reported as per BSI records** | |
| | **Endangered plants** | **No endangered plant species observed during study period and also from records of Botanical Survey of India ( Red data of Books of Indian Plants)** | |

## TABLE-3.1
## PHYTOSOCIOLOGICAL STUDIES NEAR KADOLIA

| Name of the plant species | Re.basal | Re.Density | R.FR | IVI |
|---|---|---|---|---|
| *Abutilon polyandrum* | 0.09 | 2.88 | 3.03 | 5.99 |
| *Abutilon indicum* | 0.01 | 0.22 | 1.52 | 1.75 |
| *Achyranthes aspera* | 0.00 | 2.88 | 3.03 | 5.91 |
| *Aristida sp* | 0.27 | 11.06 | 3.03 | 14.36 |
| *Blepharis boerheviafolia* | 3.78 | 13.27 | 6.06 | 23.11 |
| *Blumea lacera* | 0.05 | 0.44 | 1.52 | 2.01 |
| *Cassia tora* | 0.05 | 1.11 | 3.03 | 4.19 |
| *Cajanus indicus* | 0.07 | 2.21 | 4.55 | 6.83 |
| *Coriandrum sp* | 0.18 | 3.76 | 3.03 | 6.97 |
| *Croton bonplandinum* | 20.42 | 2.21 | 4.55 | 27.17 |
| *Dichanthium sp* | 0.13 | 2.65 | 1.52 | 4.30 |
| *Dysophilla quadrifolia* | 0.27 | 0.88 | 1.52 | 2.67 |
| *Eupatorium sp* | 1.32 | 2.21 | 1.52 | 5.05 |
| *Euphorbia elegans* | 0.56 | 2.88 | 3.03 | 6.47 |
| *Evolvuls alsinoides* | 0.94 | 10.84 | 4.55 | 16.33 |
| *Grewia hirta* | 13.50 | 1.11 | 1.52 | 16.13 |
| *Indigofera tinctoria* | 0.03 | 0.66 | 1.52 | 2.21 |
| *Justia betonia* | 29.29 | 2.21 | 3.03 | 34.54 |
| *Lepidogathis cuspidata* | 1.14 | 3.76 | 4.55 | 9.45 |
| *Ocimum americanum* | 0.18 | 3.76 | 4.55 | 8.49 |
| *Oxalis cornuculata* | 0.48 | 4.42 | 4.55 | 9.45 |
| *Parthenium hysterophorus* | 0.90 | 11.73 | 4.55 | 17.17 |
| *Phaseolus sublobatus* | 0.10 | 1.77 | 4.55 | 6.41 |
| *Rungia parviflora* | 0.07 | 1.11 | 3.03 | 4.21 |
| *Tephrosia purpuria* | 0.39 | 4.20 | 6.06 | 10.65 |
| *Strobilanthes heymareus* | 16.15 | 0.44 | 1.52 | 18.10 |
| *Tephrosia tinctoria* | 1.21 | 1.55 | 4.55 | 7.30 |
| *Themeda laxa* | 0.65 | 2.21 | 6.06 | 8.92 |
| *Thunbergia grandiflora* | 7.77 | 0.88 | 3.03 | 11.68 |
| *Vernonia sp* | 0.00 | 0.66 | 1.52 | 2.18 |

## TABLE-3.2
## PHYTOSOCIOLOGICAL STUDIES NEAR VILLAGE KRIYAKUDAR

| Name of the plant species | Re.basal | Re.Density | R.FR | IVI |
|---|---|---|---|---|
| *Abutilon indicum* | 0.01 | 0.28 | 1.59 | 1.88 |
| *Achyranthes aspera* | 9.15 | 3.13 | 7.94 | 20.21 |
| *Andrographis paniculata* | 0.00 | 0.57 | 1.59 | 2.16 |
| *Aristida sp* | 0.21 | 14.20 | 3.17 | 17.59 |
| *Blepharis boerheviafolia* | 3.00 | 17.05 | 6.35 | 26.40 |
| *Blumea lacera* | 0.04 | 0.57 | 1.59 | 2.19 |
| *Cassia tora* | 0.04 | 1.42 | 3.17 | 4.64 |
| *Cajanus indicus* | 5.89 | 3.69 | 6.35 | 15.93 |

## ANNEXURE-VII
## ECOLOGICAL DETAILS

| Name of the plant species | Re.basal | Re.Density | R.FR | IVI |
|---|---|---|---|---|
| *Crotalaria sp* | 0.10 | 3.41 | 1.59 | 5.10 |
| *Croton bonplandinum* | 16.29 | 3.69 | 6.35 | 26.34 |
| *Desmodium sp* | 0.87 | 1.99 | 6.35 | 9.21 |
| *Dysophilla quadrifolia* | 0.21 | 1.14 | 1.59 | 2.94 |
| *Eupatorium sp* | 1.05 | 2.84 | 1.59 | 5.48 |
| *Grewia hirta* | 10.74 | 1.42 | 1.59 | 13.75 |
| *Impatiens balsamina* | 10.32 | 3.98 | 4.76 | 19.06 |
| *Justia betonia* | 21.15 | 2.27 | 3.17 | 26.60 |
| *Leucas montana* | 0.16 | 2.56 | 3.17 | 5.89 |
| *Oxalis cornuculata* | 0.39 | 5.68 | 4.76 | 10.83 |
| *Parthenium hysterophorus* | 0.71 | 15.06 | 4.76 | 20.53 |
| *Phaseolus sublobatus* | 0.08 | 2.27 | 4.76 | 7.11 |
| *Rungia parviflora* | 16.14 | 1.99 | 3.17 | 21.30 |
| *Tephrosia purpuria* | 0.31 | 5.40 | 6.35 | 12.05 |
| *Rungia repens* | 0.00 | 0.85 | 1.59 | 2.44 |
| *Strobilanthes heymareus* | 0.00 | 0.28 | 1.59 | 1.87 |
| *Tephrosia tinctoria* | 0.96 | 1.99 | 4.76 | 7.71 |
| *Vernonia sp* | 2.16 | 2.27 | 6.35 | 10.79 |

## TABLE-3.3
## PHYTOSOCIOLOGICAL STUDIES NEAR VILLAGE MITHIDA

| Name of the plant species | Re.basal | Re.Density | R.FR | IVI |
|---|---|---|---|---|
| *Abutilon polyandrum* | 0.03 | 4.10 | 5.38 | 9.51 |
| *Abutilon indicum* | 0.00 | 0.18 | 1.08 | 1.26 |
| *Achyranthes aspera* | 2.62 | 3.74 | 6.45 | 12.82 |
| *Andrographis paniculata* | 0.00 | 0.36 | 1.08 | 1.43 |
| *Aristida sp* | 0.06 | 8.91 | 2.15 | 11.12 |
| *Blepharis boerheviafolia* | 0.81 | 10.70 | 4.30 | 15.81 |
| *Cassia tora* | 0.02 | 1.43 | 1.08 | 2.52 |
| *Cajanus indicus* | 1.60 | 2.32 | 4.30 | 8.21 |
| *Coriandrum sp* | 0.04 | 3.03 | 2.15 | 5.22 |
| *Crotalaria sp* | 0.03 | 2.14 | 1.08 | 3.24 |
| *Croton bonplandinum* | 0.05 | 1.60 | 3.23 | 4.88 |
| *Dichanthium sp* | 16.75 | 4.28 | 2.15 | 23.18 |
| *Dysophilla quadrifolia* | 0.06 | 0.71 | 1.08 | 1.85 |
| *Eupatorium sp* | 0.80 | 4.99 | 3.23 | 9.01 |
| *Euphorbia elegans* | 0.12 | 2.32 | 2.15 | 4.59 |
| *Evolvuls alsinoides* | 0.20 | 8.73 | 3.23 | 12.16 |
| *Evolvulus sp* | 15.80 | 4.10 | 4.30 | 24.20 |
| *Grewia hirta* | 2.91 | 0.89 | 1.08 | 4.88 |
| *Impatiens balsamina* | 7.54 | 3.74 | 5.38 | 16.66 |
| *Indigofera tinctoria* | 0.47 | 0.36 | 1.08 | 1.90 |
| *Leucas montana* | 29.23 | 4.10 | 4.30 | 37.63 |
| *Ocimum americanum* | 0.04 | 3.03 | 3.23 | 6.30 |
| *Oxalis cornuculata* | 0.10 | 3.57 | 3.23 | 6.90 |
| *Parthenium hysterophorus* | 0.08 | 6.77 | 4.30 | 11.15 |
| *Phaseolus sublobatus* | 0.00 | 0:71 | 1.08 | 1.79 |
| *Tephrosia purpuria* | 0.08 | 3.39 | 4.30 | 7.77 |
| *Rungia repens* | 1.05 | 1.78 | 3.23 | 6.06 |
| *Strobilanthes heymareus* | 8.61 | 1.25 | 4.30 | 14.16 |
| *Tephrosia tinctoria* | 0.26 | 1.25 | 3.23 | 4.73 |
| *Thunbergia grandiflora* | 5.86 | 1.96 | 3.23 | 11.05 |
| *Tilia* | 4.19 | 1.25 | 3.23 | 8.66 |
| *Vernonia sp* | 0.60 | 2.32 | 6.45 | 9.37 |

**ANNEXURE-VII**
**ECOLOGICAL DETAILS**

**TABLE-3.4**
**PHYTOSOCIOLOGICAL STUDIES NEAR VILLAGE PANPOSH**

| Name of the plant species panposh village | Re.basal | Re.Density | R.FR | IVI |
|---|---|---|---|---|
| | Re.basal | Re.Density | R.FR | IVI |
| *Abutilon indicum* | 0.00 | 0.28 | 1.47 | 1.75 |
| *Achyranthes aspera* | 31.75 | 8.15 | 4.41 | 44.31 |
| *Blumea lacera* | 0.02 | 1.40 | 1.47 | 2.89 |
| *Cassia tora* | 2.55 | 3.37 | 5.88 | 11.81 |
| *Coriandrum sp* | 0.04 | 6.18 | 2.94 | 9.16 |
| *Crotalaria sp* | 0.02 | 3.37 | 1.47 | 4.86 |
| *Croton bonplandinum* | 3.33 | 3.65 | 5.88 | 12.86 |
| *Desmodium sp* | 0.09 | 1.12 | 2.94 | 4.15 |
| *Eupatorium sp* | 3.37 | 6.74 | 4.41 | 14.52 |
| *Euphorbia elegans* | 0.11 | 4.49 | 2.94 | 7.55 |
| *Evolvulus sp* | 0.02 | 2.81 | 1.47 | 4.30 |
| *Grewia hirta* | 2.19 | 1.40 | 1.47 | 5.07 |
| *Leucas montana* | 22.01 | 6.46 | 5.88 | 34.36 |
| *Ocimum americanum* | 0.03 | 4.78 | 4.41 | 9.22 |
| *Oxalis cornuculata* | 0.02 | 1.69 | 1.47 | 3.18 |
| *Parthenium hysterophorus* | 0.12 | 13.20 | 4.41 | 17.74 |
| *Phaseolus sublobatus* | 0.02 | 2.25 | 4.41 | 6.67 |
| *Rungia parviflora* | 9.75 | 4.78 | 5.88 | 20.41 |
| *Tephrosia purpuria* | 0.06 | 5.34 | 5.88 | 11.28 |
| *Rungia repens* | 0.79 | 2.81 | 4.41 | 8.01 |
| *Sterculia villosa* | 0.01 | 3.09 | 4.41 | 7.52 |
| *Strobilanthes heymareus* | 6.48 | 1.97 | 5.88 | 14.33 |
| *Tephrosia tinctoria* | 0.20 | 1.97 | 4.41 | 6.57 |
| *Thunbergia grandiflora* | 2.52 | 1.69 | 5.88 | 10.09 |
| *Tilia sp* | 1.89 | 0.84 | 1.47 | 4.20 |
| *Vernonia sp* | 12.59 | 6.18 | 4.41 | 23.19 |

**TABLE-3.5**
**PHYTOSOCIOLOGICAL STUDIES NEAR VILLAGE PATMUNDA**

| Name of the plant species | Re.basal | Re.Density | R.FR | IVI |
|---|---|---|---|---|
| *Achyranthes aspera* | 6.43 | 4.11 | 4.92 | 15.46 |
| *Andrographis paniculata* | 0.00 | 0.55 | 1.64 | 2.19 |
| *Blepharis boerheviafolia* | 3.80 | 16.44 | 6.56 | 26.80 |
| *Blumea lacera* | 0.05 | 0.55 | 1.64 | 2.24 |
| *Cassia tora* | 0.05 | 1.37 | 3.28 | 4.70 |
| *Cajanus indicus* | 0.07 | 2.19 | 3.28 | 5.54 |
| *Coriandrum sp* | 0.18 | 4.66 | 3.28 | 8.12 |
| *Crotalaria sp* | 0.13 | 3.29 | 1.64 | 5.06 |
| *Croton bonplandinum* | 13.29 | 3.29 | 4.92 | 21.50 |
| *Eupatorium sp* | 1.33 | 2.74 | 1.64 | 5.71 |
| *Euphorbia elegans* | 0.56 | 3.56 | 3.28 | 7.40 |
| *Evolvuls alsinoides* | 0.95 | 13.42 | 4.92 | 19.29 |
| *Evolvulus sp* | 0.00 | 1.92 | 3.28 | 5.20 |
| *Grewia hirta* | 13.60 | 1.37 | 1.64 | 16.61 |
| *Justia betonia* | 0.20 | 0.55 | 1.64 | 2.38 |
| *Ocimum americanum* | 0.03 | 0.82 | 1.64 | 2.49 |
| *Oxalis cornuculata* | 0.49 | 5.48 | 4.92 | 10.88 |
| *Parthenium hysterophorus* | 0.90 | 14.52 | 4.92 | 20.34 |
| *Phaseolus sublobatus* | 0.10 | 2.19 | 4.92 | 7.21 |
| *Pimpinella diversifolia* | 0.12 | 1.37 | 1.64 | 3.13 |
| *Rungia parviflora* | 20.43 | 1.92 | 3.28 | 25.63 |
| *Tephrosia purpuria* | 0.10 | 1.92 | 3.28 | 5.29 |
| *Rungia repens* | 0.11 | 3.56 | 4.92 | 8.59 |
| *Tephrosia tinctoria* | 1.22 | 1.92 | 4.92 | 8.05 |
| *Themeda laxa* | 0.65 | 2.74 | 6.56 | 9.95 |
| *Thunbergia grandiflora* | 15.64 | 1.64 | 6.56 | 23.85 |
| *Tilia* | 19.55 | 1.92 | 4.92 | 26.39 |

## ANNEXURE-VII
## ECOLOGICAL DETAILS

### TABLE-3.6
### PHYTOSOCIOLOGICAL STUDIES NEAR VILLAGE KADOLIA

| Name of the plant species | Re.basal | Re.Density | R.FR | IVI |
|---|---|---|---|---|
| *Acacia lenticularis* | 0.99 | 2.74 | 2.94 | 6.68 |
| *Acacia nilotica* | 0.99 | 1.37 | 1.47 | 3.83 |
| *Adina cordifolia* | 0.60 | 2.74 | 2.94 | 6.28 |
| *Albizzia marginata* | 20.20 | 8.22 | 5.88 | 34.30 |
| *Dalbergia sisoo* | 19.22 | 8.22 | 5.88 | 33.32 |
| *Anogeissus latifolia* | 3.14 | 1.37 | 1.47 | 5.98 |
| *Dendrocalamus strictus* | 1.20 | 5.48 | 5.88 | 12.57 |
| *Sesbania suevalens* | 3.14 | 4.11 | 4.41 | 11.66 |
| *Delonix regia* | 4.63 | 5.48 | 5.88 | 15.99 |
| *Bauhinia racemosa* | 3.91 | 4.11 | 4.41 | 12.44 |
| *Bauhinia variegata* | 1.39 | 1.37 | 1.47 | 4.23 |
| *Anthocephalus cadamba* | 1.39 | 2.74 | 2.94 | 7.07 |
| *Shorea robusta* | 4.46 | 5.48 | 5.88 | 15.82 |
| *Dalbergia paniculata* | 4.35 | 4.11 | 4.41 | 12.87 |
| *Diospyros melanoxylon* | 4.14 | 4.11 | 4.41 | 12.66 |
| *Emblica officinalis* | 0.14 | 4.11 | 4.41 | 8.66 |
| *Ficus hispida* | 7.12 | 2.74 | 2.94 | 12.80 |
| *Garuga pinnata* | 6.04 | 5.48 | 5.88 | 17.40 |
| *Ficus glomerata* | 0.54 | 2.74 | 2.94 | 6.22 |
| *Kydia calcina* | 0.99 | 1.37 | 1.47 | 3.83 |
| *Lagerstroemia parvilora* | 0.00 | 2.74 | 2.94 | 5.68 |
| *Lannea grandis* | 0.00 | 1.37 | 1.47 | 2.84 |
| *Mallotus phillippines* | 2.46 | 2.74 | 1.47 | 6.67 |
| *Pothocolbium dulce* | 0.71 | 5.48 | 5.88 | 12.07 |
| *Aegle marmelos* | 7.04 | 4.11 | 4.41 | 15.56 |
| *Stereospermum angustifolium* | 1.20 | 2.74 | 2.94 | 6.88 |
| *Terminalia tomentosa* | 0.00 | 2.74 | 2.94 | 5.68 |

### TABLE-3.7
### PHYTOSOCIOLOGICAL STUDIES NEAR VILLAGE KRIYAKUDAR

| Name of the plant species | Re.basal | Re.Density | R.FR | IVI |
|---|---|---|---|---|
| *Acacia lenticularis* | 0.84 | 1.30 | 1.45 | 3.59 |
| *Albizia lebbeck* | 0.84 | 2.60 | 2.90 | 6.34 |
| *Adina cordifolia* | 5.51 | 7.79 | 5.80 | 19.10 |
| *Albizzia marginata* | 4.36 | 3.90 | 4.35 | 12.60 |
| *Anogeissus latifolia* | 8.68 | 2.60 | 2.90 | 14.17 |
| *Bauhinia racemosa* | 2.85 | 3.90 | 4.35 | 11.10 |
| *Anthocephalus cadamba* | 1.18 | 7.79 | 4.35 | 13.32 |
| *Boswellia serrata* | 4.71 | 2.60 | 2.90 | 10.20 |
| *Bridelia pubescens* | 1.26 | 1.30 | 1.45 | 4.01 |
| *Dalberiga sisoo* | 1.87 | 3.90 | 4.35 | 10.11 |
| *Ficus glomerata* | 4.51 | 5.19 | 5.80 | 15.50 |
| *Diospyros melanoxylon* | 3.68 | 1.30 | 1.45 | 6.43 |
| *Shorea robusta* | 12.34 | 6.49 | 7.25 | 26.08 |
| *Emblica officinalis* | 0.00 | 1.30 | 1.45 | 2.75 |
| *Ficus hispida* | 4.63 | 3.90 | 4.35 | 12.88 |
| *Garuga pinnata* | 2.36 | 5.19 | 5.80 | 13.35 |
| *Derris indica* | 4.51 | 5.19 | 5.80 | 15.51 |
| *Acacia nilotica* | 2.73 | 3.90 | 4.35 | 10.98 |
| *Lagerstroemia parvilora* | 3.34 | 2.60 | 2.90 | 8.83 |
| *Lannea grandis* | 0.84 | 2.60 | 2.90 | 6.34 |
| *Mallotus phillippines* | 2.09 | 2.60 | 1.45 | 6.13 |
| *Azadirachta indica* | 2.67 | 1.30 | 1.45 | 5.42 |
| *Pongamia indica* | 7.82 | 3.90 | 4.35 | 16.07 |
| *Sesbania suavalens* | 2.35 | 1.30 | 1.45 | 5.09 |
| *Pithocolobium dulce* | 0.81 | 6.49 | 5.80 | 13.10 |
| *Sterculia urens* | 10.49 | 5.19 | 4.35 | 20.03 |
| *Stereospermum angustifolium* | 0.84 | 1.30 | 1.45 | 3.59 |
| *Terminalia tomentosa* | 1.89 | 2.60 | 2.90 | 7.38 |

## ANNEXURE-VII
## ECOLOGICAL DETAILS

### TABLE-3.8
### PHYTOSOCIOLOGICAL STUDIES NEAR VILLAGE MITHIDA

| Name of the plant species | Re.basal | Re.Density | R.FR | IVI |
|---|---|---|---|---|
| *Acacia lenticularis* | 2.36 | 1.33 | 1.49 | 5.19 |
| *Acacia lebbeck* | 2.03 | 4.00 | 4.48 | 10.50 |
| *Albizzia marginata* | 7.17 | 6.67 | 5.97 | 19.80 |
| *Anogeissus latifolia* | 2.80 | 2.67 | 2.99 | 8.45 |
| *Delonix regia* | 6.85 | 6.67 | 7.46 | 20.98 |
| *Boswellia serrat* | 3.11 | 4.00 | 4.48 | 11.59 |
| *Bridelia pubescens* | 3.97 | 5.33 | 5.97 | 15.28 |
| *Dalbergia paniculata* | 2.82 | 2.67 | 2.99 | 8.48 |
| *Anthocephalus cadamba* | 4.73 | 5.33 | 5.97 | 16.03 |
| *Diospyros melanoxylon* | 3.69 | 6.67 | 5.97 | 16.33 |
| *Emblica officinalis* | 0.06 | 4.00 | 2.99 | 7.05 |
| *Ficus hispida* | 12.66 | 4.00 | 4.48 | 21.13 |
| *Garuga pinnata* | 10.69 | 9.33 | 5.97 | 25.99 |
| *Ficus glomerata* | 1.01 | 5.33 | 5.97 | 12.31 |
| *Lagerstroemia parvilora* | 1.07 | 5.33 | 4.48 | 10.88 |
| *Lannea grandis* | 4.38 | 5.33 | 5.97 | 15.68 |
| *Shorea robusta* | 3.28 | 2.67 | 2.99 | 8.94 |
| *Memecylon edule* | 0.00 | 1.33 | 1.49 | 2.83 |
| *Azadirachta indica* | 2.46 | 1.33 | 1.49 | 5.29 |
| *Sesbania suavalens* | 4.30 | 5.33 | 5.97 | 15.60 |
| *Derris indica* | 9.17 | 4.00 | 4.48 | 17.65 |
| *Sterculia urens* | 8.08 | 2.67 | 1.49 | 12.24 |
| *Terminalia tomentosa* | 3.30 | 4.00 | 4.48 | 11.77 |

### TABLE-3.9
### PHYTOSOCIOLOGICAL STUDIES NEAR KADOLIA

| Name of the plant species | Re.basal | Re.Density | R.FR | IVI |
|---|---|---|---|---|
| *Acacia lenticularis* | 1.35 | 3.28 | 3.77 | 8.40 |
| *Xylophora xylocarpa* | 1.73 | 1.64 | 1.89 | 5.25 |
| *Albizia lebbeck* | 4.43 | 4.92 | 5.66 | 15.01 |
| *Anogeissus latifolia* | 2.01 | 1.64 | 1.89 | 5.54 |
| *Bauhinia racemosa* | 3.95 | 3.28 | 3.77 | 11.00 |
| *Bauhinia variegata* | 0.00 | 1.64 | 1.89 | 3.53 |
| *Bridelia pubescens* | 2.01 | 1.64 | 1.89 | 5.54 |
| *Boswellia serrata* | 4.29 | 3.28 | 3.77 | 11.34 |
| *Azadirachta indica* | 7.18 | 6.56 | 7.55 | 21.28 |
| *Dalbergia sisoo* | 4.25 | 4.92 | 5.66 | 14.83 |
| *Emblica officinalis* | 0.00 | 1.64 | 1.89 | 3.53 |
| *Ficus hispida* | 14.22 | 3.28 | 3.77 | 21.28 |
| *Garuga pinnata* | 1.06 | 3.28 | 3.77 | 8.12 |
| *Zizyphus numalarica* | 0.00 | 1.64 | 1.89 | 3.53 |
| *Gmelina arborea* | 3.39 | 3.28 | 3.77 | 10.44 |
| *Ficus glomerata* | 2.92 | 13.11 | 7.55 | 23.59 |
| *Eucalyptus sp* | 5.68 | 3.28 | 3.77 | 12.73 |
| *Sesbania suavalens* | 1.63 | 6.56 | 5.66 | 13.85 |
| *Derris indica* | 8.31 | 9.84 | 7.55 | 25.69 |
| *Delonix regia* | 3.32 | 3.28 | 1.89 | 8.49 |
| *Dendroacalamus strictus* | 0.81 | 4.92 | 5.66 | 11.39 |
| *Terminalia catapa* | 7.48 | 3.28 | 3.77 | 14.53 |
| *Shorea robusta* | 16.20 | 4.92 | 5.66 | 26.78 |
| *Terminalia tomentosa* | 3.77 | 4.92 | 5.66 | 14.35 |

## ANNEXURE-VII
## ECOLOGICAL DETAILS

### TABLE-3.10
### PHYTOSOCIOLOGICAL STUDIES NEAR VILLGE PATMUNDA

| Name of the plant species | Re.basal | Re.Density | R.FR | IVI |
|---|---|---|---|---|
| *Acacia lenticularis* | 1.99 | 4.84 | 5.45 | 12.28 |
| *Tamarindus indica* | 3.96 | 9.68 | 7.27 | 20.91 |
| *Albizzia marginata* | 12.41 | 8.06 | 7.27 | 27.74 |
| *Albizia lebbeck* | 20.41 | 6.45 | 7.27 | 34.13 |
| *Bauhinia racemosa* | 0.44 | 1.61 | 1.82 | 3.87 |
| *Bauhinia variegata* | 0.52 | 6.45 | 5.45 | 12.43 |
| *Bridelia pubescens* | 12.33 | 8.06 | 9.09 | 29.48 |
| *Artocarpus heterophylla* | 1.20 | 3.23 | 1.82 | 6.25 |
| *Azadirachta indica* | 5.30 | 6.45 | 7.27 | 19.02 |
| *Diospyros melanoxylon* | 0.00 | 1.61 | 1.82 | 3.43 |
| *Emblica officinalis* | 0.66 | 3.23 | 3.64 | 7.52 |
| *Ficus hispida* | 3.14 | 1.61 | 1.82 | 6.57 |
| *Garuga pinnata* | 2.50 | 3.23 | 3.64 | 9.36 |
| *Ficus benghalensis* | 0.59 | 4.84 | 5.45 | 10.88 |
| *Pongamia pinnata* | 1.99 | 3.23 | 3.64 | 8.85 |
| *Lagerstroemia parvilora* | 3.35 | 3.23 | 3.64 | 10.21 |
| *Anthocephalus cadamba* | 1.23 | 1.61 | 1.82 | 4.66 |
| *Delonix regia* | 2.45 | 3.23 | 1.82 | 7.50 |
| *Acacia nilotica* | 8.45 | 6.45 | 7.27 | 22.17 |
| *Terminalia catapa* | 7.29 | 4.84 | 5.45 | 17.58 |
| *Gmelina arborea* | 5.52 | 3.23 | 1.82 | 10.56 |
| *Shorea robusta* | 2.81 | 3.23 | 3.64 | 9.67 |
| *Terminalia tomentosa* | 1.48 | 1.61 | 1.82 | 4.92 |

## ANNEXURE-VIII
## DEMOGRAPHIC DETAILS

| S.No | Village Name | House holds | Total Population | Total Male Population | Total Female Population | Persons < 6 years of age | SC Population | ST Population | Total Literates | Male literates | female literates | Total Illiterates | Total Workers | Total Main workers | Male Main workers | Female Main workers | Cultivators | Agricultural Labours | Household workers | Other workers | Total marginal workers | Male marginal workers | Female marginal workers | Total non workers | Male non workers | Female non workers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0-3 Km radius | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Odagadi | 524 | 3054 | 1577 | 1477 | 728 | 790 | 672 | 1117 | 832 | 285 | 1937 | 1490 | 1235 | 696 | 539 | 836 | 274 | 22 | 103 | 255 | 90 | 165 | 1564 | 791 | 773 |
| 2 | Khekhada | 238 | 1538 | 791 | 747 | 333 | 195 | 258 | 482 | 344 | 138 | 1056 | 690 | 374 | 304 | 70 | 345 | 12 | 6 | 11 | 316 | 61 | 255 | 848 | 426 | 422 |
| 3 | Dhaudar | 222 | 1222 | 608 | 614 | 301 | 377 | 118 | 333 | 272 | 61 | 889 | 661 | 503 | 269 | 234 | 368 | 71 | 2 | 62 | 158 | 70 | 88 | 561 | 269 | 292 |
| 4 | Barainia | 325 | 1723 | 919 | 804 | 351 | 219 | 494 | 610 | 447 | 163 | 1113 | 657 | 507 | 415 | 92 | 282 | 151 | 4 | 70 | 150 | 54 | 96 | 1066 | 450 | 616 |
| 5 | Badokhar | 607 | 3381 | 1753 | 1628 | 767 | 1321 | 413 | 1021 | 809 | 212 | 2360 | 1585 | 884 | 805 | 79 | 508 | 202 | 4 | 170 | 701 | 74 | 627 | 1796 | 874 | 922 |
| 6 | Barhawatola | 503 | 2727 | 1413 | 1314 | 579 | 464 | 541 | 1046 | 703 | 343 | 1681 | 989 | 580 | 449 | 131 | 269 | 23 | 26 | 262 | 409 | 208 | 201 | 1738 | 756 | 982 |
| | 3-7 Km radius | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | Betahadand | 143 | 866 | 454 | 412 | 190 | 1 | 199 | 287 | 212 | 75 | 579 | 416 | 308 | 182 | 126 | 237 | 23 | 1 | 47 | 108 | 30 | 78 | 450 | 242 | 208 |
| 8 | Baghadih | 649 | 3821 | 1947 | 1874 | 990 | 1257 | 1614 | 1014 | 751 | 263 | 2807 | 1880 | 1101 | 848 | 253 | 681 | 363 | 28 | 29 | 779 | 100 | 679 | 1941 | 999 | 942 |
| 9 | Jobgarh | 269 | 1612 | 834 | 778 | 327 | 99 | 953 | 553 | 411 | 142 | 1059 | 772 | 497 | 362 | 135 | 195 | 277 | 1 | 24 | 275 | 42 | 233 | 840 | 430 | 410 |
| 10 | Bhalugarh | 148 | 931 | 477 | 454 | 231 | 208 | 222 | 311 | 206 | 105 | 620 | 426 | 304 | 207 | 97 | 156 | 119 | 11 | 18 | 122 | 5 | 117 | 505 | 265 | 240 |
| 11 | Godwali | 545 | 3305 | 1663 | 1642 | 836 | 850 | 427 | 704 | 548 | 156 | 2601 | 938 | 500 | 488 | 12 | 227 | 153 | 2 | 118 | 438 | 266 | 172 | 2367 | 909 | 1458 |
| 12 | Kanai | 229 | 1373 | 731 | 642 | 291 | 492 | 271 | 501 | 376 | 125 | 872 | 761 | 365 | 334 | 31 | 242 | 98 | 6 | 19 | 396 | 65 | 331 | 612 | 332 | 280 |
| 13 | Bargawan | 410 | 2441 | 1290 | 1151 | 463 | 145 | 527 | 1235 | 810 | 425 | 1206 | 840 | 627 | 528 | 99 | 143 | 188 | 43 | 253 | 213 | 58 | 155 | 1601 | 704 | 897 |
| 14 | Daga | 472 | 2516 | 1318 | 1198 | 525 | 671 | 113 | 1227 | 849 | 378 | 1289 | 993 | 533 | 456 | 77 | 238 | 64 | 4 | 227 | 460 | 162 | 298 | 1523 | 700 | 823 |
| 15 | Dadar | 148 | 814 | 428 | 386 | 170 | 140 | 257 | 247 | 165 | 82 | 567 | 358 | 203 | 195 | 8 | 180 | 15 | 1 | 7 | 155 | 12 | 143 | 456 | 221 | 235 |
| 16 | Gidher | 431 | 2357 | 1185 | 1172 | 482 | 765 | 1071 | 441 | 315 | 126 | 1916 | 1022 | 810 | 568 | 242 | 730 | 65 | 0 | 15 | 212 | 31 | 181 | 1335 | 586 | 749 |
| 17 | Karri | 158 | 994 | 500 | 494 | 256 | 13 | 757 | 322 | 262 | 60 | 672 | 526 | 479 | 241 | 238 | 375 | 79 | 9 | 16 | 47 | 0 | 47 | 468 | 259 | 209 |
| 18 | Ghinhagaon | 267 | 1469 | 759 | 710 | 323 | 499 | 268 | 717 | 474 | 243 | 752 | 727 | 575 | 338 | 237 | 311 | 174 | 6 | 84 | 152 | 42 | 110 | 742 | 379 | 363 |
| 19 | Majhigawan | 307 | 1524 | 772 | 752 | 329 | 203 | 965 | 488 | 370 | 118 | 1036 | 1088 | 588 | 315 | 273 | 423 | 94 | 8 | 63 | 500 | 256 | 244 | 436 | 201 | 235 |
| | 7-10 Km radius | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | Chhadna | 46 | 251 | 120 | 131 | 74 | 0 | 21 | 51 | 42 | 9 | 200 | 89 | 49 | 49 | 0 | 30 | 18 | 0 | 1 | 40 | 1 | 39 | 162 | 70 | 92 |
| 21 | Talwa | 129 | 676 | 330 | 346 | 165 | 53 | 440 | 173 | 129 | 44 | 503 | 284 | 151 | 146 | 5 | 103 | 39 | 0 | 9 | 133 | 24 | 109 | 392 | 160 | 232 |
| 22 | Ujjaini | 362 | 1953 | 996 | 957 | 441 | 417 | 617 | 814 | 560 | 254 | 1139 | 779 | 451 | 426 | 25 | 246 | 167 | 1 | 37 | 328 | 69 | 259 | 1174 | 501 | 673 |
| 23 | Majhauli | 172 | 982 | 520 | 462 | 226 | 46 | 169 | 462 | 330 | 132 | 520 | 434 | 242 | 215 | 27 | 184 | 35 | 4 | 19 | 192 | 46 | 146 | 548 | 259 | 289 |
| 24 | Kunda | 33 | 198 | 105 | 93 | 49 | 0 | 13 | 86 | 62 | 24 | 112 | 82 | 39 | 36 | 3 | 24 | 12 | 0 | 3 | 43 | 10 | 33 | 116 | 59 | 57 |
| 25 | Manihari | 217 | 1489 | 751 | 738 | 329 | 44 | 652 | 572 | 443 | 129 | 917 | 584 | 436 | 335 | 101 | 326 | 87 | 15 | 8 | 148 | 26 | 122 | 905 | 390 | 515 |
| 26 | Rampurwa | 128 | 706 | 380 | 326 | 158 | 29 | 439 | 190 | 150 | 40 | 516 | 337 | 301 | 221 | 80 | 192 | 93 | 1 | 15 | 36 | 9 | 27 | 369 | 150 | 219 |
| 27 | Bodi | 106 | 580 | 297 | 283 | 118 | 0 | 575 | 96 | 72 | 24 | 484 | 321 | 314 | 168 | 146 | 206 | 103 | 2 | 3 | 7 | 0 | 7 | 259 | 129 | 130 |
| 28 | Birchhi | 26 | 174 | 95 | 79 | 41 | 29 | 121 | 40 | 26 | 14 | 134 | 79 | 78 | 42 | 36 | 55 | 21 | 2 | 0 | 1 | 0 | 1 | 95 | 53 | 42 |
| 29 | Parihasi | 142 | 780 | 405 | 375 | 178 | 0 | 326 | 196 | 158 | 38 | 584 | 383 | 306 | 186 | 120 | 273 | 20 | 0 | 13 | 77 | 19 | 58 | 397 | 200 | 197 |
| 30 | Pokhara | 263 | 1506 | 761 | 745 | 314 | 95 | 852 | 738 | 471 | 267 | 768 | 760 | 747 | 369 | 378 | 620 | 55 | 12 | 60 | 13 | 7 | 6 | 746 | 385 | 361 |
| 31 | Silaph | 223 | 1266 | 645 | 621 | 298 | 68 | 995 | 437 | 301 | 136 | 829 | 612 | 470 | 302 | 168 | 404 | 31 | 11 | 24 | 142 | 4 | 138 | 654 | 339 | 315 |
| 32 | Amo | 236 | 1220 | 616 | 604 | 237 | 38 | 617 | 529 | 360 | 169 | 691 | 531 | 335 | 226 | 109 | 261 | 50 | 2 | 22 | 196 | 65 | 131 | 689 | 325 | 364 |
| 33 | Jharia | 13 | 55 | 32 | 23 | 12 | 0 | 0 | 28 | 20 | 8 | 27 | 25 | 25 | 14 | 11 | 24 | 1 | 0 | 0 | 0 | 0 | 0 | 30 | 18 | 12 |
| 34 | Purwa Jagir | 278 | 1566 | 827 | 739 | 308 | 345 | 564 | 632 | 425 | 207 | 934 | 548 | 307 | 276 | 31 | 152 | 133 | 1 | 21 | 241 | 77 | 164 | 1018 | 474 | 544 |
| 35 | Sajhar | 161 | 903 | 450 | 453 | 171 | 22 | 539 | 267 | 202 | 65 | 636 | 382 | 295 | 221 | 74 | 249 | 29 | 1 | 16 | 87 | 9 | 78 | 521 | 220 | 301 |
| 36 | Sarvo | 89 | 527 | 277 | 250 | 115 | 0 | 308 | 118 | 88 | 30 | 409 | 269 | 218 | 134 | 84 | 60 | 155 | 0 | 3 | 51 | 6 | 45 | 258 | 137 | 121 |
| 37 | Bastali Abad | 22 | 136 | 76 | 60 | 33 | 27 | 0 | 53 | 40 | 13 | 83 | 76 | 60 | 34 | 26 | 52 | 0 | 1 | 7 | 16 | 6 | 10 | 60 | 36 | 24 |
| 38 | Bastali Viran | 20 | 93 | 47 | 46 | 26 | 77 | 0 | 24 | 15 | 9 | 69 | 48 | 41 | 21 | 20 | 23 | 7 | 0 | 11 | 7 | 4 | 3 | 45 | 22 | 23 |
| 39 | Uska | 56 | 375 | 183 | 192 | 72 | 236 | 19 | 116 | 90 | 26 | 259 | 149 | 147 | 89 | 58 | 114 | 4 | 0 | 29 | 2 | 0 | 2 | 226 | 94 | 132 |
| 40 | Jamual | 25 | 117 | 63 | 54 | 24 | 0 | 27 | 58 | 43 | 15 | 59 | 73 | 55 | 36 | 19 | 25 | 0 | 0 | 30 | 18 | 10 | 8 | 44 | 17 | 27 |
| 41 | Semuar | 148 | 1060 | 524 | 536 | 242 | 141 | 84 | 579 | 334 | 245 | 481 | 483 | 473 | 239 | 234 | 379 | 71 | 2 | 21 | 10 | 9 | 1 | 577 | 276 | 301 |
| 42 | Ajani | 51 | 291 | 152 | 139 | 68 | 5 | 198 | 94 | 67 | 27 | 197 | 138 | 129 | 66 | 63 | 55 | 60 | 1 | 13 | 9 | 0 | 9 | 153 | 86 | 67 |
| 43 | Pali | 55 | 381 | 199 | 182 | 86 | 0 | 165 | 143 | 88 | 55 | 238 | 176 | 138 | 79 | 59 | 107 | 17 | 0 | 14 | 38 | 10 | 28 | 205 | 110 | 95 |
| 44 | Dhasada | 216 | 1376 | 697 | 679 | 321 | 265 | 112 | 603 | 419 | 184 | 773 | 539 | 406 | 246 | 160 | 336 | 46 | 3 | 21 | 133 | 61 | 72 | 837 | 390 | 447 |
| 45 | Sapaha | 30 | 211 | 103 | 108 | 41 | 13 | 54 | 84 | 62 | 22 | 127 | 112 | 56 | 33 | 23 | 47 | 5 | 0 | 4 | 56 | 23 | 33 | 99 | 47 | 52 |
| 46 | Pateri | 111 | 575 | 303 | 272 | 122 | 37 | 170 | 219 | 140 | 79 | 356 | 351 | 195 | 106 | 89 | 184 | 2 | 0 | 9 | 156 | 71 | 85 | 224 | 126 | 98 |
| 47 | Larwa | 40 | 237 | 119 | 118 | 41 | 0 | 106 | 83 | 55 | 28 | 154 | 119 | 81 | 53 | 28 | 75 | 5 | 0 | 1 | 38 | 9 | 29 | 118 | 57 | 61 |
| 48 | Kacharitola | 53 | 292 | 142 | 150 | 50 | 110 | 113 | 82 | 53 | 29 | 210 | 151 | 35 | 27 | 8 | 34 | 0 | 0 | 1 | 116 | 48 | 68 | 141 | 67 | 74 |
| 49 | Chingi | 89 | 479 | 254 | 225 | 138 | 341 | 11 | 109 | 83 | 26 | 370 | 241 | 119 | 71 | 48 | 82 | 30 | 0 | 7 | 122 | 51 | 71 | 238 | 132 | 106 |
| 50 | Chingo | 215 | 1403 | 709 | 694 | 302 | 586 | 92 | 504 | 369 | 135 | 899 | 741 | 494 | 310 | 184 | 299 | 155 | 1 | 39 | 247 | 36 | 211 | 662 | 363 | 299 |
| 51 | Kharkata | 207 | 1127 | 589 | 538 | 227 | 140 | 295 | 384 | 292 | 92 | 743 | 585 | 422 | 239 | 183 | 300 | 39 | 14 | 69 | 163 | 65 | 98 | 542 | 285 | 257 |
| | TOTAL | 10557 | 60653 | 31186 | 29467 | 13499 | 11873 | 18834 | 21220 | 15145 | 6075 | 39433 | 27300 | 18588 | 13015 | 5573 | 12267 | 3935 | 258 | 2128 | 8712 | 2401 | 6311 | 33353 | 15770 | 17583 |

**ANNEXURE-IX**
**DETAILS OF PUBLIC HEARING**

**NOTIFICATION FOR PUBLIC HEARING**

**ADVERTISEMENT FOR PUBLIC HEARING – DAINIK BHASKAR DAILY**

**(HINDI DAILY)**

**क्षेत्रीय कार्यालय म.प्र. प्रदूषण नियंत्रण बोर्ड,**
**एचआईजी 190 –191 नेहरू नगर, रीवा**

# लोक सुनवाई-सूचना

भारत सरकार, पर्यावरण एवं वन मंत्रालय को पर्यावरण प्रभाव आकलन अधिसूचना क्रमांक एसओ 1533 दिनांक 14-09-2006 के प्रावधानों के अनुसार सर्व संबंधितों को सूचित किया जाता है कि मे. हिण्डालको इंडस्ट्रीज लिमिटेड द्वारा प्रस्तावित परियोजना 3.25 लाख टन प्रति वर्ष क्षमता का ग्रीनफील्ड इन्टीग्रेटेड एल्यूमिनियम स्मेल्टर एवं 750 मेगावाट कोल बेस्ड केप्टिव थर्मल पावर प्लांट, सर्किल बरगवां, तहसील देवसर जिला सीधी म.प्र.में स्थापित किये जाने हेतु केन्द्र शासन से पर्यावरणीय स्वीकृति प्राप्त करने की प्रक्रिया में म.प. प्रदूषण नियंत्रण बोर्ड भोपाल, के समक्ष आवेदन प्रस्तुत किया गया है। अतः जिस किसी भी व्यक्ति को उपरोक्त प्रस्तावित उद्योग / परियोजना के संबंध में पर्यावरण एवं प्रदूषण नियंत्रण संबंधी सुझाव, विचार, टीका-टिप्पणी एवं आपत्ति प्रस्तुत करना हो तो इस सूचना के प्रकाशन तिथि से 30 दिवस के अंदर क्षेत्रीय कार्यालय म.प. प्रदूषण नियंत्रण बोर्ड, रीवा या उप क्षेत्रीय कार्यालय म.प्र. प्रदूषण नियंत्रण बोर्ड, बैढ़न जिला सीधी के कार्यालय में प्रस्तुत कर सकते हैं। उक्त परियोजना का कार्यकारी सारांश एवं पर्यावरण प्रभाव आकलन रिपोर्ट (ई.आई.ए.रिपोर्ट)जनसामान्य के अवलोकनार्थ जिलाध्यक्ष कार्यालय, सीधी, अपर कलेक्टर बैढ़न जिला सीधी, अध्यक्ष जिला पंचायत सीधी, जिला उद्योग एवं व्यापार केन्द्र सीधी, उप क्षेत्रीय कार्यालय म.प्र. प्रदूषण नियंत्रण बोर्ड बैढ़न जिला सीधी, क्षेत्रीय कार्यालय म.प्र. प्रदूषण नियंत्रण बोर्ड, रीवा, ग्रामीण पंचायत कार्यालय, थौड़र तथा म.प्र. प्रदूषण नियंत्रण बोर्ड भोपाल की वेबसाइट डब्ल्यू डब्ल्यू डब्ल्यू.एमपीपीसीबी.नीक.इन पर उपलब्ध रहेगा।परियोजना के सम्बंध में लोक सुनवाई का आयोजन दिनांक 14 मार्च 2008, दिन शुक्रवार, समय प्रातः 11 बजे से दो बजे तक, स्थान ग्राम थौड़र, पेड़ी पालन भवन के समीप, बरगवां, जिला सीधी म.प्र. में किया जावेगा। इच्छुक नागरिक लोग सुनवाई में सम्मिलित होकर अपने मत लिखित अथवा मौखिक रूप से प्रस्तुत कर सकते हैं।

क्षेत्रीय अधिकारी
म.प्र. नियंत्रण बोर्ड, रीवा म.प्र.

दैनिक भास्कर 12/2/2008

## ANNEXURE-IX
## DETAILS OF PUBLIC HEARING

### ADVERTISEMENT FOR PUBLIC HEARING

### (HINDI DAILY)

**क्षेत्रीय कार्यालय म.प्र. प्रदूषण नियंत्रण बोर्ड, एचआईजी 190 -191 नेहरू नगर, रीवा**

**लोक सुनवाई-सूचना**

भारत सरकार, पर्यावरण एवं वन मंत्रालय को पर्यावरण प्रभाव आकलन अधिसूचना क्रमांक एसओ 1533 दिनांक 14-09-2006 के प्रावधानों के अनुसार सर्व संबंधितों को सूचित किया जाता है कि मे. हिण्डालको इंडस्ट्रीज लिमिटेड द्वारा प्रस्तावित परियोजना 3.25 लाख टन प्रति वर्ष क्षमता का ग्रीनफील्ड इन्टीग्रेटेड एल्यूमिनियम स्मेलटर एवं 750 मेगावाट कोल बेस्ड केप्टिव्ह थर्मल पावर प्लांट, सर्किल बरगवाँ, तहसील देवसर जिला सीधी म.प्र.में स्थापित किये जाने हेतु केन्द्र शासन से पर्यावरणीय स्वीकृति प्राप्त करने की प्रक्रिया में म.प. प्रदूषण नियंत्रण बोर्ड भोपाल, के समक्ष आवेदन प्रस्तुत किया गया है। अतः जिस किसी भी व्यक्ति को उपरोक्त प्रस्तावित उद्योग / परियोजना के संबंध में पर्यावरण एवं प्रदूषण नियंत्रण संबंधी सुझाव, विचार, टीका-टिप्पणी एवं आपत्ति प्रस्तुत करना हो तो इस सूचना के प्रकाशन तिथि से 30 दिवस के अंदर क्षेत्रीय कार्यालय म्र.प. प्रदूषण नियंत्रण बोर्ड, रीवा या उप क्षेत्रीय कार्यालय म.प्र. प्रदूषण नियंत्रण बोर्ड, बैढ़न जिला सीधी के. कार्यालय में प्रस्तुत कर सकते हैं। उक्त परियोजना का कार्यकारी सारांश एवं पर्यावरण प्रभाव आकलन रिपोर्ट (ई.आई.ए.रिपोर्ट)जनसामान्य के अवलोकनार्थ जिलाध्यक्ष कार्यालय, सीधी, अपर कलेक्टर बैढ़न जिला सीधी, अध्यक्ष जिला पंचायत सीधी. जिला उद्योग एवं व्यापार केन्द्र सीधी, उप क्षेत्रीय कार्यालय म.प्र. प्रदूषण नियंत्रण बोर्ड बैढ़न जिला सीधी, क्षेत्रीय कार्यालय म.प्र. प्रदूषण नियंत्रण बार्ड, रीवा, ग्रामीण पंचायत कार्यालय, धौड़र तथा म.प्र. प्रदूषण नियंत्रण बोर्ड. भोपाल की वेबसाइट डब्ल्यू डब्ल्यू डब्ल्यू.एमपीपीसीबी.नीक.इन पर उपलब्ध रहेगा।परियोजना के सम्बंध में लोक सुनवाई का आयोजन दिनांक 14 मार्च 2008, दिन शुक्रवार, समय प्रातः 11 बजे से दो बजे तक, स्थान ग्राम धौड़र. भेड़ी पालन भवन के समीप, बरगौं, जिला सीधी म.प्र. में किया जावेगा। इच्छुक नागरिक लोग सुनवाई में सम्मिलित होकर अपने मत लिखित अथवा मौखिक रूप से प्रस्तुत कर सकते हैं।

क्षेत्रीय अधिकारी
म.प्र. नियंत्रण बोर्ड, रीवा म.प्र.

**ANNEXURE-IX**
**DETAILS OF PUBLIC HEARING**

**ADVERTISEMENT FOR PUBLIC HEARING – NAV BHARAT**

**(HINDI DAILY)**

# क्षेत्रीय कार्यालय म.प्र. प्रदूषण नियंत्रण बोर्ड,

एच.आई.जी. 190-191 नेहरू नगर रीवा ( म.प्र. )

## लोक सुनवाई सूचना

[illegible] एवं वन मंत्रालय की पर्यावरण प्रभाव आंकलन अधिसूचना क्रमांक [illegible] दिनांक 14.9.06 के प्रावधानों के अनुसार सर्व संबंधितों को सूचित किया जाता है [illegible] लिमिटेड द्वारा प्रस्तावित परियोजना 3.25 लाख टन प्रति वर्ष क्षमता [illegible] प्राइमरी एल्युमिनियम स्मेलटर एवं 750 मेगावाट कोल बेस्ड कैपिटिव थर्मल [illegible] बरगवां, तहसील देवसर जिला सीधी म.प्र. में स्थापित किए जाने हेतु केन्द्र [illegible] पर्यावरणीय स्वीकृति प्राप्त करने की प्रक्रिया में म.प्र. प्रदूषण नियंत्रण बोर्ड भोपाल, के [illegible] आवेदन प्रस्तुत किया गया है।

[illegible] किसी भी व्यक्ति को उपरोक्त प्रस्तावित उद्योग /परियोजना के संबंध में पर्यावरण एवं प्रदूषण नियंत्रण संबंधी सुझाव, विचार, टीका-टिप्पणी एवं आपत्ति प्रस्तुत करना हो तो इस सूचना के प्रकाशन तिथि से 30 दिवस के अंदर क्षेत्रीय कार्यालय म.प्र. प्रदूषण नियंत्रण बोर्ड, रीवा या उपक्षेत्रीय कार्यालय म.प्र. प्रदूषण नियंत्रण बोर्ड, बैढ़न जिला सीधी के कार्यालय में प्रस्तुत कर सकते हैं, उक्त परियोजना का कार्यकारी सारांश एवं पर्यावरण प्रभाव आंकलन रिपोर्ट (ई.आई.ए. रिपोर्ट) जनसामान्य के अवलोकनार्थ जिलाध्यक्ष कार्यालय, सीधी, अपर कलेक्टर बैढ़न जिला सीधी, अध्यक्ष जिला पंचायत सीधी, जिला उद्योग एवं व्यापार केन्द्र सीधी, उप क्षेत्रीय कार्यालय म.प्र. प्रदूषण नियंत्रण बोर्ड, बैढ़न, जिला सीधी, क्षेत्रीय कार्यालय म.प्र. प्रदूषण नियंत्रण बोर्ड, रीवा, ग्राम पंचायत कार्यालय, धीरौली तथा म.प्र. प्रदूषण नियंत्रण बोर्ड भोपाल की वेबसाइट www.mppcb.nic.in पर उपलब्ध रहेगा।

[illegible] परियोजना के संबंध में लोक सुनवाई का आयोजन दिनांक 14 मार्च 2008, दिन शुक्रवार, समय प्रातः 11 बजे से 2.00 बजे तक, स्थान-ग्राम धीरौली, [illegible] भवन के समीप, बरगवां, जिला सीधी (म.प्र.) में किया जायेगा। इच्छुक नागरिक लोक सुनवाई में सम्मिलित होकर अपने मत लिखित अथवा मौखिक रूप से प्रस्तुत कर सकते हैं।

( क्षेत्रीय अधिकारी )
म.प्र. प्रदूषण नियंत्रण बोर्ड, रीवा ( म.प्र. )

## ANNEXURE-IX
## DETAILS OF PUBLIC HEARING

## DETAILS OF PUBLIC HEARING

# लोकसुनवाई कार्यवाही विवरण

**मे. हिंडालको इंडस्टीज लिमिटेड के ग्रीनफील्ड इंटीग्रेटेड एल्यूमीनियम स्मेल्टर क्षमता 3.25 लाख टन प्रतिवर्ष एवं 750 मेगावाट कोलबेस्ड कैप्टिव पावर प्लांट बरगवाँ तह. देवसर जिला सीधी (म.प्र.)**

भारत सरकार , पर्यावरण एवं वन मंत्रालय की पर्यावरण प्रभाव आंकलन (ई.आई.ए.) अधिसूचना कमांक एस.ओ. 1533 दिनांक 14.09.2006 के प्रावधानो के अनुसार मेसर्स हिंडालको इंडस्टीज लिमि. के ग्रीनफील्ड इंटीग्रेटेड एल्यूमीनियम स्मेल्टर क्षमता 3.25 लाख टन प्रतिवर्ष एवं 750 मेगावाट कोलवेस्ड कैप्टिव पावर प्लांट बरगवाँ तह. देवसर जिला सीधी (म.प्र.) के लिये केन्द्र शासन से पर्यावरण स्वीकृति प्राप्त करने के संबंध मे लोक सुनवाई आज दिनांक 14.03.08 को ग्राम घौड़र, तहसील देवसर, जिला–सीधी (म.प्र.) मे निर्धारित समय प्रातः 11.00 बजे प्रारंभ हुई।

नोटीफिकेशन मे प्रावधान के अनुसार लोक सुनवाई के संबंध मे सूचना का प्रकाशन क्षेत्र मे वितरित होने वाले राष्ट्रीय स्तर के समाचार पत्र दैनिक भास्कर, नवभारत एवं स्थानीय समाचार पत्र 'समय' मे दिनांक 12 फरवरी 2008 को प्रकाशन कराया गया एवं प्रचार प्रसार हेतु बैनर लगाये गये।

लोक सुनवाई के दौरान लोक सुनवाई पैनल मे कलेक्टर सीधी प्रतिनिधि अपर कलेक्टर बैढन जिला सीधी श्री मनोज खत्री एवं म.प्र.प्रदूषण नियंत्रण बोर्ड के क्षेत्रीय अधिकारी श्री सी.पी.खरे एवं अन्य अधिकारी उपस्थित रहे। उद्योग प्रबंधन के प्रतिनिधि श्री आर.एस. रवि – संयुक्त अधिशासी अध्यक्ष, श्री ए.टी. मैथ्यू – वरिष्ठ उपाध्यक्ष, श्री आई. जे. जोशी – वरिष्ठ उपाध्यक्ष, श्री संजय शर्मा – सहायक महाप्रबन्धक, श्री संजय श्रीवास्तव – परियोजना प्रबंधक, एवं पर्यावरण सलाहकार मेसर्स विमटा लैब की ओर से श्री बी. के. चौधरी – वरिष्ठ वैज्ञानिक तथा प्रस्तावित परियोजना क्षेत्र एवं आस पास के रहवासी नागरिक एवं मीडिया प्रतिनिधि उपस्थित हुये। लोक सुनवाई की कार्यवाही का विवरण निम्नानुसार है:

सर्वप्रथम श्री एस.पी. [illegible] सहायक यंत्री म.प्र. प्रदूषण नियंत्रण बोर्ड, रीवा ने उपस्थित सभी महानुभावों का स्वागत किया एवं क्षेत्रीय अधिकारी, म.प्र. प्रदूषण नियंत्रण बोर्ड रीवा श्री सी.पी.खरे ने लोक सुनवाई प्रकिया की आवश्यकता के सम्बन्ध में संक्षिप्त जानकारी दी गई तथा आवेदक उद्योग मेसर्स हिंडालको इंडस्टीज लिमिटेड के परियोजना प्रबंधक श्री संजय श्रीवास्तव से आग्रह किया कि प्रस्तावित परियोजना के सम्बन्ध में जानकारी एवं ई.आई.ए. सारांश इस क्षेत्र की भाषा (हिन्दी) में लोक सुनवाई में प्रस्तुत करें।

मेसर्स हिंडालको इंडस्टीज लिमिटेड के श्री संजय श्रीवास्तव परियोजना प्रबंधक ने श्री मनोज खत्री अपर कलेक्टर एवं श्री सी.पी. खरे क्षेत्रीय अधिकारी, म.प्र. प्रदूषण नियंत्रण बोर्ड, रीवा एव उनके सहयोगी, पत्रकार बन्धुओं, गणमान्य व्यक्ति एवं सम्मानित नागरिकों का मेसर्स हिंडाल्को इंडस्ट्रीज लिमिटेड की ओर से हार्दिक अभिनंदन एवं स्वागत किया गया एवं परियोजना से संबंधित जानकारी देने के लिये श्री संजय शर्मा सहायक महाप्रबन्धक को आमत्रित किया।

श्री संजय शर्मा सहायक महाप्रबन्धक द्वारा प्रस्तुत जानकारी संलग्न है (संग्लनक क)

तदुपरान्त अपर कलेक्टर बैढन जिला सीधी श्री मनोज खत्री द्वारा परियोजना स्थल के आसपास स्थित ग्राम के रहवासियों को कोई अन्य जानकारी प्राप्त करने, सुझाव, आपत्ति या टीका–टिप्पणी, करने हेतु आमंत्रित किया गया। उपस्थित लोगो द्वारा प्रस्तुत सुझाव, आपत्ति या टीका–टिप्पणी के मुख्य बिन्दु तथा परियोजना प्रबंधन द्वारा प्रस्तुत जवाब निम्नानुसार हैं :–

# ANNEXURE-IX
## DETAILS OF PUBLIC HEARING

| क. | नाम व पता | प्रस्तुत की गई टीका टिप्पणी एवं आक्षेप व सुझाव | उद्योग प्रतिनिधि द्वारा प्रत्युत्तर |
|---|---|---|---|
| 1 | राधा कान्त सिंह ग्राम –बरगवॉ | उद्योग के आने से विकास तो होगा, यहॉ कृषि पर निर्भरता है और सूखा पड़ गया है। विस्तापितों का पुनर्वास वर्ष 2007 की नीति के अनुरूप किया जायें। उद्योग द्वारा वृक्षों वनस्पतियों नदियों एवं जलाशयों को संरक्षित करें तथा यहॉ की जनता को वायु, ध्वनि, जल एवं रासायनिक प्रदूषण से मुक्त रखें। | श्री.आई.जे.जोशी ने प्रस्तुतीकरण दिया कि कम्पनी पर्यावरण संरक्षण हेतु प्रतिबद्व है। कम्पनी ने इस हेतु लगभग रू. 400 करोड़ का प्रावधान किया है। कम्पनी जल/ वायु प्रदूषण नियंत्रण हेतु नवीनतम तकनीकी को अपनायेगी एवं पर्यावरण नियमों के अन्तर्गत निर्धारित मानदण्डो का पालन करेगी। प्रस्तावित परियोजना में 150 मेगावॉट की 5 इकाईयॉं लगाई जावेगी, इस प्रकार कुल 750 मेगावॉट विद्युत का उत्पादन किया जावेगा। पर्यावरणीय अधिनियमों के अन्तर्गत दी गई मार्गदर्शिका के अनुसार चिमनी की ऊँचाई लगभग 220 मीटर रखी जावेगी तथा ई.एस.पी. संयत्र लगायें जावेगें। कम्पनी परियोजना स्थल के चारो तरफ विभिन्न प्रजातियों के लगभग 12 लाख वृक्षों का रोपण किया जावेगा। कम्पनी द्वारा इस प्रयोजन हेतु कुल भूमि का 30 प्रतिशत (लगभग 600 हे. भूमि) रखे जाने का प्रावधान है। चिकित्सा, शिक्षा इत्यादि सुविधायें कम्पनी के सामाजिक उत्तरदायित्व के अन्तर्गत तथा विस्थापन एवं पुनर्वास नीति के प्रावधानुसार की जावेंगी, तथा भूमि का अर्जन शासन के निर्देशानुसार ही किया जावेगा। परियोजना स्वयं लगभग 30 कि.मी की दूरी से गोपद नदी से अपने उपयोग हेतु जल लायेंगी तथा परियोजना से निकलने वाले दूषित जल को उपचार उपरान्त पुन उपयोग किया जावेगा एवं जल को परिसर के बाहर नही छोड़ा जायेगा. साथ ही जल संरक्षण पर विशेष ध्यान दिया जावेगा। पातन हेतु वृक्षों की संख्या नगण्य है एवं वृक्षो की कटाई न्यूनतम एवं विधि सम्मत ढंग से की जावेगी । रेनहार्वेस्टिंग का प्रबंध किया जावेगा एवं कम्पनी शासन द्वारा निर्धारित जल संरक्षण नीतियों के पालन हेतु प्रतिवद्ध हैं। |
| 2 | हरबंश अग्रवाल ग्राम –बरगवॉ | आवास एवं पुनर्वास नीति 2007 को लागू किया जाये और पर्यावरण संरक्षण हेतु जो प्रदर्शिका प्रस्तुत की गई है उसे उद्योग द्वारा कियान्वयन भी किया जाये। | |
| 3 | जवाहर लाल कुशवाहा, ग्राम– धोंड़र | हम तीन बार विस्थापित हो चुके है अतः पुनर्वास नीति में विशेष लाभ दिया जाये। हम उद्योग की स्थापना से सहमत है। | |
| 4 | लखपति सिंह वैश्य ग्राम– ओड़गड़ी | उद्योग प्रबंधन उद्योग से होने वाले वायु, जल व ध्वनि प्रदूषण पर रोकथाम के उपाय किये जायें तथा वृक्षों को कटने से रोका जाये। | |
| 5 | विद्यासागर भट्ट ग्राम– बरहवा टोला | 'सेज' का नियम है कि उद्योगों को बंजर भूमि आवंटित की जावेगी, पर यहॉं पर उपजाऊ भूमि उद्योगों को दी जा रही है। | |

**ANNEXURE-IX**

**DETAILS OF PUBLIC HEARING**

| क्र. | नाम व पता | प्रस्तुत की गई टीका टिप्पणी एवं आक्षेप व सुझाव | उद्योग प्रतिनिधि द्वारा प्रत्युत्तर |
|---|---|---|---|
| 6 | उपेन्द्र पाण्डेय ग्राम– बैढन | विमटा लैब द्वारा सिंगरौली क्षेत्र के भूमि, जल एवं पर्यावरण संरक्षण पर जो आकड़े प्रस्तुत किये गयें है वे पूर्व में टाटा कन्सलटेन्सी, ई.डी.एफ. द्वारा किये गये सर्वेक्षण से भिन्न हैं अतः स्थिति स्पष्ट की जावे तथा उन्होंने चार किलोमीटर क्षेत्र तक फ्री बिजली प्रबंधन उपलब्ध करायेगा सुझाव दिया गया आगे यह भी कहा कि परियोजना द्वारा 86 प्रतिशत कृषि भूमि ली जावेगी इस पर इन्होने पंजाब उच्च न्यायालय के निर्णय पर भी जानकारी देते हुए कहा कि, कृषि भूमि का अर्जन उद्योग हेतु नही किया जावे। | पर्यावरण संरक्षण अधिनियम, जल अधिनियम, वायु अधिनियम एवं इनके अन्तर्गत बनाये गये सहपठित नियमों का पालन किया जावेगा एवं परियोजना इस हेतु प्रतिबद्ध है।<br>सिंगरौली क्षेत्र मे पूर्व में कराये गये पर्यावरणीय सर्वेक्षण जिन क्षेत्रो में करायें गयें है वहाँ थर्मल पावर इकाईयाँ , कोल इकाईयां एवं अन्य उद्योग कार्यरत हैं, जब कि इस उद्योग के प्रस्तावित स्थल के आस–पास कोई अन्य वृहद् उद्योग कार्यरत नही है। साथ ही भौगोलिक स्थिति भी परिवर्तित है अतः पर्यावरणीय अध्ययन में फर्क आना स्वाभाविक है। |
| 7 | भगत सिंह ग्राम सिंगरौली | यहाँ पर जल का संकट है अतः कम्पनी से अनुरोध है कि जल स्तर में वृद्धि एवं जल संरक्षण के उपाय किये जाये ताकि जल संकट से न जूझना पड़े। मुआवजा उचित दिया जाये। | |
| 8 | अनिल वर्मा | वृक्षों का अंधाधुन्ध कटाई पर रोक लगाई जावे। | |
| 9 | कामता प्रसाद बसोर जिला पंचायत सदस्य सीधी | यहाँ पर पर्यावरण अभी शुद्व है। कपम्नी से अनुरोध है कि हवा, पानी व भूमि प्रदूषित न हों। प्रस्ताव के अनुसार सभी मापदण्ड अपनाये जायें। | |
| 10 | अशोक शाह जिला पंचायत अध्यक्ष सीधी | उद्योग द्वारा प्रदूषण नियंत्रण एवं पर्यावरण संरक्षण हेतु निर्धारित मानकों का पालन आवश्यक रूप से किया जावे। | |
| 11 | छत्रपति सिंह विधायक, धौहनी | उद्योग विस्तापितों के हित में स्वास्थ्य, शिक्षा, चिकित्सा एवं रोजगार उपलब्ध करायें तथा प्रदूषण नियंत्रण करें। | |

# ANNEXURE-IX
# DETAILS OF PUBLIC HEARING

इसके उपरान्त श्री सी.पी. खरे क्षेत्रीय अधिकारी द्वारा उपरोक्त प्राप्त सुझाव, विचार एवं टीका–टिप्पणी के संबंध में परियोजना प्रबंधन द्वारा प्रस्तुत जबाब के उपरान्त लोक सुनवाई दौरान लिखित में प्राप्त 05 टीका–टिप्पणी के संबंध में परियोजना प्रबंधन जबाब प्रस्तुत करने को कहा गया। परियोजना प्रबंधन द्वारा इस संबंध में लिखित जबाब प्रस्तुत किया गया जो इस कार्यवाही विवरण के साथ संलग्नक 'ख' के रूप में संलग्न है जो इस विवरण का भाग है।

लोक सुनवाई के अंत में अपर कलेक्टर बैढन के द्वारा कहा गया कि आज की इस पर्यावरणीय स्वीकृत हेतु लोक सुनवाई के दौरान विभिन्न नागरिकों एवं परियोजना के आस–पास से आये ग्रामवासी द्वारा जो भी सुझाव, विचार, टीका, टिप्पणी प्रस्तुत किये गये है वह अधिकांशतः विस्थापन एवं पुनर्वास तथा मुआवजा, नौकरी तथा बुनियादी सुविधाओं के संबंध में दिये तथापि लोक सुनवाई पर्यावरण से संबंधित थी। उन्होनें नें कहा की इस क्षेत्र में आ रहे नये उद्योग विस्थापन एवं पुनर्वास नीति अक्टू. 07 के अनुसार कार्य करने के लिए बाध्य है एवं शासन द्वारा संबंधितों विस्थापितों को जो मुआवजा निर्धारित किया जावेगा वह उन्हें दिया जावेगा। पर्यावरण प्रदूषण नियंत्रण हेतु परियोजना के प्रस्ताव के अनुसार परियोजना प्रबधन द्वारा पालन किये जाने हेतु आश्वासन दिया गया। जैसा कि इस क्षेत्र में प्रस्तावित अन्य परियोजनाओं द्वारा विस्थापन एवं पुर्नवास हेतु अपनी–अपनी योजनायें बनाई है। उसी प्रकार प्रस्तावित हिण्डाल्को भी अपनी प्रस्तावित नीति बनावेगी, फिर भी पुर्नवास एवं विस्थापन हेतु उठाये गये मुद्दो को क्षेत्रीय विधायक एवं जिला पंचायत अध्यक्ष के माध्यम से शासन के स्तर पर प्रेषित किया जा सकता है, जिससे शासन स्तर पर कार्यवाही की जा सकें। लोक सुनवाई के अन्त में परियोजना प्रबंधन को समझाइस देते हुए कहा कि सामुदायिक विकास हेतु जो कार्य किये जाने है। उस का प्रारंभ अभी से किया जाये तो बेहतर होगा। इस के साथ ही लोक सुनवाई में उपस्थित जन समुदाय एवं गणमान्य नागरिको, अधिकारियों, प्रेस मीडिया, जन प्रतिनिधियों को धन्यवाद देते हुए बैठक की समाप्ति की घोषणा की।

दिनांकः 14.03.08
स्थानः ग्राम धौड़र बरगवां जिला–सीधी

| | |
|---|---|
| 14/3/08<br>सी.पी.खरे<br>क्षेत्रीय अधिकारी,रीवा<br>(म.प्र.प्रदूषण नियंत्रण बोर्ड प्रतिनिधि) | मनोज खत्री<br>अपर कलेक्टर बैढन जि. सीधी<br>(कलेक्टर सीधी प्रतिनिधि) |

## ANNEXURE-IX
## DETAILS OF PUBLIC HEARING

## ATTENDANCE DURING PUBLIC HEARING

संलग्नक 'क'

दिनांक 14 मार्च, 2008

लोक सुनवाई में उपस्थित सभी पैनल सदस्यों, ग्रामीण भाईयों, बहनों एवं सहभागियों का हिण्डालको इण्डस्ट्रीज लिमिटेड हार्दिक स्वागत करता है ।

ग्राम ओड़गड़ी, गिधेर, बरैनिया एवं धौड़र तहसील–देवसर, जिला–सीधी मध्य प्रदेश मे हिण्डाल्को इण्डस्ट्रीज लिमिटेड द्वारा प्रस्तावित 3,25,000 टन प्रति वर्ष अल्युमिनियम स्मेल्टर एवं 750 मेगावाट कैप्टिव पावर प्लांट

| | | |
|---|---|---|
| स्थल | : | ग्राम – ओड़गड़ी, गिधेर, बरैनिया एवं धौड़र तहसील–देवसर जिला–सीधी, मध्य प्रदेश |
| अक्षांश | : | 24° 13' 15 उत्तर |
| देशान्तर | : | 82° 26' 14" पूर्व |
| उँचाई | : | 390 मी0 समुद्र तल से ऊपर |
| स्थल रूप–रेखा | : | लगभग समतल |
| टोपोशीट | : | 63 L/8 |

| कमांक | वर्णन | ब्यौरा |
|---|---|---|
| 1 | निकटतम आबादी | ओड़गड़ी, गिधेर, बरैनिया, धौडर एवं बारोखर गॉव |
| 2 | निकटतम बड़ा शहर | बैढन 35 किमी0, सिंगरौली 28 किमी0 |
| 3 | निकटतम राजमार्ग | NH-75 E (1-km, NE) |
| 4 | निकटतम रेलवे स्टेशन | बरगावॉ (4-km, NW) |
| 5 | पुरातात्विक स्थान | 10 किमी की परिधिय सीमा में कोई नहीं है । |
| 6 | रक्षा स्थापन | 10 किमी की परिधिय सीमा में कोई नहीं है । |
| 7 | राष्ट्रीय उद्यान, वन्य जीव अभ्यारण्य, संरक्षित क्षेत्र | 10 किमी की परिधिय सीमा में कोई नहीं है । |
| 8 | नदियॉ / नाला | गोपद नदी : 30 किमी द0<br>कंचन नदी : 6.0 किमी द0<br>खाखन नाला : 1.2 किमी उ0<br>झरनी नाला : 4.2 किमी प0 |
| 9 | संरक्षित / आरक्षित वन | अध्ययन क्षेत्र के अन्तर्गत 3 संरक्षित वन ब्लाक एवं 11 आरक्षित वन ब्लाक । |

| कमांक | वर्णन | ब्यौरा |
|---|---|---|
| 1 | अल्युमिनियम उत्पादन टन / साल | 3,25,000 |
| 2 | टेक्नोलॉजी | प्वाइंट फीडर प्री–बेक |
| 3 | विद्युत उत्पादन | 5 x 150 मेगावाट (750 मेगावाट) |
| 4 | विद्युत उत्पादन टेकनोलॉजी | प्लवराईज्ड ब्वायलर |
| 5 | कुल भूमि की जरूरत | 2025 हे0 |
| 6 | जल की जरूरत | 4600 घन मी0 प्रति घंटा (गोपद नदी) |
| 7 | विद्युत की जरूरत | 549 मेगावाट (स्मेल्टर हेतु) |
| 8 | अल्युमिना की जरूरत | 6.4 लाख टन सालाना (स्वयं के स्रोत द्वारा) |
| 9 | कोयले की जरूरत | 35 लाख टन सालाना (महान कोल लि0 से) |

## ANNEXURE-IX
## DETAILS OF PUBLIC HEARING

**पर्यावरणीय प्रभाव मूल्यांकन पद्धति**

आधारभूत पर्यावरण मूल्यांकन
शरद ऋतु 1 दिसम्बर, 2006 – 28 फरवरी, 2007
परियोजना आधारित प्रदूषण संसाधनों की पहचान
प्रभाव का मूल्यांकन
पर्यावरणीय प्रबन्धन योजना
जोखिम विश्लेषण एवं आपदा प्रबंधन योजना

**मानक मूल्यांकन आधार**

**मौसम संबंधी मूल्यांकन**
प्रधानतः हवा की दिशा – पश्चिम (11.5 प्रतिशत)
**जलवायु मूल्यांकन**

| कमांक | मनक | न्यूनतम | अधिकतम |
|---|---|---|---|
| 1 | तापमान (°C) | 8.0 | 32.3 |
| 2 | सापेक्ष आर्द्रता (%) | 44 | 68 |

**मानक मूल्यांकन आधार**

**परिवेशी वायु गुणवत्ता**

सस्पेन्डेड विशिस्ट पार्टिकुलेट मैटर = 59.4 to 143.7 μg/m³ (200)
रेस्पाईरेबुल पार्टिकुलेट मैटर = 20.7 to 47.5 μg/m³ (150)
सल्फर डाई ऑक्साइड = 6.1 to 10.2 μg/m³ (80)
ऑक्साइड ऑफ नाइटरोजन = 7.2 to 10.8 μg/m³ (80)

**सतही जल गुणवत्ता – 5 स्थानों पर**

| मानक | परिणाम | आई एस:2296 मानक |
|---|---|---|
| पी०एच | 7.6 – 8.2 | 6.5-8.5 |
| विलियत ऑक्सीजन | 5.4 – 5.9 mg/l | 4.0 mg/l (न्यूनतम) |
| बी.ओ.डी (Biochemical Oxygen Demand) | < 3.0 mg/l | 3.0 mg/l |
| तेल एवं ग्रीस | <0.1 mg/l | 0.1 mg/l |
| कुल कोलीफार्मस (Bacteria) | 134-529 MPN/100ml | 5000 MPN/100ml |

**भू–जल गुणवत्ता – 8 स्थानों पर**

| मानक | परिणाम | आई एस:2296 मानक |
|---|---|---|
| पी०एच | 7.6 – 8.2 | 6.5-8.5 |
| टी०डी०एस० (Total Dissolved Solid) | 332 – 549 mg/l | अधिकतम 2000 mg/l |
| कठोरता | 170 – 332 mg/l | अधिकतम 600 mg/l |
| ई–कोली (Bacteria) | नहीं पाया गया। | नहीं होना चाहिये। |
| कुल कोलीफार्मस | <2 MPN/100ml | 10 MPN/100ml |

## ध्वनि स्तर

अध्ययन क्षेत्र में ध्वनि स्तर केन्द्रीय प्रदूषण नियंत्रण बोर्ड के नियत मानकों के अन्तर्गत पाया गया है ।

## पारिस्थितिकी (Ecology)

अध्ययन क्षेत्र में अवलोकित प्रजातियाँ अनुसूची 6–1 के अनुसार है ।
इस क्षेत्र में वनस्पति सामान्य प्रकृति की है ।
यहाँ 3 सुरक्षित वन एवं 11 रक्षित वन हैं ।
अध्ययन क्षेत्र में राष्ट्रीय उद्यान ( नेशनल पार्क ) एवं वन्य जीव अभ्यारण्य नहीं है ।

## वायु गुणवत्ता पर प्रभाव

| प्रदूषित तत्व | संकेन्द्रणशीलता (mg/m3) | | |
|---|---|---|---|
| | आधारभूत | वर्धित | परिणामित |
| एसओ–2 ($SO_2$) | 10.6 | 40.0 | 50.6 |
| एसपीएम (SPM) | 142.2 | 2.9 | 145.1 |
| एन ओ एक्स (NOX) | 13.1 | 36.1 | 49.2 |
| फलोराईड | .. | उच्चतम सीमा से कम | उच्चतम सीमा से कम |

**प्रदूषित तत्व की बर्धित एवं परिणामित संकेन्द्रणशीलता की मात्रा केन्द्रीय प्रदूषण नियंत्रण बोर्ड द्वारा ग्रामीण एवं रिहायशी क्षेत्रों के मानकों के अन्दर है ।**

## पर्यावरणीय प्रभाव का मूल्यांकन

### जल गुणवत्ता पर प्रभाव.

करीब 560 घन मी0 प्रति घन्टे अनुपयोगी जल का निष्काशन विद्युत संयंत्र के कुलिंग टावर द्वारा होगा। उपरोक्त विसर्जित जल का पुर्नचकण कर ऐश हैण्डलिंग सिस्टम, फलाई ऐश अनुकूलन, धूल निस्कर्षण प्रणाली तथा अन्य जलोपयोगी कार्यो में किया जायेगा ।
कुलिंग टावर का बाकी अनुपयोगी जल एवं स्मेल्टर के अपशिष्ट को सामान्य शोधन संयंत्र में शुद्ध किया जायेगा व उसके बाद उसका पुर्नउपयोग किया जायेगा ।
सामान्य प्रचालन अनुकूलन के तहत कोई भी अनुपयोगी जल बाहर निस्सरित नहीं होगा ।

## पर्यावरणीय प्रभाव मूल्यांकन

### ध्वनि स्तर पर प्रभाव

प्लान्ट के सीमा के अन्दर पूर्वानुमानित ध्वनि स्तर 45 dB(A) के अन्दर रहेगा।
ध्वनि स्तरों का प्रभाव नगण्य रहेगा ।

### पारिस्थितिकी प्रभाव

वायु प्रदूषण की वर्धित संकेन्द्रशीलता का प्रभाव वनों पर बहुत कम होगा ।
वर्धित ध्वनि स्तर वन क्षेत्रों में नगण्य होगा ।
पारिस्थितिकी प्रभाव नगण्य होगा ।

## ANNEXURE-IX
## DETAILS OF PUBLIC HEARING

### पर्यावरणीय प्रबन्धन योजना

**वायु प्रदूषण प्रबन्धन**

धूलकण को 100 (mg/Nm3) से नीचे नियंत्रित करने के लिये विद्युत संयंत्र ईएसपी की स्थापना की जायेगी ।

सभी नियमों का पालन सुनिश्चित करते हुए पाट लाईनों से निकलने वाले फलोराईड को नियंत्रित मापदण्डों के अन्तर्गत करने हेतु स्मेल्टर में शुष्क स्क्रबिंग सिस्टम लगाया जायेगा ।

स्मेल्टर में ढके हुए पाट लगाये जायेंगे ताकि फलोराईड कण को कम किया जा सके।

आधुनिक तकनीक के संसाधनों का उपयोग किया जायेगा ।

पर्याप्त उँचाई एवं चौड़ाई की चिमनी लगायी जायेगी ।

एन.ओ.एक्स. उत्सर्जन को नियंत्रण में रखने के लिये कम एन.ओ.एक्स वाले बर्नर विद्युत संयंत्र में लगाया जायेगा ।

कोयला एवं राख के लिये पानी छिड़काव प्रणाली अपनायी जायेगी।

प्लांट सीमा के चारों ओर हरित पट्टिका विकसित की जायेगी।

सी.आर.ई.पी. (Corporate Responsibility for Enviromental Protection) के निर्देशों के अनुसार आधुनिक तकनीक के संयंत्र लगाये जायेंगे।

**जल प्रदूषण प्रबन्धन**

विद्युत संयंत्र व स्मेल्टर से उत्पादित अनुपयोगी जल का अधिकतम उपयोग किया जायेगा एवं बाकी बचे जल का उपयोग शोधन के बाद स्मेल्टर में किया जायेगा ।

कालोनी एवं प्लांट से उत्सर्जित घरेलु अनुपयोगी जल को सीवरेज ट्रीटमेन्ट प्लान्ट में शोधन के बाद उसका उपयोग हरित पट्टिका के विकास में किया जायेगा ।

अनुपयोगी जल संयंत्र व कालोनी से बाहर उत्सर्जित नहीं किया जायेगा ।

**ठोस अपशिष्ट प्रबन्धन**

प्लांट से निकलने वाली अधिकतम राख सीमेंट उद्योगों, ईट निर्माताओं एवं अन्य दूसरे उपभोक्ताओं को निःशुल्क दी जायेगी तथा बची हुई राख को राख बन्ध में रखा जायेगा ।
राख का निस्तारण हाई कन्संटेरेटेड स्लरी डिस्पोजल मेथड द्वारा किया जायेगा ।
राख बन्ध की दीवालें एवं तलहटी काफी मजबूत बनायी जायेगी ताकि पानी का रिसाव अन्दर जमीन में न हो ।
अनुपयोगी जल खुले स्थान पर नहीं छोड़ा जायेगा ।
स्मेल्टर से उत्पन्न होने वाले ठोस अपशिस्ट को केन्द्रीय प्रदूषण नियंत्रण बोर्ड के निर्देशों के अनुसार सुरक्षित स्थान पर जमा किया जायेगा ।

# ANNEXURE-IX
# DETAILS OF PUBLIC HEARING

**हरित पट्टिका विकास**

प्लान्ट के चारों ओर 602 हेक्टर जमीन (जो कि कुल भूमि का 30 प्रतिशत है) पर हरित पट्टिका का विकास किया जायेगा ।
लगभग बारह लाख विभिन्न प्रजातियों के पेड़–पौधे लगाये जायेंगे ।
संयंत्र निर्माण के पश्चात् लगभग पॉच वर्षो के अन्दर हरित पट्टिका का विकास पूरा कर लिया जायेगा।

**परियोजना से सामाजिक एवं आर्थिक लाभ**

क्षेत्र की सड़कों का विकास/ सुधार होगा ।
संचार व्यवस्था में सुधार होगा ।
क्षेत्र में शैक्षिक सुविधाओं की उपलब्धता बढ़ेगी ।
क्षेत्र में चिकित्सकीय सुविधाओं की उपलब्धता बढ़ेगी ।
क्षेत्र में वैकल्पिक रोजगार के अवसरों की उपलब्धता बढ़ेगी ।
इस बड़ी परियोजना से अन्य अनेक छोटी–छोटी ईकाइयों का निर्माण होगा जिससे रोजगार के अवसरों की उपलब्धता बढ़ेगी ।
उद्योग द्वारा अपने सामाजिक उत्तरदायित्व का निर्वहन करते हुए प्रभावित क्षेत्र के लोगों के सामाजिक स्तर को उँचा उठाने हेतु विशेष योजनाओं को कियान्वित किया जायेगा ।

**विस्थापित एवं पुनर्वास योजना**

विस्थापित लोगों को नये जगह बसाया जायेगा व अनुसूचित जातियों/जनजातियों के परिवारों को बसाने में खास ध्यान दिया जायेगा ।
परियोजना के निर्माण कार्यो में प्रभावित परिवारों को कार्य देने में प्राथमिकता दी जायेगी ।
विस्थापित परिवारों को एक मुश्त क्षतिपूर्ति का भुगतान मध्य प्रदेश राज्य की आदर्श पुर्नवास नीति, 2002 के प्रावधानों के अन्तर्गत किया जायेगा ।
विस्थापित एवं पुनर्वास कालोनी को पक्की सड़क से मुख्य मार्ग तक जोड़ा जायेगा।
जलापूर्ति के लिये नल एवं चापाकल लगाये जायेंगे ।
सड़क के दोनों तरफ खुली नाली का निर्माण किया जायेगा ।

## ANNEXURE-IX
## DETAILS OF PUBLIC HEARING

संलग्नक

**लोक सुनवाई के दौरान उपस्थित लोगों के द्वारा उठाये गये बिन्दु, आपत्ति, सुझाव एवं परियोजना प्रबंधन द्वारा प्रस्तुत किये गये जवाब :–**

1. श्री अर्जुन प्रसाद – जिलाध्यक्ष

उत्तर 2(ii)

भूमि उपयोग अध्ययन से पूर्ण सहमत नहीं हैं। क्योंकि 53.311 प्रतिशत कृषि भूमि के रूप में है। यह जो प्रतिशत दर्शाया गया है यह कुल 10 कि. मी. त्रिज्या का अध्ययन क्षेत्र की कुल भूमि है। लेकिन प्रस्तावित परियोजना के लिए कुल भूमि 2025 हे. की आवश्कता है। उसमें कृषि भूमि 750 हे. जो कि कुल भूमि का 30 प्रतिशत है।

उत्तर 2 (vi)

आज के लोक सुनवाई में ए.डी.एम. साहब ने स्पष्ट रूप से कहा कि सरकार की आर्दश पुनर्वास नीति 2002 तथा अक्टूबर 2007 को भी अनिवार्य रूप से लागू किया जाएगा।

2. जवाहर लाल कुशवाहा ग्राम –धौड़र

उत्तर 1

भूमि उपयोग अध्ययन से पूर्ण सहमत नही है। क्योंकि 53.311 प्रतिशत कृषि भूमि के रूप में है। यह जो प्रतिशत दर्शाया गया है यह कुल 10 कि. मी. त्रिज्या का अध्ययन क्षेत्र की कुल भूमि है। लेकिन प्रस्तावित परियोजना के लिए कुल भूमि 2025 हे. की आवश्कता है। उसमें कृषि भूमि 750 हे. जो कि कुल भूमि का 30 प्रतिशत है।

उत्तर 2(ii)

आवेदन कर्ता 54.31 प्रतिशत कृषि भूमि लिखा है जो कुल अध्ययन श्रेत्र का है जो 10 कि. मी. त्रिज्या में दर्शाता है पर प्लांट के लिए कुल भूमि का मात्रा 30 प्रतिशत कृषि भूमि है। प्लांट के लिए 70 प्रतिशत बंजर और उसर भूमि है।

उत्तर 2 (vi)

आज के लोक सुनवाई में ए.डी.एम. साहब ने स्पष्ट रूप से कहा कि सरकार की आर्दश पुनर्वास नीति 2002 तथा अक्टूबर 2007 को लागू किया जाएगा।

......2

(आई. जे. जोशी)
वरिष्ठ उपाध्यक्ष
हिण्डालको इण्डस्ट्रीज लि०

3. राधा कान्त सिंह ग्राम –बरैनिया

उत्तर
अधिशासी सांराश में इसका पूरा विवरण दिया गया है तथा जो भी कार्यवाही प्लांट के द्वारा की जाएगी वह राज्य सरकार एवं केन्द्र सरकार के निर्देश पर ही की जाएगी। नई तकनीकी लगा कर ही प्लांट चलाया जायेगा, जिससे जल, धुआँ, वायु, ध्वनि पर कोई कुप्रभाव नही पड़ेगा तथा कृषि और मानव जीवन पर इसका कोई विपरीत प्रभाव नही पड़ेगा।

4. लखपती प्रसाद वैश्य ग्राम – ओड़गडी

उत्तर (1)
धारा 4 की अधिसूचना की कार्यवाही नियमानुसार की गयी।

उत्तर (2).
कंपनी ने अपने भाषण में कहा है कि नई तथा देश विदेश के श्रेष्ठतम तकनीकी लगाकर प्लांट चलाई जायेगी जिससे आस–पास का क्षेत्र के पर्यावरण पर कोई दुस्प्रभाव न पड़े तथा इसके लिए वह कटिबद्व है तथ रिपोर्ट राज्य सरकार को दिया जा चुका है।
उत्तर (3)
राज्य सरकार के दिशानिर्देशों व उनके निर्देशानुसार कार्यवाही होगी।

5. उपेन्द्र पाण्डेय वैढन
श्री उपेन्द्र पाण्डेय के प्रतिवेदन के प्रथम भाग पर कोई टिप्पणी आवश्यक नही है।
उत्तर (2)
पुनर्वास तथा पुर्नस्थापना हेतु जमीन तथा स्थान का निर्णय पुनर्वास तथा पुर्नस्थापना योजना में लिया जायेगा।
उत्तर (3).
प्रभावित परिवारो एवं स्थानीय लोगों को शासन की निर्धारित नीतियों के अन्तर्गत पात्रता एवं योग्यता के आधार पर रोजगार में प्राथमिकता दी जावेगी।
उत्तर (4)
आवेदन कर्त्ता 54.31 प्रतिशत कृषि भूमि लिखा है जो कुल अध्ययन श्रेत्र का है जो 10 कि.मी. त्रिज्या में दर्शाता है पर प्लांट के लिए कुल भूमि का मात्रा 30 प्रतिशत कृषि भूमि है। प्लांट के लिए 70 प्रतिशत बंजर और ऊसर भूमि है।
उत्तर (5)
जो भी पुनर्वास नीति सरकार के तरफ से होगी उसका पालन हिण्डाल्को इन्डट्रीज करेगी।
उत्तर (6)
इस संबंध में शासन के दिशानिर्देशानुसार कार्यवाही की जावेगी।

....3

(आई. जे. जोशी)
वरिष्ठ उपाध्यक्ष
हिण्डालको इन्डस्ट्रीज लि०

उत्तर (7)
इस संबंध में आदर्श पुनर्वास नीति के अन्तर्गत कार्यवाही की जावेगी।

उत्तर (8)
इस बात का ख्याल रखा जायेगा कि वहाँ पर बहुवर्षीय एवं हर किस्म के वृक्ष लगाए जायंगे।

उत्तर (9,10)
इस बात का ख्याल रखा जायेगा कि पेड़ पौधों के रख–रखाव के लिए उचित व्यवस्था हो।

उत्तर (11)
शासन के निर्देशानुसार कार्यवाही की जायेगी।

उत्तर (12 )
अध्ययन के अधार पर जो भी ऑकड़े उपलब्ध हुए है वे वन एवं पर्यावरण मंत्रालय द्वारा मान्यता प्राप्त कम्पनी विमटा लैब, जो देश विदेशों में भी काम कर रही है, द्वारा उपलब्ध कराये गये हैं।

उत्तर (13)
आदर्श पुनर्वास नीति के अनुरूप कार्यवाही की जायेगी।

(आई० जे० जोशी)
वरिष्ठ उपाध्यक्ष
हिण्डालको इण्डस्ट्रीज लि०

## ANNEXURE-IX
## DETAILS OF PUBLIC HEARING

### PROCEEDINGS OF PUBLIC HEARING – ENGLISH VERSION

**M/s Hindalco Industries Limited's proposed Greenfield Integrated Aluminium Smelter capacity 3.25 Lacs TPA and Coalbased Captive Power Plant capacity 750 MW at Bargawan, Tehsil-Devsar, Distt. Sidhi (MP).**

As per the provisions of Notification No.S.O.1533 dt.14.09.2006 in respect of Environmental Impact Assessment (EIA) issued by Ministry of Environment & Forest, Govt. of India, for getting environmental clearance from Central Govt. for establishment of Hindalco Industries Limited's Greenfield Aluminium Smelter having capacity of 3.25 Lacs TPA and Coalbased Captive Power Plant having capacity of 750 MW public hearing started today i.e. 14.03.2008 at scheduled time at 11.00 AM at Village-Dhodar, Tehsil-Devsar, Distt. Sidhi (MP).

According to the provisions, the notice regarding public hearing was published in the National level newspapers i.e. Dainik Bhasker, Nav Bharat being distributed in the region and in local newspaper 'SAMAY' on 12.02.2008 and banners were fixed at different locations for wide publicity.

During the public hearing, representative of District Collector, Sidhi, Shri Manoj Khatri, Additional Collector, Baidhan, Distt. Sidhi, and Shri C.P. Khare, Regional Officer, M.P. Pollution Control Board, Rewa were present as Members of Public Hearing Panel. The Representatives of Management Shri R.S. Ravi, Joint Executive President, Shri A.T. Mathew – Sr. Vice President, Shri I.J. Joshi – Sr. Vice Preisedent, Shri Sanjay Sharma – Asst. General Manager, Shri Sanjay Shrivastava – Project Manager, Shri B.K. Chaudhary, Consultant of M/s Vimta Labs, residents of local villages of the Proposed Project Area and representative of Newspapers were also present. The details of Public Hearing is as under:

First of all, Shri S.P. Jha, Asst. Engineer, M.P. Pollution Control Board, Rewa welcomed all the persons. Regional Officer, M.P. Pollution Control Board, Shri C.P. Khare briefed about the purpose of organizing the public hearing and requested Shri Sanjay Shrivastava, Manager – Project, M/s Hindalco Industries Limited to present the details of the proposed project and EIA summary in language of this area in Hindi in the public hearing.

Shri Sanjay Shrivastava, Manager welcomed Shri Manoj Khatri, Addl. Collector, Shri C.P. Khare, Regional Officer, M.P. Pollution Control Board, Rewa and his team members, Representatives of Newspapers, well known Persons, residents on behalf of Hindalco Industries Limited and invited Shri Sanjay Sharma, Asst. General Manager of the Project for making his presentation about the Project.

After this, Additional Collector, Baidhan, Distt. Sidhi, Shri Manoj Khatri requested residents living in nearby areas of the project for knowing details, making suggestion, objection or comment. The main points raised/objections/comments are as under:

| Sl. No. | Name & Address | Produced Comments, Objections and Advice | Answer by Representative of the Project |
|---|---|---|---|
| 1. | Radha Kant Singh, Village-Bargawan | The area will develop due to establishment of the project. The area depends on agriculture and the area is drought affected. Rehabilitation and resettlement of displaced persons may be done according to the Policy of 2007. Industry should conserve the trees, vegetations, rivers and reservoirs and the area must be free from air, noise and water pollution for local people. | Shri I.J. Joshi informed that the Company is committed for environment conservation and has made provisions for approx. Rs.400 Crores for this purpose. Company will adopt latest technology /install equipment to control water/air pollution and comply with the prescribed standards. The height of chimney will be kept approx. 200 meter and ESP Plants will be commissioned. The Company will plant approx. 1200000 saplings of different species around the Project. Company has made provisions of 30% land (Approx. 600 hectrs. land) for plantation. Medical, Education etc. facilities will be provided under Social Responsibilities of Project and as per the provisions of Rehabilitation and Resettlement Policy and land acquisition will be done by the M.P. Govt. The Project itself will draw water from Gopad River which is situated at the distance of 30 Km. away from the plant for utilization in the project and the wastewater coming from the plant will be utilized after treatment and this water will not be discharged out side the plant. Special attention will be given on water conservation. Cutting of trees will be |
| 2. | Harbansh Agarwal, Village-Bargawan | The Rehabilitation and Resettlement Policy 2007 may be implemented and the measures presented for environment conservation must also be implemented. | |
| 3. | Jawahar Lal Kushwaha, Village-Dhodar | We have been displaced thrice. We should be given special benefits. We agree for establishment of the project. | |
| 4. | Lakhpati Singh Baisya, Village-Odgadi | Steps should be taken to control the air, water and noise pollution and cutting of trees may be prevented. | |

| | | | |
|---|---|---|---|
| 5. | Vidyasagar Bhatta, Village-Barhawa Tola | According to Special Economic Zone "SEZ", only Bunjar land should be given to the Industry but in this case fertile land is being given to the Industry. | negligible and minimum cutting of trees will be done and as per the rule. Arrangement will be made for rain water harvesting and Company is committed to follow the Water Conservation Policy of Govt. |
| 6. | Upendra Pandey, Village-Baidhan | The report presented by Vimta Labs on land, water and environment conservation is different from the report prepared by Tata Consultancy, E.D.F. earlier. Therefore, this should be clarified. Mr. Pandey advised that Management provide free electricity in the periphery of 4 Km. area and also said that 86% agricultural land will be acquired by the Project and pointing out the judgement of Punjab High Court said that acquisition of agricultural land should not be done for industry. | Compliance of Rules and Sub-Rules of Environment Protection Act, Water (Prevention & Control) Act and Air(Prevention & Control) Act will be done and the Company is committed for the same. The environmental impact study of Singrauli Region was conducted earlier. Moreover, Singrauli Region has got Thermal Power Plant/Coal Mines and other industries. While in our proposed Project area, there is no major industry established. Besides this, the geographical situation is also different hence the difference in environmental study parameters are quite natural. |
| 7. | Bhagat Singh, Singrauli | The area is having water problem. Therefore, the industry is requested to take proper steps for increasing water table and water conservation so that there is no water problem. Proper compensation may be given. | |
| 8. | Anil Verma | Unnecessary cutting of trees may be prevented. | |
| 9. | Kamta Prasad Basor, Distt. Panchayat Member, Sidhi | At present the environment of this area is well. Industry is requested that air, water and land are not polluted. All the standards may be adopted according to presentation. | |

| | | | |
|---|---|---|---|
| 10. | Ashok Shah, President – Distt. Panchayat, Sidhi | Compliance of prescribed standards for pollution control and environment conservation may be done compulsorily. | |
| 11. | Kshatrapati Singh, M.L.A., Dhauhani | Industry may provide medical, education and employment to the displaced people and control the pollution. | |

On receipt of suggestion and comments from the persons presented in the Public Hearing and reply from the Project Management, Shri C.P. Khare asked the Project Management to submit the reply in writing to the five representations received in writing. The written reply was submitted by Project Management and is enclosed with the working details as Annexure-Kh which is the part of the proceedings.

It was again emphasized by the Additional Collector, Baidhan while concluding the proceedings that this public hearing was organized for the purpose of environmental clearance whereas the suggestions and comments made by several people and the residents of the nearby areas of the Project were in respect of the displacement, rehabilitation and compensation. He said that the industries being established in this area are committed to implement the provisions of Rehabilitation and Resettlement Policy 2007 and the compensation as decided by M.P. Govt. will be given to the concerned displaced persons. It was assured by Project Management that steps will be taken to control the pollution as per their proposal. Hindalco will make its own Rehabilitation and Resettlement Policy at par with other industries being established in this area. However, the points raised on Rehabilitation and Resettlement may also be submitted through local M.L.A. and President, District Panchayat to the Govt. so that problem could be resolved. While concluding the public hearing Mr. Khatri advised Hindalco Management that it will be better if the works related to community development are started at the earliest. In the end of the meeting, Mr. Khatri extended his thanks to all who were present in the public hearing i.e. local people, Govt. Officials, Media persons, Representative of People and announced the conclusion of the meeting.

THE POINTS RAISED, OBJECTIONS AND SUGGESTIONS MADE BY THE VARIOUS PERSONS WHO WERE PRESENT IN THE PUBLIC HEARING AND REPLY GIVEN BY THE REPRESENTATIVE OF HINDALCO MANAGEMENT

1. Shri Arjun Prasad – District President

Answer 2(ii)

I do not agree with the study of land utilization because only 53.311% is agricultural land. The percentage shown is of the total study area of 10 Km. radius. There is a requirement of total 2025 hectares land for this proposed project. Out of this, 750 hectares is agricultural land which is about 30% of the total land.

Answer 2 (vi)

A.D.M. Baidhan has clarified in today's public hearing that the Ideal Resettlement Policy 2002 and October 2007 will be implemented compulsorily.

2. Jawahar Lal Kushwaha, Village - Dhodar

Answer 1

I do not agree with the study of land utilization, because only 53.311% is agricultural land. The percentage shown is of the total study area of 10 Km radius. There is a requirement of total 2025 hectares land for this proposed project. Out of this, 750 hectares is agricultural land which is about 30% of the total land.

Answer 2 (ii)

Applicant has written 54.31% agricultural land which shows the total study area of 10 Km. radius. But 30% of the land proposed for the project is agricultural land. 70% land is Bunjar and Barren land for the Project.

Answer 2 (vi)

A.D.M. Baidhan has clarified in today's public hearing that the Ideal Resettlement Policy 2002 and October 2007 will be implemented compulsorily.

3. Radha Kant Singh, Village-Barainya

Answer

All the details have been given in the Executive Summary and all the actions which will be initiated by Project Management will be as per the directions of State and Central Pollution Control Board. Plant will use latest technology ensuring that water, air and noise level is kept within standards and there is no adverse effect on human life and agriculture.

4. Lakhpati Prasad Vaisya, Villae-Orgari

Answer (1)

Proceedings of Section 4 of the Notification were completed as per rules.

Answer (2)

The Company has announced that after installing the latest new technology equipment, the plant will run so that the environment of the nearby areas may not be affected and Company is committed for the same. The report has been submitted to State Govt.

Answer (3)

The policy will be implemented as per the guidelines and directions of State Govt.

5. Upendra Pandey - Baidhan

The first part of the application of Upendra Pandey needs no comment.

Answer (2)

Decision for land and site for Rehabilitation and Resettlement will be taken in Rehabilitation and Resettlement Planning.

Answer (3)

Priority will be given in providing employment to the displaced families and local persons as per the eligibility and qualifications under the prescribed policy of the Govt.

Answer (4)

Applicant has written 54.31% agricultural land which shows the total study area of 10 Km. radius. But 30% of the land proposed for the project is agricultural land. 70% land is Bunjar and Barren land for the Project.

Answer (5)

The Project Management will comply with the Rehabilitation Policy as decided by State Govt.

Answer (6)

The actions will be initiated as per the guidelines of State Govt

Answer (7)

Implementation will be done under the Ideal Rehabilitation Policy in this respect.

Answer (8)

It will be ensured that saplings of various species with long life will be planted in the area.

Answer (9,10)

Arrangement will be made for maintenance of plantation.

Answer (11)

The actions will be initiated as per the guidelines of State Govt

Answer (12)

On the basis of study, the report has been prepared by M/s Vimta Labs, an approved Company by Ministry of Environment & Forest, Govt. of India and they have got experience of working in foreign countries also in this field.

Answer (13)

Implementation will be done under the Ideal Rehabilitation Policy in this respect.