BEFORE THE NATIONAL GREEN TRIBUNAL

EASTERN ZONE BENCH KOLKATA

IN

OA No.150/2024/EZ

(Earlier OA No. 316/2024/PB)

IN THE MATTER OF:

Geeta Devi

...APPLICANTS

VERSUS

State Of Jharkhand

...RESPONDENTS

INDEX

Sl No.	Particulars	Annexures	Page Nos.
1	Counter Affidavit on behalf of Respondent No. 03		1 - 2
2	True copy of the Report of the Joint Committee constituted by the Hon'ble Tribunal.	Annexure-A	3 - 140

Mrinal Kanti Biswas

Regional Director & Scientist E,

CPCB, Kolkata

Filed through

Counsel

Dated:____ 2024 Place:

Kolkata

NOTARY GOVT. OF WEST BENGAL

-X-

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COUNTER AFFIDAVIT ON BEHALF OF CENTRAL POLLUTION CONTROL BOARD i.e. RESPONDENT NO. 03 IN COMPLIANCE OF ORDER DATED 20.08.2024

I, Mrinal Kanti Biswas S/o Shri Saroj Kumar Biswas, aged about 43 years, having office at the Regional Directorate, Central Pollution Control Board, Southend Conclave, Block No.502, 5th & 6th floor, 1582, Rajdanga Main Road, Kolkata700107, do hereby state as follows:

1. That, I am presently working as Regional Director, Regional Directorate (East), Central Poilution Control Board (hereinafter referred to as CPCB), Kolkata and have been authorized to file the present Counter affidavit. I am fully conversant with the facts of the case and hence, competent and authorize to submit the present affidavit.
2. That nothing contained in this Affidavit shall be construed as admission of any statement unless specifically admitted by me. I reserve the right to deal with legal position of the matter at the time of hearing.
3. That I have gone through the order dated 20.08.2024 passed by Hon'ble NGT and has understood the contents therein.
4. That, I am authorized to swear this affidavit on behalf of Respondent No. 03. Further it is stated that I have gone through the relevant files and record in present case.
5. That, it is humbly submitted that the Joint Committee constituted by the Hon'ble National Green Tribunal has visited the site in question and the report is being submitted with this counter affidavit. A copy of the report submitted by the Joint Committee is annexed and marked as **Annexure-A.**
6. That, it is humbly submitted that this affidavit is being filed bonafide and in the interest of justice.

NOTARY C.S.H. Court Calcutta Regn. No. 005/2022 Expiry Date 31.03.27 GOVT. OF WEST BENGAL

7. That the statement made in forgoing paragraphs are true to my knowledge and the report annexed at annexure is original copy of the report.
8. That, CPCB shall abide by all the direction/ orders passed by Hon'ble Tribunal in the instant matter.

IDENTIFIED BY ME

ADVOCATE

DEPONENT

VERIFICATION

Verified at Kolkata on this day of 4th, November, 2024 that the contents of the above reply are correct and true on the basis of the record of the cases as mentioned in the day today affairs of the CPCB. Nothing has been concealed therefrom or mis-stated.

Verified at Kolkata on this the 4th Day of November 2024.

IDENTIFIED BY ME

ADVOCATE

DEPONENT

SOLEMNLY AFFIRMED
&
Declared Before me
on Identification Adv.

NOTARY
N. DAS GUPTA
C.M.M. Court
Govt. W.B

04 NOV 2024

N. DASGUPTA
Notary
Regn. No. 0CS/2022
3, Bankshal Street
Calcutta-700001

NOTARY
C.M.M. Court Calcutta
Regn. No.
0CS/2022
Expiry Date
31.03.27
GOVT. OF WEST BENGAL

'Annexure - A'

-X-

REPORT OF THE JOINT COMMITTEE

In Compliance with the

Hon'ble NGT Order dated 29.05.2024

In the matter of

Geeta Devi Versus State of Jharkhand

In

OA No. 150/2024/EZ

(Earlier OA No. 316/2024/PB)

-Submitted by-

DM Dhanbad, MoEF&CC Ranchi, JSPCB and CPCB

OCTOBER, 2024

-✳-

Contents

List of tables

List of Annexures

1.0 Introduction:

The Original Application No. 316 of 2024, registered suo motu by the Hon'ble National Green Tribunal (NGT), Principal Bench, New Delhi, on 29.05.2024, originates from a letter petition dated 25.09.2023 (actual date 19.09.2023) submitted by Smt. Geeta Devi, Pramukh of Baghmara Prakhand, District Dhanbad, Jharkhand. The complaint raises concern over significant air pollution caused by coal transportation activities managed by various agencies outsourced by M/s Bharat Coking Coal Ltd. (BCCL).

According to the letter petition, the following agencies were engaged by BCCL for coal transportation without adequate adherence to environmental precautions:

1. Hiltop Outsourcing, Barora Area-1
2. Maa Ambey Pvt., Block-2 Area
3. Sanjay Udyog Pvt., Block-2 Area
4. Khemkha Carrier, Block-2 Area
5. GTS Deco Outsourcing Company, Katras, Govindpur Area-3
6. Ambey Mining Pvt., Katras Area No.4
7. Bhumi Outsourcing, Katras Area No.4
8. Hiltop Outsourcing, Sijua Area-5
9. Deco, Sijua Area-5
10. Ram Avtar Khemka, Sijua Area-5
11. Sanjay Udyog, Sijua Area-5

The Hon'ble NGT, Principal Bench heard the case on 29/05/2024 and directed the following:

"...before taking any further action in matter we find it appropriate to obtain a factual Report for which we constitute a Joint Committee comprising Jharkhand State Pollution Control Board, District Magistrate, Dhanbad, Central Pollution Control Board and Regional Director MoEF&CC, Dhanbad."

"CPCB shall be the Nodal Agency for compliance and co-ordination of this order".

The matter was transferred to the Hon'ble NGT, Eastern Bench, Kolkata, and re-registered as Original Application No. 150 of 2024. Copies of the relevant orders dated 29.05.2024 (OA 316 of 2024, Principal Bench) and 20.08.2024 (OA 150 of 2024, Eastern Bench) are included as **Annexures I and II**, respectively.

2.0 Formation of the Joint Committee

In compliance with the Hon'ble NGT's directions, the Joint Committee was constituted based on nominations received from the relevant authorities. The Committee's initial site visit was conducted on August 6-7, 2024, with the following members in attendance:

1. Shri Mrinal Kanti Biswas, Regional Director, Central Pollution Control Board, Regional Directorate, Kolkata
2. Shri Mihir Salkar, District Mining Officer, District Mining Office, Dhanbad
3. Shri Ram Pravesh Kumar, Regional Officer, Jharkhand State Pollution Control Board, Dhanbad
4. Shri Sandeep Nandi, Scientist 'B', Ministry of Environment, Forest & Climate Change, Integrated Regional Office, Ranchi

For the Committee's second site visit on October 22, 2024, the following members were present:

1. Shri Mrinal Kanti Biswas, Regional Director, Central Pollution Control Board, Regional Directorate, Kolkata
2. Shri Ritesh Tigga, District Mining Officer, District Mining Office, Dhanbad
3. Shri Vivek Kujur, Regional Officer, Jharkhand State Pollution Control Board, Dhanbad

3.0 Committee Mandate

Based on the NGT order 20/8/2024 and the nature of the complaint, the committee's mandate is expected to include the following:

a) Investigate the allegations:

- Verify if the agencies involved in coal transportation are complying with the environmental regulations.
- Examine the practices of the mentioned agencies, such as Hiltop Outsourcing, Maa Ambey Pvt., Sanjay Udyog Pvt., etc., to identify any violations.

b) Conduct site visits:

- Visit the affected areas to observe the air pollution

- Inspect the coal transportation routes, loading/unloading points, and storage facilities.
- Interact with local residents to gather firsthand accounts of the pollution and its impact.

c) Collect data and evidence:

- Gather data on air quality parameters, including particulate matter (PM) levels in the affected areas.
- Document any violations of environmental regulations or NGT orders.

d) Prepare a detailed report:

- Summarize the findings of the investigation, including the extent of air pollution, and the nature of violations.
- Provide recommendations to mitigate the air pollution, such as stricter enforcement of regulations, improved transportation practices, and installation of pollution control equipment.

e) Submit the report to the NGT:

- Submit the report to the NGT within the specified timeframe.

4.0 Committee Activities

4.1 Initial Meetings and Planning

The 1st meeting of the Joint Committee was held virtually on 30th July, 2024, to discuss the preliminary investigation plan and to coordinate with relevant stakeholders. Recognizing the need for additional information, the committee decided to invite M/s BCCL to provide a detailed presentation on their mining and transportation activities in the Dhanbad region.

4.2 Interaction with M/s BCCL

A second meeting was held on 2nd August 2024, with senior officials from M/s BCCL to discuss the specific allegations raised in the NGT order. M/s BCCL presented a presentation outlining their mining operations, including the transportation activities of the alleged agencies.

4.3 Scope of Work of the agencies engaged by M/s BCCL

Based on the information provided by M/s BCCL, it was clarified that not all 11 agencies listed in the NGT order are involved in coal transportation. Among the 11

alleged agencies, only 4 are involved in transportation activities, while the others are primarily engaged in excavation and mining operations.

A detailed summary of the agencies and their respective roles is provided in Table 1 below:

Table 1: Summary of alleged agencies and their operational details:

Sl No	Transport Agency - Area (As per Named in Complaint	Scope of Work	Mine	Siding/ Washery	Remarks / Operational Status
1	Hill Top Agency - Barora **Area**	-	-	-	Not working in Barora Area
2	Maa Ambey Pvt. Ltd. - **Block 2**	Excavation & **Transport** (Ambey Mining Pvt Ltd)	ABOCP-New Benidih	Madhuband Washery	Ambey Mining Pvt Ltd
3	Sanjay Udyog Pvt ltd.- Block **-2**	-	-	-	Not working in Block -2
4	Khemka Carrier - **Block-2**	Excavation & **Transport**	ABOCP-New Nadkhurki	Kessargarh Siding and KKC Siding	
5	GTS Deco Outsourcing Company - **Katras, Govindpur**	Excavation	NAKC Patch H	-	
6	Ambey Mining Pvt Ltd, - **Katras area**	Excavation & **Transport**	Katapahari Patch-II AKWMC	Lakarka and Sijua Siding	
7	Bhumi Outsourcing - Katras	Excavation	AKWMC, Tetulmari Patch	-	
8	HillTop Outsourcing- **Sijua Area**	Excavation	Mudidih (Tetulmuri Patch A & Kankanee Patch B)	-	
9	Deco- **Sijua Area**	Excavation	Nicitpur-patch B	-	
10	Ram Avtar Khemka- **Sijua Area**	Excavation	Kankanee-Patch D	-	
11	Sanjay Udyog - **Sijua Area**	**Transport**	Nicitpur, Sendra Bansjora, Tetulamari & Mudidih	Sendra bansjora Siding and KDS-II	

The transport agencies are mainly engaged in 5 mine areas namely 1) Barora, 2) Block 2, 3) Katras, 4) Govindpur and 5) Sijua area.

4.4 Site Visits:

To gather firsthand information, the Joint Committee conducted site visits on 6th and 7th August, 2024 and also on 22nd October, 2024.

5.0 Profile of M/s BCCL

5.1 Overview

M/s Bharat Coking Coal Limited (BCCL) is a major coal mining company headquartered in Dhanbad, Jharkhand, India. As a subsidiary of Coal India Limited, BCCL plays a significant role in India's coal production. The company operates primarily in the coal-rich regions of Dhanbad, covering an extensive area of approximately 2,407 square kilometres.

5.2 Mining Operations and Infrastructure

BCCL's mining operations are primarily focused on underground and opencast mining techniques. The company's mining areas are located in the Jharia and Bokaro coalfields in Dhanbad district, which are renowned for their high-quality coal reserves.

5.3 Coal Transportation

The transportation of coal from the mines to various destinations is a crucial aspect of BCCL's operations. The company utilizes a combination of rail and road transportation to move coal. The detailed information of the transporters, number of mines, number of vehicles involved is attached in the **Annexure III**.

5.3.1 Rail Transportation

BCCL has a network of railway sidings connected to its mines, which facilitate the transportation of coal to various destinations. The following table provides details of the railway sidings and their distances from the connected mines:

Table 2: Details of Railway Sidings and Their Proximity to Mines under BCCL

Sl. No	Area	Railway Siding Details	Distances from Connected Mines
1	Barora	KKC Link Siding	Shatabdi - 7 km, Phularitand – 3.5 to 4 km
2	Block II	KKC Main Siding & Kessurgarh	KKC Main - 2.5 km, Kessurgarh - 2.2 km
3	Govindpur	SLG Railway Siding	New Akash Kinaree - 4.9 to 5.2 km, others as listed
4	Katras	Sijua/Lakurka Siding	AKWMC - 1 km
5	Sijua	Bansjora Railway Siding	Various distances, as noted

This table indicates the distance of railway sidings from the key mines. Efficient management and implementation of dust control measures at these sidings are critical.

5.3.2 Road Transportation

For shorter distances and supplementary transportation, M/s BCCL employs road transportation. As per the information provided by M/s BCCL, in addition to Tarpaulin-Covered Coal Transport, Plantation Along Siding, they have implemented various measures to mitigate dust pollution from road transportation, which include the following;

Table 3: Air Pollution Mitigation Measures in Alleged Areas by BCCL

Alleged Area	Truck-Mounted Fog Cannon	Trolley-Mounted Fog Cannon	Mobile Water Tanker	Mist Sprinklers	Fixed Sprinklers	Jet Sprays	Water Curtain
Barora	1	-	6	2	-	-	-
Block II	1 (12kL)	-	-	3 (28KL each)	19	4 (20KL)	-
Govindpur	-	3	-	-	1	-	Present
Katras	Present	-	Present	-	Present	-	-
Sijua	-	-	-	Present	20	-	Present

The table reveals a range of air pollution control measures, including fog cannons, mist sprinklers, and tarpaulin-covered transport, varying across areas. However, there are gaps, such as the limited use of water curtains in some areas, which could enhance dust control effectiveness. Also, fixed sprinklers are not used uniformly.

5.4 Coal Processing

BCCL operates several washery units to clean and process the extracted coal. The following table provides details of the washery units and their locations:

Table 4: Washery Units and Their Locations

Sl. No	Area	Washery Unit Details	Distance from Connected Mines
1	Barora	No Washery	NA
2	Block II	Madhuband Washery with Belt Conveyor System	Departmental Patch - 3150m, Conveyor - 1026m
3-5	Others	No Washery in Govindpur, Katras, Sijua Areas	NA

This table highlights that only Block II has an operational coal washery, while other areas lack such facilities.

5.5 Coal Production and Vehicle Deployment Overview in BCCL Areas

The information related to production and vehicle movement help in assessing the scale of mining and transportation activities, correlating increased production and vehicle usage with potential environmental impacts, particularly in terms of air quality.

5.5.1 Area-Wise Annual Coal Production

The following table, outlines the coal production trends in the key areas under M/s Bharat Coking Coal Limited from 2021-22 to 2023-24. This data highlights annual variations in coal output, indicating operational and demand-driven shifts across different regions in recent years.

Table 5 Area-Wise Annual Coal Production (Million Tonnes per Annum)

Area	Production (Coal) in Million Tonne per annum		
	2021-22	2022-23	2023-24
Barora	1.935	2.450	5.416
Block-II	3.7	4.68	5.36
Govindpur	0.792	0.857	0.979
Katras	4.251	3.944	3.119
Sijua	3.43	3.75	4.01

The production data reveals a marked increase in coal output, especially in the Barora area, which saw a sharp rise from 1.935 million tonnes in 2021-22 to 5.416 million tonnes in 2023-24. This significant increase in production necessitates a corresponding increase in transportation activities too, which may add pollution risks if mitigation measures are not taken accordingly.

5.5.2 Area-Wise Number of Vehicles Deployed by Outsourcing Agencies

The following table shows the number of vehicles deployed by outsourcing agencies in each BCCL operational area over the last three years. This data highlights the transportation resources supporting coal production, reflecting the scaling of vehicle deployment to meet production demands, particularly in high-output areas like Barora and Sijua. These trends are crucial for assessing potential contributions to air pollution and for guiding decisions on transportation and dust management measures to minimize environmental impacts

Table 6: Area-Wise Number of Vehicles Deployed by Outsourcing Agency

Area	2021-22	2022-23	2023-24
Barora	30	45	58
Block-II	40	55	60
Govindpur	20	20	20
Katras	27	27	27
Sijua	35	40	45

The vehicle deployment data aligns with increased production, particularly in Barora and Sijua, where vehicle numbers rose to match production demands. The stable vehicle counts in areas like Govindpur and Katras, despite production changes, suggests resource use at varied efficiency.

6.0 Site Visits by the Joint Committee

6.1 Initial Site Visit (6th and 7th August 2024)

To assess the environmental impact of coal transportation, the Joint Committee conducted site visits to the mines under Barora Area-1, Block II Area, Govindpur Area-3, Katras Area No.4, and Sijua Area-5 during 6th and 7th August, 2024.

6.1.1 Specific areas of inspection included:

- Coal handling and conveying systems from pit head to coal storage areas
- Loading and unloading operations at coal storage areas
- Coal handling and conveying systems from storage areas to crushers
- Coal transportation from crushers to railway sidings
- Coal handling operations by railway authorities

In addition, the committee observed that M/s BCCL has established Standard Operating Procedures (SOPs) for coal transportation, which cover:

- Loading and unloading operations for trucks and dumpers
- Coal handling procedures for railway authorities

However, due to heavy rainfall during the inspection period and the subsequent impact on mining operations, the committee was unable to observe significant coal transportation activities. Most of the mines were non-operational due to water accumulation and safety concerns.

6.1.2 Observations made by the Committee during site visit on 6th and 7th August:

I. Due to heavy rainfall on the day of the inspection as well as for the past few days, the allegations made in the application regarding air pollution could not be observed. Most of the mines inspected are open-cast type mines, which were observed non-operational during the visit due to water accumulation in the pits. Consequently, coal transportation and associate activities were minimal because of the rainfall.

II. The alleged areas of Barora and Block II fall within Cluster II, while Govindpur is in Cluster III. Katras is categorised under Cluster IV and Sijua falls within Cluster V. Mines were having valid Consent to Operate (CTO) issued by Jharkhand State Pollution Control Board. Copy of CTOs attached as **Annexure IV, V, VI, VII**).

III. Records are maintained by each mine for loading and unloading of coal using trucks and railways transport system. This also includes quantity of coal and transport route.

IV. The Water is sprayed to moist the coal, which helps in controlling dust generation during transportation and loading and unloading activities.

V. To mitigate dust pollution in the surrounding areas, roads used for transporting coal are sprinkled with water from water sprinkling system.

VI. The mines are equipped with mist curtain systems around crushing units to capture and control dust emissions that occur during coal crushing operations.

VII. Tyre washing facility for Dumpers/ trucks is available in mines before entering the public roads.

VIII. The fixed sprinklers were inactive due to the rainy season; however, many appeared poorly maintained, with blocked nozzles and incomplete pipe connections. This suggests a need for immediate repair to ensure that the system is fully operational for effective dust suppression when required.

6.2 Observations from the Committee's Surprise Site Visit on 22 Oct 2024

The committee conducted a second, unannounced site visit on October 22 to gather factual observations under operating conditions unaffected by the monsoon, given that the initial inspection had been hindered by heavy rainfall.

I. Reassessment Under Operational Conditions

In light of the previous visit's limited observations due to rainfall and halted operations, the committee aimed to closely monitor transport movement and assess its environmental impact under regular, drier conditions.

II. Meeting with the Complainant

During the visit to the Block II area, the committee met with the complainant and several local villagers, allowing them to express concerns in detail. This interaction provided insights into the community's direct experiences, including specific allegations of increased pollution linked to M/s BCCL's mining activities. Complainant mentioned that there was rain two days before the date of the visit.

III. Observed Mining and Transportation Activities

Mining was underway at Block II, although transportation operations were observed to be running at a lower capacity during the inspection.

IV. Inspection of Alleged Pollution Areas

The committee, accompanied by the complainant, inspected areas alleged to have elevated pollution levels due to mining. The committee recommended ambient air quality sampling to quantify pollution impacts. The committee also noted that local villagers used coal for cooking and other essentials, which likely contributed to local air pollution.

V. Environmental Concerns at the Overburden (OB) Dump Site

The complainant raised concerns about ecological disruption. At the OB dump site, BCCL's plantation of legume species aims to restore the area's natural ecosystem. The committee observed signs of plant die-off attributed to residual site heat.

VI. Inspection of Alleged Harmful Gas Emissions

The committee was guided by the complainant to a site where smouldering coal seams were observed near residential houses. The complainant raised concerns regarding BCCL's lack of proactive measures to safeguard residents in the area. BCCL acknowledged that coal deposits below the surface are fuelling the ongoing underground fires and stated that extracting these coal deposits would be necessary to extinguish the fires permanently. This approach, however, would require relocating nearby residents to secure their safety and to allow for the effective remediation of the impacted area.

7.0 Source Apportionment Study of Ambient Air Particulate Matter

The **Source Apportionment Study of Ambient Air Particulate Matter** in the Jharia Coalfields region, Jharkhand, was conducted by CSIR-NEERI in April 2022 upon the recommendation of MoEF&CC and sponsored by M/s BCCL (**Annexure VIII**). This extensive study covers the areas identified in the applicant's letter petition, providing detailed insights into air quality sources and management. Key highlights include:

1. **Study Objective**: The primary aim was to assess air quality, offering data crucial for developing an air quality management plan.
2. **Air Quality Monitoring Scope**: The study included monitoring both standard criteria pollutants and specific local pollutants.
3. **Classification of Emission Sources**: Emission sources were categorized into three inventories:
    - *Point Source Inventory*
    - *Area Source Inventory*
    - *Line Source Inventory*
4. **Methodology**: The Chemical Mass Balance (CMB) Model, an EPA-recommended receptor model, was employed for source apportionment.
5. **Vehicular Activity Analysis**: Traffic data across Jharia revealed that vehicle distribution includes:
    - Two-wheelers (51%)
    - Light motor vehicles (26%)
    - Three-wheelers (17%)
    - Heavy-duty diesel vehicles (6%)
6. **Vehicular Emission Load Analysis**: Findings show the relative share of PM10 emissions primarily stemming from different vehicles as:
    - Heavy-duty vehicles (41%)

- Two-wheelers (26%)
- Light vehicles (19%)
- Three-wheelers (14%)

7. **Detailed Emission Load Calculation**: Emission sources were evaluated, encompassing industrial activities, mining operations, residential areas (slum and non-slum), and commercial sources like hotels, restaurants, bakeries, crematoriums, and open eat-outs.
8. **Air Quality Monitoring and Receptor Modelling**: The Jharia region was divided into 16 clusters across three zones for detailed receptor-based analysis.
9. **Ambient Air Sampling and Analysis**: Comprehensive ambient air sampling provided insights into pollutant types and concentrations.
10. **Particulate Matter Composition**: Major elements identified in PM10 and PM2.5 samples included aluminium (Al), chromium (Cr), and iron (Fe).
11. **Air Quality Compliance**: Ambient air quality analysis indicated compliance with CPCB-prescribed guidelines.

This study lays a scientific foundation for targeted air quality management and provides actionable data to reduce particulate matter and enhance regional air quality.

8.0 Committee Recommendations

1. **Control of PM10 Emissions from Heavy-Duty Vehicles**

   - The NEERI source apportionment study indicates that heavy-duty vehicles are a significant contributor (41%) to vehicular PM10 load, despite representing only 6% of total vehicles. BCCL should consistently operate Truck-Mounted Fog Cannons, Mobile Water Tankers, and Mist Sprinklers to curb dust emissions. Technical institutions should verify the adequacy of these systems, and BCCL should consider adopting additional controls as necessary, especially in regions like Barora, Block-II, and Sijua where coal production and vehicle movement have increased significantly between 2021-22 and 2023-24.

   - M/s BCCL should ensure that Vehicle Tyre washing facility shall be provided in all the mines.

2. **Ensuring Compliance in Coal Transportation Practices**

   - All vehicles operating in the area have valid Pollution Under Control (PUC) certificates, as per documentation. However, BCCL should enforce protocols requiring coal loads to be adequately moistened and fully tarpaulin-covered throughout transportation to minimize dust emissions ensuring compliance to coal transportation notification of May, 2020 (**Annexure – IX**).

3. **Regular Road Sprinkling**

   - Road sprinkling should be conducted regularly on coal transportation routes to effectively control dust. This includes maintaining detailed records of water usage and sprinkler operations.

4. **Monitoring SOP Compliance for Transportation**

   - The State Transport Authority and Jharkhand State Pollution Control Board (JSPCB) should perform regular surveillance to ensure strict adherence to the established Standard Operating Procedures (SOPs)

for coal transport. This will help mitigate dust and reduce air pollution from transport activities.

5. **Ambient Air Quality Monitoring During Dry Season (24 hr)**

   - JSPCB is recommended to conduct 24-hour ambient air quality monitoring during the dry season, measuring air quality in the buffer zones, involving habitants from primary pollution sources in order to verify compliance with Jharia Coalfield's standards notified vide notification G.S.R. 742(E), dated 25.9.2000. under Environment (Protection) Amendment Rules, 2000 (**Annexure X**).

6. **Enhancing Air Quality Management and Record-Keeping**

   - BCCL should address gaps in air quality management by maintaining logs for all air quality control activities, including sprinkler movements and water usage. Expanding and ensuring the functionality of fixed-type sprinklers at feasible locations is essential for effective dust suppression.

7. **Improvement of Road Infrastructure**

   - Repairs are urgently needed for transport routes, with particular attention to improving approach roads. Safe and well-maintained roads are essential to support high coal transportation volumes and reduce dust generation.

8. **Enhancement of Plant Survival on Overburden (OB) Dump Sites**

   - BCCL should implement advanced techniques to improve plant survival rates on OB dumps and roadside areas. This will not only enhance site ecology but also help in reducing dust generation along transportation routes.

9. **Handing of Fiery OB Dumb**

   - M/s BCCL should ensure control unloading of the fiery (burnt) OB. This is a potential source of air pollution. Therefore, M/s BCCL should adopt proper mitigation measures to reduce the air pollution during unloading.

10. **Household Coal Burning Mitigation**

- During the site visit, household coal burning was observed as a significant source of local air pollution. To address this, it is recommended to impose restrictions on household coal use, encouraging residents to adopt cleaner fuel options, such as electricity, natural gas, or LPG in urban areas.

11. In addition to the aforementioned recommendations, BCCL is also required to implement the measures outlined in the NEERI Source Apportionment Study, funded by BCCL, which include the following:

- **Installation of Conveyor Systems:** Where feasible, BCCL should set up conveyor systems to transport coal from coal handling plants to the nearest railway siding or thermal power plant. This change would significantly reduce emissions associated with truck-based coal transportation.

- **Vegetation Planting Around Mine Pits:** To help control dust dispersion into adjacent areas, extensive vegetation should be planted around my pits.

- **Design of Optimized Green Belts and Wind Barriers:** BCCL should conduct meteorological studies to design green belts and wind barriers optimized to local weather patterns, ensuring efficient reduction of particulate dispersion.

- **Enhanced Dust Control Measures:** Effective dust control requires mechanized sweeping, water sprinkling, and mist spraying on haul roads and at loading sites. Long-range misting or fogging cannons should be used to manage dust emissions over larger areas.

- **Comprehensive Dust Suppression in Mining Operations:** Dust control measures should be enforced at every stage of mining operations to ensure minimal emissions from these activities.

- **Covering of Coal-Transporting Trucks and Rail Wagons:** Trucks and railway wagons transporting coal should be fully covered with tarpaulin sheets to prevent dust from escaping during transit.

- **Use of Closed Trucks for Coal Transportation:** As a long-term solution, BCCL should consider using closed trucks to minimize dust pollution from coal transport.
- **End-to-End Coverage of Curb Sides:** To reduce coal dust re-suspension, coal transport roads should have continuous curb side coverage from end to end.

12. BCCL should conduct feasibility study and prepare plans to extend the railway lines and construct the coal handling plants (CHPs) for directly loading coal in railway wagons to phase out road transportation through areas outside mine area

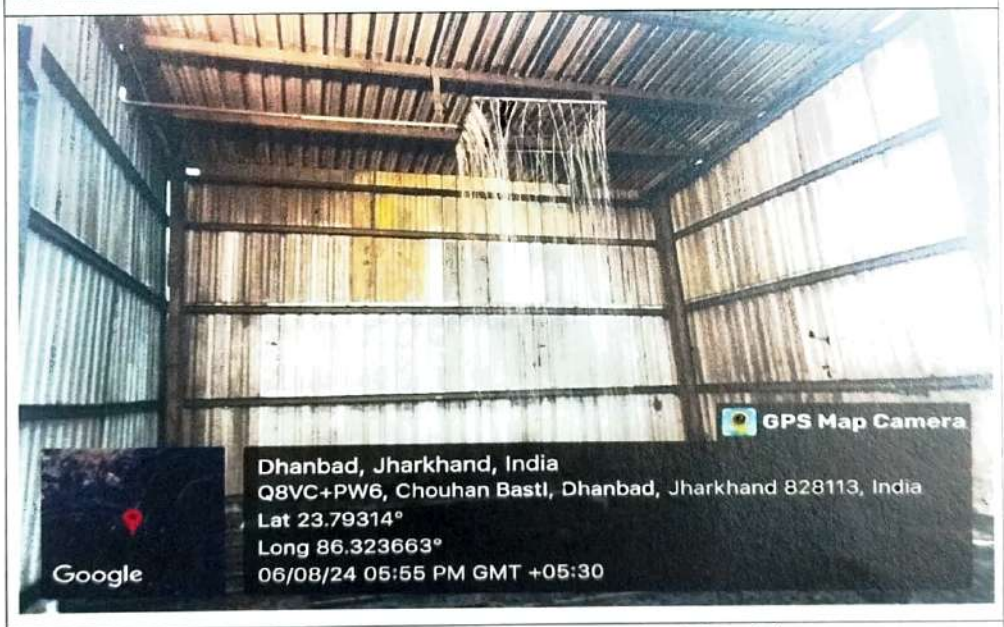
(Ram Pravesh Kumar) (Vivek Kujur)
Regional Officer, JSPCB

(Sandeep Nandi)
Scientist 'B' MoEF&CC, Ranchi

(Ritesh Raj Tigga)
District Mining Officer, Dhanbad
Nominated and Deputed by Deputy Commissioner, Dhanbad

(M K Biswas)
Sc E & Regional Director, CPCB-RD,
Kolkata

PHOTOGRAPHS OF THE FIRST VISIT DATED 6th AND 7th AUGUST

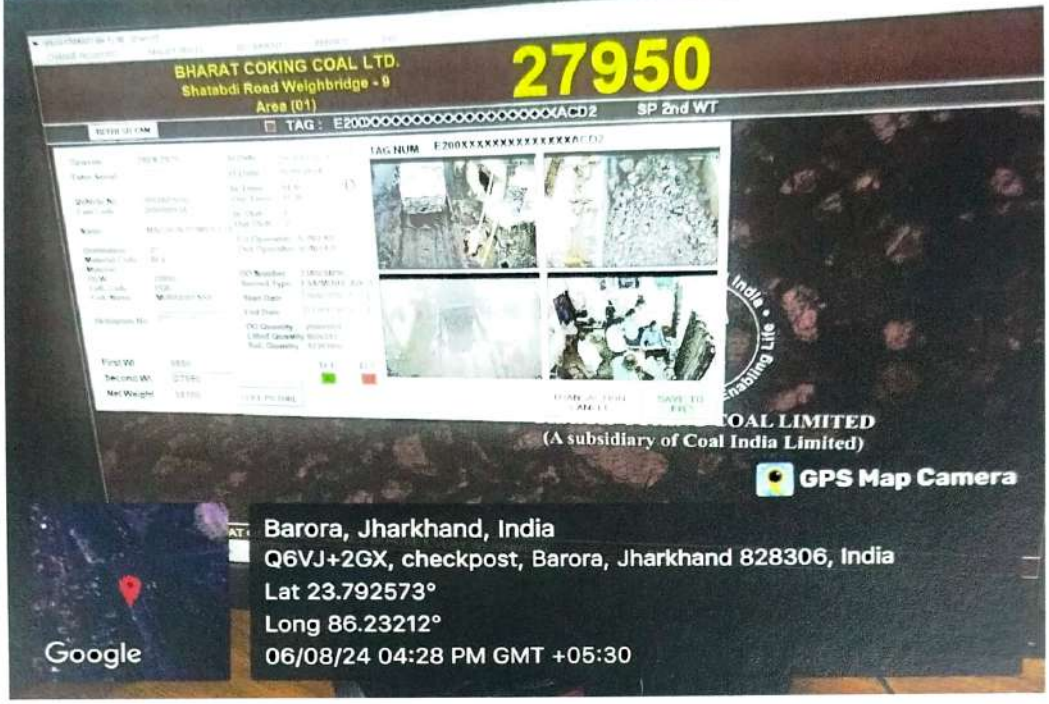


Pic 1 &2: Water Sprinkling during Coal Crushing

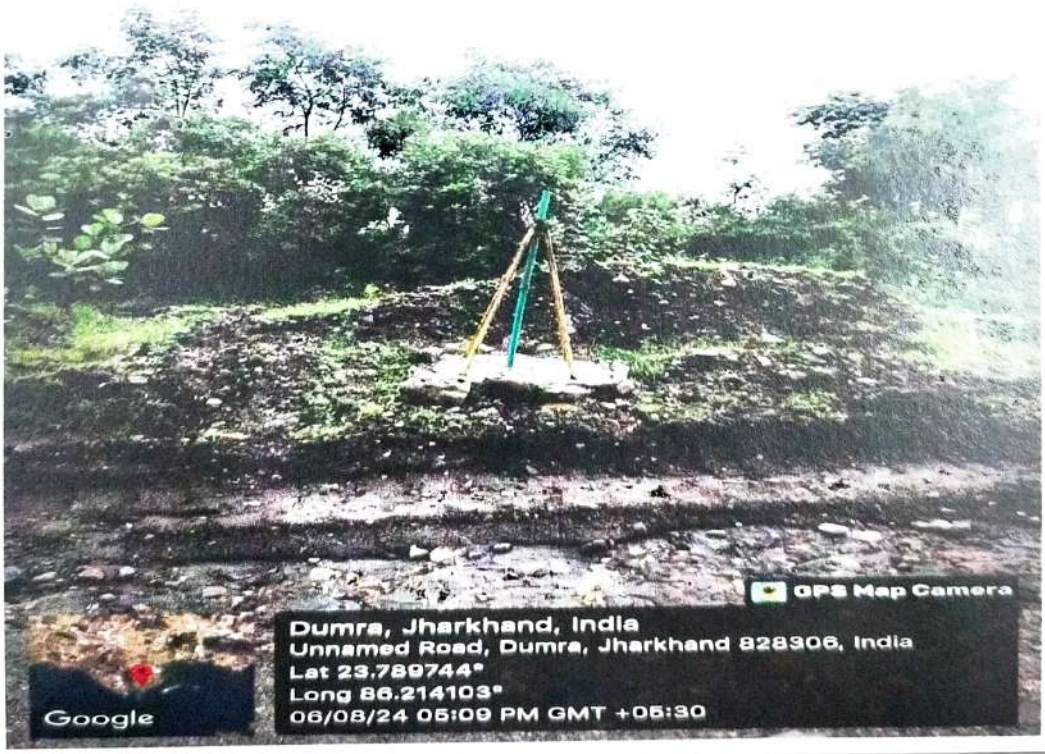
Pic 3: Coal loaded Trucks covered with Tarpaulin

Pic 4: Railway Yard

Pic 5 & 6: Water sprinkling on major roads using water tanker and mist cannon

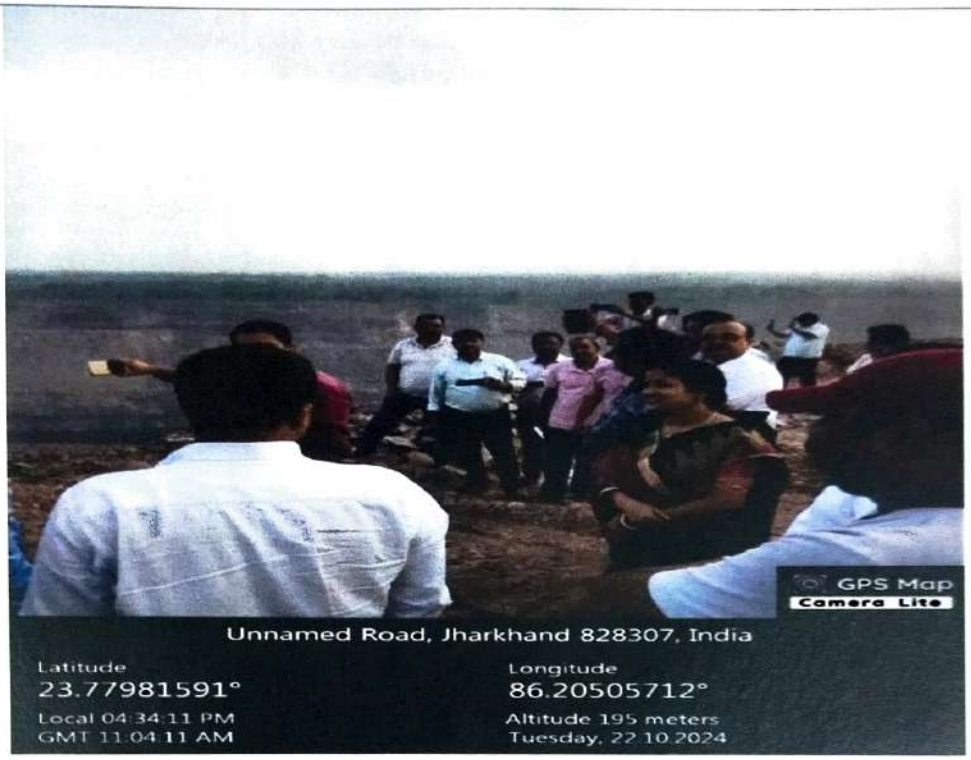


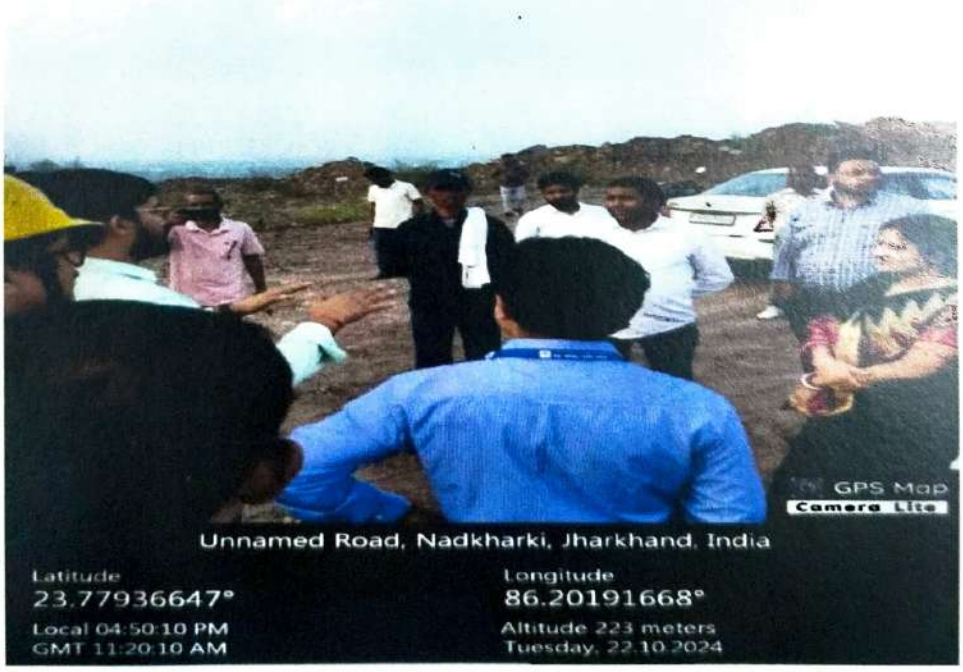
Pic 7: CCTV Surveillance



Pic 8: Static water sprinkler at roadside

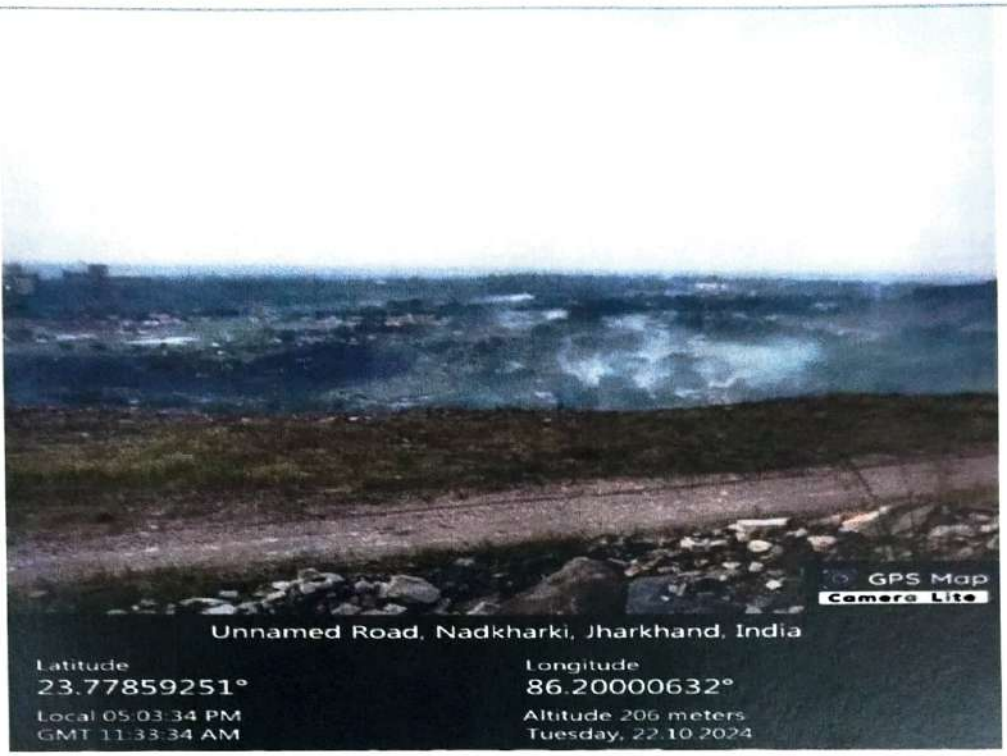
PHOTOGRAPHS OF THE SECOND VISIT DATED 22nd OCTOBER, 2024

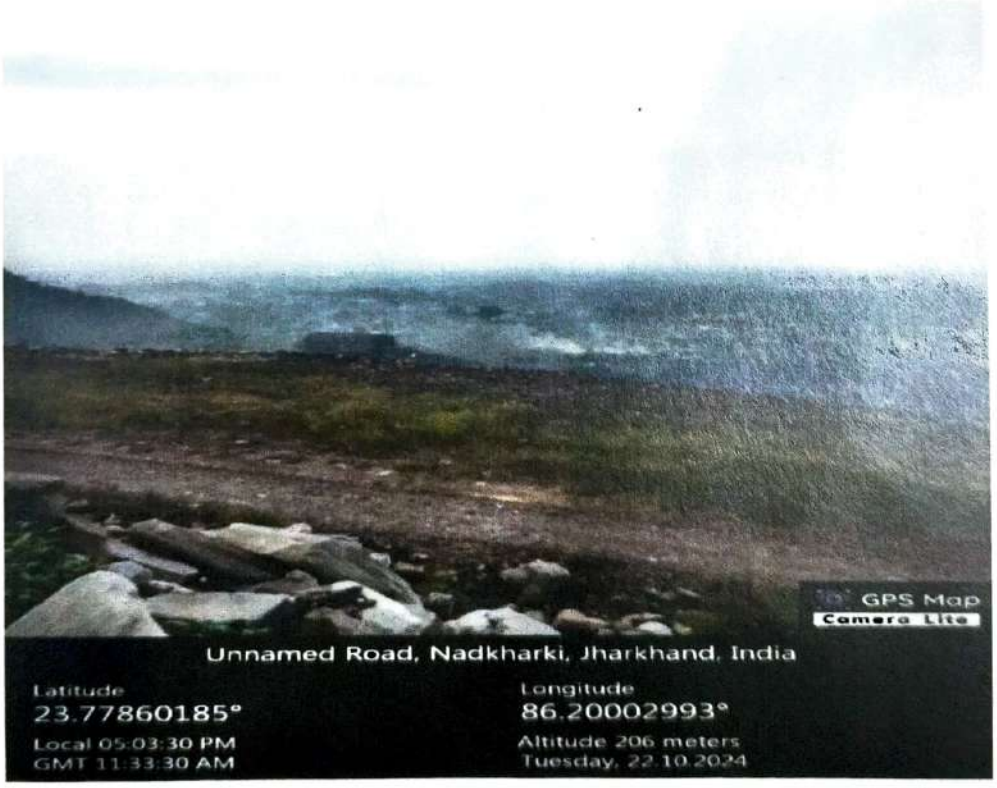




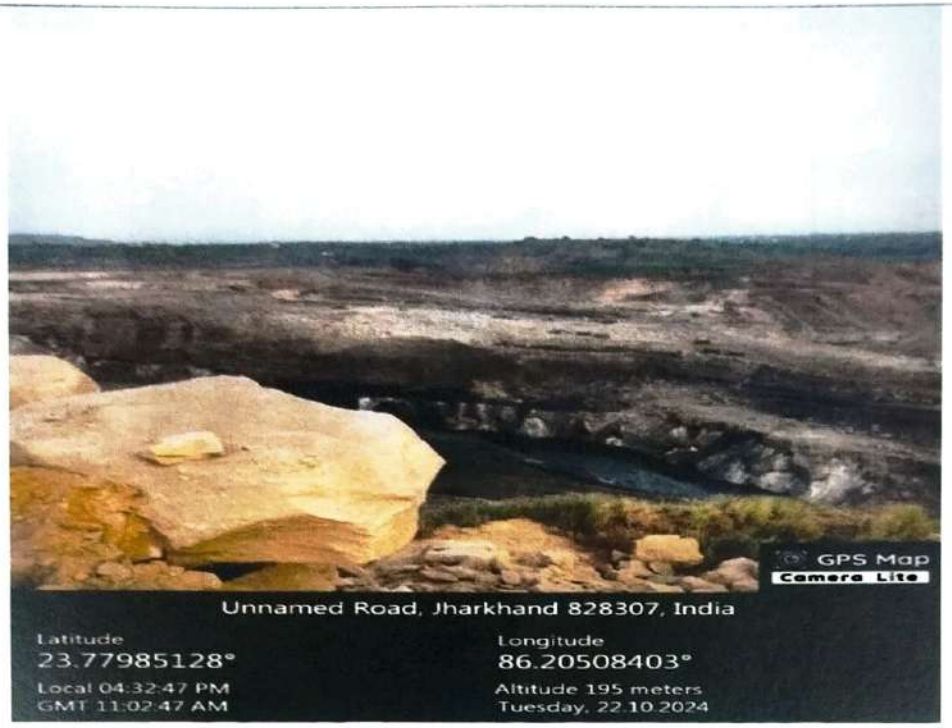
Pic 9 & 10: Committee members interacting with the applicant and villagers at the site.

Pic 11&12: The image depicting the legumes planted by the BCCL and the process for conversion of the dump site to a natural ecosystem





Pic 13& 14: The image of the pollution in the nearby village due to the villagers using coal for their daily activities.



Pic 15 & 16: The Image depicting the pollution load in the mine due to mining activities.

ANNEXURE- I

Item No.05 Court No.02

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

Original Application No.316/2024

Geeta Devi Applicant(s)

Versus

State of Jharkhand Respondent(s)

Date of hearing: 29.05.2024

CORAM: HON'BLE MR. JUSTICE SUDHIR AGARWAL, JUDICIAL MEMBER
HON'BLE DR. AFROZ AHMAD, EXPERT MEMBER

Applicant: None

ORDER

1. This Original Application in exercise of *suo-moto* jurisdiction has been registered under Sections 14 and 15 of National Green Tribunal Act, 2010 (hereinafter referred to as **'NGT Act, 2010'**) on a letter petition dated 25.09.2023, sent by Geeta Devi Pramukh Baghmara Prachand, District Dhanbad and State Jharkhand.

2. Complainant has said that Bharat Coal Company Ltd., is owner of coal mines in area and carrying out work of excavation of coal and its distribution and transportation. However, for the purpose of transportation of coal work has been outsourced to following agencies:

1. Hiltop Outsourcing, Barora Area-1
2. Maa Ambey Pvt. Block-2 Area
3. Sanjay Udyog Pvt., Block-2 Area
4. Khemkha Carrier, Block-2 Area

5. GTS Deco Outsourcing Company Katras, Govindpur Area-3

6. Ambey Mining Pvt., Katras Area No.4

7. Bhumi Outsourcing, Katras Area No.4

8. Hiltop Outsourcing, Sijua Area-5

9. Deco Sijua Area-5

10. Ram Avtar Khemka, Sijua Area-5

11. Sanjay Udyog Sijua Area-5.

3. Said agencies are transporting coal without compliance with directions issued by this Tribunal with regard precaution to be taken in transportation of coal which is causing huge air pollution in the area concerned.

4. In our view, a substantial question relating to environment due to implementation of Scheduled Enactments has been raised in this matter. However, before taking any further action in matter we find it appropriate to obtain a factual Report for which we constitute a Joint Committee comprising Jharkhand State Pollution Control Board, District Magistrate, Dhanbad, Central Pollution Control Board and Regional Director MoEF and CC, Dhanbad.

5. CPCB shall be the Nodal Agency for compliance and co-ordination of this order.

6. Said Committee shall visit site, collect relevant information and submit a factual Report within two months with Registrar of Eastern Bench of this Tribunal at Kolkata.

7. Since the matter pertains to jurisdiction of Eastern Bench, we direct Registry to transmit record of this Original Application to Eastern Zonal Bench, Kolkata for further proceedings.

8. List this matter before appropriate Bench on 20.08.2024.

Sudhir Agarwal, JM

Dr. Afroz Ahmad, EM

May 29, 2024
Original Application No.316/2024
M

ANNEXURE-II

Item No.08 Court No. 1

BEFORE THE NATIONAL GREEN TRIBUNAL
EASTERN ZONE BENCH, KOLKATA
(THROUGH PHYSICAL HEARING WITH HYBRID MODE)

Original Application No.150/2024/EZ
(Earlier OA No.316/2024/PB)

Geeta Devi Applicant(s)

Versus

State of Jharkhand Respondent(s)

Date of hearing: 20.08.2024

CORAM: HON'BLE MR. JUSTICE B. AMIT STHALEKAR, JUDICIAL MEMBER
HON'BLE DR. ARUN KUMAR VERMA, EXPERT MEMBER

For Applicant(s) : None

ORDER

1. Original Application No. 316/2024/PB was registered *suo motu* on a letter petition dated 25.09.2023 submitted by the complainant Geeta Devi, Pramukh Baghmara Prakhand, District- Dhanbad. The nature of the complaint as quoted in para 2 and 3 of the order of the Tribunal is as under: -

2. *"Complainant has said that Bharat Coal Company Ltd., is owner of coal mines in area and carrying out work of excavation of coal and its distribution and transportation. However, for the purpose of transportation of coal work has been outsourced to following agencies:*

1. *Hiltop Outsourcing, Barora Area-1*
2. *Maa Ambey Pvt. Block-2 Area*
3. *Sanjay Udyog Pvt., Block-2 Area*
4. *Khemkha Carrier, Block-2 Area*
5. *GTS Deco Outsourcing Company Katras, Govindpur Area-3*
6. *Ambey Mining Pvt., Katras Area No.4*
7. *Bhumi Outsourcing, Katras Area No.4*
8. *Hiltop Outsourcing, Sijua Area-5*
9. *Deco Sijua Area-5*
10. *Ram Avtar Khemka, Sijua Area-5*
11. *Sanjay Udyog Sijua Area-5.*

3. *Said agencies are transporting coal without compliance with directions issued by this Tribunal with regard precaution to be taken in transportation of coal which is causing huge air pollution in the area concerned."*

2. The Tribunal constituted a Committee comprising of the following members: -

   i) Jharkhand State Pollution Control Board;

   ii) District Magistrate, Dhanbad;

   iii) Central Pollution Control Board; and

   iv) Regional Director MoEF&CC, Dhanbad

   and directed the Central Pollution Control Board to file factual Report on affidavit.

3. Thereafter, by the order dated 29.05.2024, the said Original Application was transferred to the Eastern Bench of the Tribunal and has been re-numbered as Original Application No.150/2024/EZ.

4. We find that in the Committee constituted as in para 2 above, the Ministry of Environment, Forests and Climate Change (MoEF&CC), Dhanbad has been mentioned, although it should be Ministry of Environment, Forests and Climate Change (MoEF&CC), Ranchi. We direct the aforesaid correction be made in the constitution of the Committee.

5. The Respondents were not impleaded in the order of the Tribunal dated 29.05.2024 and therefore, we direct that the following may be impleaded in the array of Respondents: -

   1. Ministry of Environment, Forests and Climate Change (MoEF&CC) through its Regional Director, Ranchi;

   2. Jharkhand State Pollution Control Board;

3. Central Pollution Control Board; and

4. District Magistrate, Dhanbad

6. Mr. Rajib Ray, learned Counsel appearing for the Central Pollution Control Board files Vakalatnama and prays for and is granted four weeks time for filing counter affidavit. He further submits that considering that monsoon season is on, the case may be come up after Puja vacation so that the vehicular movement and level of pollution may be computed.

7. Mr. Surendra Kumar, learned Counsel who is present in Court, accepts notice on behalf of the Respondent No.2, Jharkhand State Pollution Control Board. He prays for and is granted four weeks time for filing Counter affidavit.

8. Ms. Aishwarya Rajyashree, learned Counsel who is present (in Virtual Mode), accepts notice on behalf of the Respondent No.4, District Magistrate, Dhanbad. Learned Counsel prays for and is granted four weeks time for filing counter affidavit.

9. Issue notice to the Respondent No.1, Ministry of Environment, Forests and Climate Change (MoEF&CC) through its Regional Director, Ranchi, returnable within four weeks.

10. All the Respondents shall file their counter affidavits within four weeks.

11. Registry of the Tribunal shall serve e-copy/soft copy of the Original Application along with all its annexures as well as the letter petition on the Counsel for the Respondents who have accepted the notices, within 48 hours.

12. **List on 07.11.2024.**

.....
B. Amit Sthalekar, JM

.....
Dr. Arun Kumar Verma, EM

August 20, 2024,
Original Application No.150/2024/EZ
(Earlier OA No.316/2024/PB)
SKB

Table 1: Summary of alleged agencies and their operational details:

Sl No	Transport Agency - Area (As per Named in Complaint	Scope of Work	Mine	Siding/ Washery	Remarks / Operational Status
1	Hill Top Agency - **Barora Area**	-	-	-	Not working in Barora Area
2	Maa Ambey Pvt. Ltd. - **Block 2**	Excavation & Transport (Ambey Mining Pvt Ltd)	ABOCP-New Benidih	Madhuband Washery	Ambey Mining Pvt Ltd
3	Sanjay Udyog Pvt ltd.- **Block -2**	-	-	-	Not working in Block -2
4	Khemka Carrier - **Block-2**	Excavation & Transport	ABOCP-New Nadkhurkl	Kessargarh Siding and KKC Siding	
5	GTS Deco Outsourcing Company - **Katras, Govindpur**	Excavation	NAKC Patch H	-	
6	Ambey Mining Pvt Ltd,- **Katras area**	Excavation & Transport	Katapahari Patch-II AKWMC	Lakarka and Sijua Siding	
7	Bhumi Outsourcing - **Katras**	Excavation	AKWMC, Tetulmari Patch	-	
8	HillTop Outsourcing- **Sijua Area**	Excavation	Mudidih (Tetulmuri Patch A & Kankanee Patch B)	-	
9	Deco- **Sijua Area**	Excavation	Nicitpur-patch B	-	
10	Ram Avtar Khemka- **Sijua Area**	Excavation	Kankanee-Patch D	-	
11	Sanjay Udyog - **Sijua Area**	Transport	Nicitpur, Sendra Bansjora, Tetulamari & Mudidih	Sendra bansjora Siding and KDS-II	

Table 2: Details of Railway Sidings and Their Proximity to Mines under BCCL

Sl. No	Area	Railway Siding Details	Distances from Connected Mines
1	Barora	KKC Link Siding	Shatabdi - 6 km, Phularitand – 4 to 5 km
2	Block II	KKC Main Siding & Kessurgarh	KKC Main - 2.5 km, Kessurgarh - 2.2 km(Within mine), no public road is involved in transportation
3	Govindpur	SLG Railway Siding	New Akash Kinaree - 4.9 to 5.2 Km, others as listed
4	Katras	Sijua/Lakurka Siding	AKWMC - 1 km
5	Sijua	Bansjora Railway Siding	Various distances, as noted

31/10/2024

महाप्रबंधक (खनन/पर्यावरण)
पर्यावरण विभाग, भारकोकोलि
कोयला भवन, धनबाद-826005

Table 3: Air Pollution Mitigation Measures in Alleged Areas by BCCL

Alleged Area	Truck-Mounted Fog Cannon	Trolley-Mounted Fog Cannon	Mobile Water Tanker	Mist Sprinklers	Fixed Sprinklers	Jet Sprays	Water Curtain
Barora	1	-	6	2	-	-	-
Block II	1 (12kL)	-	1	3 (28KL each)	19	4 (20KL)mobile sprinkler	Present
Govindpur	1(12KL)	3	4	2(28KL each)	-	-	Present
Katras	Present	-	Present	-	Present	-	-
Sijua	-	-	11	Present	20	-	Present

Table 4: Washery Units and Their Locations

Sl. No	Area	Washery Unit Details	Distance from Connected Mines
1	Barora	No Washery	NA
2	Block II	Madhuband Washery with Belt Conveyor System	Departmental Patch - 3150m, Conveyor - 1026m
3-5	Others	No Washery in Govindpur, Katras, Sijua Areas	NA

Table 5: Area-Wise Annual Coal Production (Million Tonnes per Annum)

Area	Production (Coal) in Million Tonne per annum		
	2021-22	2022-23	2023-24
Barora	1.935	2.450	5.416
Block-II	3.7	4.68	5.36
Govindpur	0.792	0.857	0.979
Katras	4.251	3.944	3.119
Sijua	3.43	3.75	4.01

महाप्रबंधक (खनन / पर्यावरण)
पर्यावरण विभाग भागेलोनि

Table 6: Area-Wise Number of Vehicles Deployed by Outsourcing Agency

Area	2021-22	2022-23	2023-24
Barora	30	45	58
Block-II	40	55	60
Govindpur	20	20	20
Katras	27	27	27
Sijua	30	35	40

29/10/25

महाप्रबंधक (खनन / पर्यावरण)
पर्यावरण विभाग, मुख्यालय
कोयला भवन, धनबाद–826005

ANNEXURE-IV

JHARKHAND STATE POLLUTION CONTROL BOARD

TOWNSHIP ADMINISTRATION BUILDING, HEC COMPLEX, DHURWA, RANCHI 834004
Telephone: 0651-2400850 (Fax)/ 2400851/2400852/2401847/2400979/2400139

Ref No. JSPCB/HO/RNC/CTO-17157397/2023/2089 Dated : 2023-12-20

Consent to operate (CTO) under section 25 /26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981

1. Application (s) dated 2023-09-22 of Cluster II including KKC(L&M) & Kessurgarh Siding, Occupier Name :CHITRANJAN KUMAR for consent under section 25 (1)(b)/25 (1) (c)/26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21(1) of the Air (Prevention & Control of Pollution) Act,1981..

2. **Documents Relied Upon:**

(a) The content of Copy of Environmental Clearance (EC) issued by MoEF&CC, New Delhi, vide ref.no.- (i) J-11015/35/2011-IA.II(M) dated 06.02.2013 of Cluster II (5 Mines of a combined production capacity of 15.55 MTPA with a Peak production capacity of 20.215 MTPA in a combined ML Area of 2025.71 Ha) of M/S Bharat Coking Coal Ltd., located in Jharia Coalfields, Distt.- Dhanbad, Jharkhand, Environmental Clearance - regarding with compliance report.

(b) The content of copy of Consent to Operate (CTO) vide Ref No. JSPCB/HO/RNC/CTO-14119867/2022/1867 Dated 30.12.2022 valid upto 31.12.2023 for production of Coal -15.55 MTPA (Normative) and 20.215 MTPA (Peak).

(c) The content of letter of declaration that no expansion/modernization in the mines has been made after last CTO/CTE.

(d) The content of authorization under HoWM Rules' 2016 vide ref. no. JSPCB/HO/RNC/HWM-10857434/2021/48, dated 20.09.2021.

(d) The content of Inspection Report vide ref. no. 1275, dated 20.10.2023.

(e) The content of copy of the certificate issued by Dy. Manager vide Ref. No. 239 dated 07.12.2017 mentions that the mining lease expired in the years 2002 & 2003, but in the interest of Coal mines the said lease has been extended to a further 30 years under the MMDR Act, 1957 (mentioned in the letter issued by Ministry of Coal and Mines) and has uploaded a copy of legal opinion dated 19.08.2015 of Sri Kaushik Chanda, Additional General Solicitor for India in the matter related.

3. The consent is granted under section 25 / 26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981 to operate the project in Mauza -LIST ATTACHED , P S -DHANBAD , District -DHANBAD , as follows:

Project	Site-Area		Investment (Rs)	Product & Capacity	Period of CTO
	Plot Nos.	Area			Date of issue To

Before Expansion	As per EC	2025.71 Ha	728.475 Crores (as per previous CTO)	Coal -15.55 MTPA (Normative) and 20.215 (Peak) [as per EC]	31/12/2026

(A) Specific Conditions:

1. That, the occupier shall reclaim mined out areas with OB and shall plant trees on them.

2. That, the occupier shall do Over Burden management properly as prescribed in environmental clearance.

3. That, the occupier shall maintain proper housekeeping within the premises.

4. That, the occupier shall construct catch drain, siltation pond retaining wall of appropriate size to arrest silt & sediment flows from soil, OB dump and mineral dump.

5. That, the occupier shall inform to Regional Office-Cum- Lab, Hazaribagh and Head Office, JSPC Board, at Ranchi within 24 hrs from the time of closure or opening of the plant.

6. That, the occupier shall if be found violating the Consent to Operate at any point of time during inspection of the plant by the competent authority, the Consent to Operate shall be revoked as per provision of the acts.

7. That, the occupier shall submit recurring expenditure data towards environmental control measures every year alongwith the compliance report.

8. That, the occupier shall operate and maintain ETP for workshop, coal washery.

9. That, the occupier shall submit details of EMP & funds earmarked for this mine and shall submit status of utilization of fund in regular intervals.

10. That, the occupier shall not exceed the production capacity beyond the capacity as mentioned in CTO.

11. That, this CTO is subject to any further decision/direction/order issued by MoEF in the context of environmental clearance.

12. That, if occupier fails to comply conditions mentioned in EC and CTO or failed to achieve compliance of timeline given in CTO, then environmental compensation shall be levied as per Hon'ble NGT order & CTO shall be revoked.

13. That, the occupier shall submit compliance of this CTO and EC on six monthly basis alongwith the recent analysis reports successively.

14. That, the occupier shall obtain authorization under HoWM Rules' 2016 and shall dispose the hazardous waste as per the rules defined.

15. That, the occupier shall maintain the Toe wall & Garland drains along the remaining parts of finalized OB dumps by and shall submit its status report to the Regional Office, Dhanbad on a quarterly basis for compliance.

16. That, the occupier shall submit the 6 monthly compliance reports to the Regional Office, Dhanbad failing which CTO may be revoked.

17. That, the occupier shall carry out the open cast mining activities only on the surface rights area.

18. That, the occupier shall operate and maintain the CAAQMS and PM 10 analyzer having CPCB approved technology and USEPA certification and ensure data connectivity to CPCB and JSPCB server uninterruptedly.

19. That, the occupier shall submit applications for renewal of consent under section 25 /26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981 again 120 days prior to the date of expiry of this consent with requisite fee and documents showing compliance of all of the above conditions.

(B) General Conditions :

(1) That, the occupier shall maintain the **National Ambient Air Quality Standard** given below:

S N	Pollutant	Time Weighted Average	Concentration in Ambient Air	
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Govt.)
(1)	(2)	(3)	(4)	(5)
1.	Sulphur Dioxide (SO2), µg/m3	Annual 24 hours	50 80	20 80
2.	Nitrogen Dioxide (NO2), µg/m3	Annual 24 hours	40 80	30 80
3.	Particulate Matter (size less than 10 µm) or PM10, µg/m3	Annual 24 hours	60 100	60 100
4.	Particulate Matter (size less than 2.5 µm) or PM2.5, µg/m3	Annual 24 hours	40 60	40 60
5.	Ozone(O3), µg/m3	8 hours 1 hour	100 180	100 180
6.	Lead (Pb) µg/m3	Annual 24 hours	0.50 1.0	0.50 1.0
7.	Carbon Monoxide (CO) mg/m3	8 hours 1 hour	02 04	02 04
8.	Ammonia (NH3) µg/m3	Annual 24 hours	100 400	100 400
9.	Benzene (C6H6) µg/m3	Annual	05	05
10.	Benzo(a) Pyrene(BaP) Particulate Phase only ng/m3	Annual	01	01
11.	Arsenic (As) ng/m3	Annual	06	06
12.	Nickel (Ni) ng/m3	Annual	20	20

Note : Serial no. 1 to 4 – Mandatory
Serial no. 5 to 12 As applicable for specific type of industry.

(2) That, the occupier shall maintain the emission quality within the standard and the quantity, as follows:

S N	Parameter	Standard
1	Particulate Matter	150 mg/Nm3

(3) That, the occupier shall keep process effluent in close-circuit and the quality of effluent from other sources in conformity with the standard (s) and the discharge quantity as below:

S N	Parameter	Standard
1	Total Suspended Solids	100 mg/L
2	BOD	30 mg/L
3	COD	250 mg/L
4	Oil & Grease	10 mg/L

(4) That, the occupier shall dispose of solid wastes as follows:

S N	Waste Type	Mode of Disposal
1	Hazardous Carbonaceous Wastes	In co-processing in high temperature furnaces or kilns
2	Hazardous Non-Carbonaceous Wastes	In TSDF
3	Non-Carbonaceous Non-Hazardous solid wastes/ Mine Over Burden	As a substitute of Soil or Mineral

(5) That, the occupier shall keep D G Set(s) within acoustic enclosure and shall keep the height(s) of exhaust pipe(s) as per Central Pollution Control Board norm.

(6) That, the occupier shall install and maintain Central Ground Water Board/ State Ground Water Directorate approved system of rain water harvesting-cum-ground water recharge and submit the photographic view of the structures within a month.

(7) That, the occupier shall grow and maintain greenery of the project in the periphery and other available spaces and shall continue enhancing its plant density and biodiversity.

(8) That, the occupier shall submit environmental statement with supporting stoichiometric calculations analyses reports, every year latest by 30th September of the next financial year.

(9) That, the occupier shall submit report(s) duly monitored and issued by an NABL accredited / ISO 9001:2008 and OHSAS 18001:2007 certified laboratory in compliance sub-para (2), (3), (4) and (5) of paragraph 3 of this CTO yearly at required periodicity.

(10) That, this CTO is valid subjected to the validity of mining Lease/Mining Plan/Ecofriendly/Environmental Clearance, if applicable. In case of no renewal of Mining Lease/Mining Plan, this consent shall be treated as revoked automatically.

(11) That, this CTO is issued from the environmental angle only and does not absolve the occupier from other statutory obligations prescribed under any other law or any other instrument in force. The sole and complete responsibility to comply with these conditions laid down in all other laws for the time-being in force, rests with the industry/ unit/ occupier.

(12) That, this CTO shall not in any way, adversely affect or jeopardize the legal proceeding , if any, instituted in the past or that could be , instituted against you by the State Board for violation of the provisions of the Act or the Rules made there under.

(13) That, the occupier shall comply with all applicable provisions of the Water (Prevention & Control of Pollution) Act, 1974; the Water (Prevention & Control of Pollution) Cess Act, 1977; the Air (Prevention & Control of Pollution) Act, 1981; and the Environment (Protection) Act, 1986 and Rules made there under.

4. **That, this CTO shall not absolve the occupier from making compliance of other statutory prescribed under any law or direction of courts or any other instrument for the time being in force.**

5. **That, this CTO is being issued on the basis of information/ documents/ certificate submitted by the unit. This CTO will be revoked if any of the information/documents/certificates/undertaking given by the occupier is found false/fictitious/forged in future.**

6. **The Order shall be valid subject to compliance of all other legal requirements applicable to the unit.**

7. **The State Board reserve the right to revoke, withdraw or make any reasonable variation / change / alteration in conditions of this consent.**

This is issued with the approval of the Competent authority

[Y. K. Das]
Member Secretary

Memo No. : JSPCB/HO/RNC/CTO-17157397/2023/2089

Dated : 2023-12-20

Copy to: M/S Cluster II including KKC (L&M) & Kessurgarh Siding, At- Office of the General Manager, Block-II Area, Distt.- Dhanbad/Director of Industry, Government of Jharkhand, Ranchi/ Deputy Commissioner, Dhanbad/ Chief Inspector of Factories, Government of Jharkhand, Ranchi/ D.F.O., Dhanbad/ Regional Officer, J.S.P.C.B., Dhanbad for information & necessary action.

[Y. K. Das]
Member Secretary

ANNEXURE-V

JHARKHAND STATE POLLUTION CONTROL BOARD

TOWNSHIP ADMINISTRATION BUILDING, HEC COMPLEX, DHURWA, RANCHI 834004
Telephone: 0651-2400850 (Fax)/ 2400851/2400852/2401847/2400979/2400139

Ref No. JSPCB/HO/RNC/CTO-13958408/2022/1632 Dated : 2022-11-23

Consent to operate (CTO) under section 25 /26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981

1. Application (s) dated 2022-08-11 of Cluster-III Mines with Railway siding, RLS (SILO), Occupier Name :Sri GC Saha for consent under section 25 (1)(b)/25 (1) (c)/26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21(1) of the Air (Prevention & Control of Pollution) Act,1981..

2. **Documents Relied Upon:**

(a) The content of Copy of Environmental Clearance issued vide J-11015/67/2013/2010-IA.II (M) dated 06.02.2013 for Cluster III (7 mines of a peak production of 3.6 MTPA in a combined ML area of 1420.61 ha) of M/s Bharat Coking Coal Ltd., located in Jharia Coalfields, Dist. Dhanbad, Jharkhand (EC based on TOR granted on 04.11.2010) -Environment Clearance with compliance report.

(b) The content of Copy of CTO issued vide Ref No. JSPCB/HO/RNC/CTO-11038917/2021/1631 Dated : 24.12.2021 valid for 31.12.2022 for Coal- Peak production of 3.6 MTPA, Unloading, Loading and Dispatch of Coal through Railway Siding - 3.6 MTPA (As per cluster III E.C) with Rapid Loading System (SILO)- 5 MTPA with compliance report.

(c) The content of inspection report (I/R) vide Ref. No. 983 dated 27.08.2022 of R.O. Dhanbad, JSPCB, Dhanbad.

(d) The content of copy of the opinion of Sri Kaushik Chanda, Additional Solicitor General for India on the issue of Renewal of Mining Leases which has been in the control of Coal India subsidiaries by virtue of the Coal Mines Nationalization Acts 1972/1973.

(e) The content of Self-Deceleration for no expansion in Cluster- III leasehold area and no modernization in the Cluster- III group of mines.

(f) The content of copy of the HWM Authorization granted by the Board vide ref. no. JSPCB/HO/RNC/HWM-10502533/2021/45 dated 20.09.2021 valid till 31.12.2025.

3. The consent is granted under section 25 / 26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981 to operate the project in Mauza -Bhatmurna,Katras, etc , P S -Sonardih , District -DHANBAD , as follows:

Project	Site-Area		Investment (Rs)	Product & Capacity	Period of CTO
	Plot Nos.	Area			Date of issue To

Before Expansion	As per EC	1420.61 Ha	475.69 Crores	Coal- Peak production of 3.6 MTPA, Unloading, Loading and Dispatch of Coal through Railway Siding - 3.6 MTPA (As per cluster III E.C) with Rapid Loading System (SILO)- 5 MTPA	30/06/2025

(A) Specific Conditions:

1. That, the occupier shall do Over Burden management properly as per the prescribed guidelines.

2. That, the occupier shall reclaim mined out areas with OB and shall plant trees on them.

3. That, the occupier shall operate & maintain ETP with workshop of heavy vehicles.

4. That, the occupier shall not exceed the production as mentioned in CTO.

5. That, the occupier shall inform to Regional Office-Cum- Lab, Dhanbad and Head Office, JSPC Board, at Ranchi within 24 hrs from the time of closure or opening of the plant.

6. That, the occupier shall if be found violating the Consent to Operate at any point of time during inspection of the plant by the competent authority, the Consent to Operate shall be revoked as per provision of the acts.

7. That, the occupier shall operate crushers at CHP with high efficiency bag filters, water sprinkling system to check fugitive emission.

8. That, the occupier shall if be found violating the Consent to Operate at any point of time during inspection of the plant by the competent authority, the Consent to Operate shall be revoked as per provision of the acts.

9. That, occupier shall maintain proper housekeeping within the premises.

10. That, the occupier shall construct catch drain, siltation pond retaining wall of appropriate size to arrest silt & sediment flows from soil, OB dump and mineral dump.

11. That, the occupier shall carry out transportation of coal in wet conditions i.e. wet transportation must be

carried out and submit the photographs to the Board.

12. That, he (they) shall in no case discharge runoff water or waste water of premises outside the railway siding.

13. That, the occupier shall allow transportation of materials either in lumps or in fines only through covered
and
leak proof dumpers/trucks within the railway siding area.

14. That, the occupier shall allow transport of materials through the railway siding of such mines/plants which have valid consent to operate order of the State Pollution Control Board and also keep a record thereof and shall make available to the officer (s) concerned during his (their) visits of the site.

15. That, the occupier shall construct permanent boundary/wind breaking wall of at least 20 ft. height all along the railway siding.

16. That, the occupier shall develop three tier plantation all along the boundary wall with de-silting pit within three months and submit the report to the Board.

17. That, the occupier shall install fixed type water sprinklers/foggers on all roads and sidings to control fugitive emission within four months from the issuance of CTO and submit the report to the Board.

18. That, the occupier shall ensure that vehicle used for transportation must be covered with tarpulin sheets.

19. That, the occupier shall operate and maintain the PM 10 analyzer and also ensure data transmission to JSPCB server uninterruptedly.

20. The occupier shall complete the construction work of toe wall, garland drain & siltation pond at Mahespur Colliery & New Akashkinaree Colliery within 3 months from the date of issuance of CTO and shall submit the report to the JSPCB Regional Office cum Laboratory, Dhanbad.

21. The occupier shall install the wheel washing facility system within 3 months from the date of issuance of CTO and shall submit the report to the JSPCB Regional Office cum Laboratory, Dhanbad.

22. The occupier shall install the CAAQMS within 3 months from the date of issuance of CTO and shall submit the report to the JSPCB Regional Office cum Laboratory, Dhanbad.

23. That, the occupier shall submit compliance of EC and this CTO conditions on six monthly basis alongwith the analysis reports to the Board and other concerned organizations.

24. That, the occupier shall submit application for renewal of consent under section 25/26 of the Water (prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (prevention & Control of

Pollution) Act, 1981 again 120 days prior to the date of expiry of this consent with documents showing compliance of all of the above conditions.

25. That, the occupier shall comply with all the conditions prescribed for siding vide JSPCB letter memo no B-387 dated. 11.04.2019 and the conditions prescribed by concerned authorities for railway siding.

26. That, this CTO supersedes the CTO granted earlier vide ref. no. JSPCB/HO/RNC/CTO-11038917/2021/1631, dated 24.12.2021.

27. That, the occupier shall submit application for renewal of consent under section 25/26 of the Water (prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (prevention & Control of Pollution) Act, 1981 again 120 days prior to the date of expiry of this consent with documents showing compliance of all of the above conditions.

(B) General Conditions :

(1) That, the occupier shall maintain the **National Ambient Air Quality Standard** given below:

S N	Pollutant	Time Weighted Average	Concentration in Ambient Air	
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Govt.)
(1)	(2)	(3)	(4)	(5)
1.	Sulphur Dioxide (SO2), µg/m3	Annual 24 hours	50 80	20 80
2.	Nitrogen Dioxide (NO2), µg/m3	Annual 24 hours	40 80	30 80
3.	Particulate Matter (size less than 10 µm) or PM10, µg/m3	Annual 24 hours	60 100	60 100
4.	Particulate Matter (size less than 2.5 µm) or PM2.5, µg/m3	Annual 24 hours	40 60	40 60
5.	Ozone(O3), µg/m3	8 hours 1 hour	100 180	100 180
6.	Lead (Pb) µg/m3	Annual 24 hours	0.50 1.0	0.50 1.0
7.	Carbon Monoxide (CO) mg/m3	8 hours 1 hour	02 04	02 04
8.	Ammonia (NH3) µg/m3	Annual 24 hours	100 400	100 400
9.	Benzene (C6H6) µg/m3	Annual	05	05
10.	Benzo(a) Pyrene(BaP) Particulate Phase only ng/m3	Annual	01	01
11.	Arsenic (As) ng/m3	Annual	06	06
12.	Nickel (Ni) ng/m3	Annual	20	20

Note : Serial no. 1 to 4 – Mandatory
Serial no. 5 to 12 As applicable for specific type of industry.

(2) That, the occupier shall maintain the emission quality within the standard and the quantity, as follows:

S N	Parameter	Standard
1	Particulate Matter	150 mg//Nm3

(3) That, the occupier shall keep process effluent in close-circuit and the quality of effluent from other sources in conformity with the standard (s) and the discharge quantity as below:

S N	Parameter	Standard
1	COD	250 mg/L
2	Total Suspended Solids	100 mg/L
3	BOD	30 mg/L
4	Oil & Grease	10 mg/L

(4) That, the occupier shall dispose of solid wastes as follows:

S N	Waste Type	Mode of Disposal
1	Hazardous Carbonaceous Wastes	In co-processing in high temperature furnaces or kilns
2	Hazardous Non-Carbonaceous Wastes	In TSDF
3	Non-Carbonaceous Non-Hazardous solid wastes/ Mine Over Burden	As a substitute of Soil or Mineral

(5) That, the occupier shall keep D G Set(s) within acoustic enclosure and shall keep the height(s) of exhaust pipe(s) as per Central Pollution Control Board norm.

(6) That, the occupier shall install and maintain Central Ground Water Board/ State Ground Water Directorate approved system of rain water harvesting-cum-ground water recharge and submit the photographic view of the structures within a month.

(7) That, the occupier shall grow and maintain greenery of the project in the periphery and other available spaces and shall continue enhancing its plant density and biodiversity.

(8) That, the occupier shall submit environmental statement with supporting stoichiometric calculations analyses reports, every year latest by 30th September of the next financial year.

(9) That, the occupier shall submit report(s) duly monitored and issued by an NABL accredited / ISO 9001:2008 and OHSAS 18001:2007 certified laboratory in compliance sub-para (2), (3), (4) and (5) of paragraph 3 of this CTO yearly at required periodicity.

(10) That, this CTO is valid subjected to the validity of mining Lease/Mining Plan/Ecofriendly/Environmental Clearance, if applicable. In case of no renewal of Mining Lease/Mining Plan, this consent shall be treated as revoked automatically.

(11) That, this CTO is issued from the environmental angle only and does not absolve the occupier from other statutory obligations prescribed under any other law or any other instrument in force. The sole and complete responsibility to comply with these conditions laid down in all other laws for the time-being in force, rests with the industry/ unit/ occupier.

(12) That, this CTO shall not in any way, adversely affect or jeopardize the legal proceeding , if any, instituted in the past or that could be , instituted against you by the State Board for violation of the provisions of the Act or the Rules made there under.

(13) That, the occupier shall comply with all applicable provisions of the Water (Prevention & Control of Pollution) Act, 1974; the Water (Prevention & Control of Pollution) Cess Act, 1977; the Air (Prevention & Control of Pollution) Act, 1981; and the Environment (Protection) Act, 1986 and Rules made there under.

4. **That, this CTO shall not absolve the occupier from making compliance of other statutory prescribed under any law or direction of courts or any other instrument for the time being in force.**

5. **That, this CTO is being issued on the basis of information/ documents/ certificate submitted by the unit. This CTO will be revoked if any of the information/documents/certificates/undertaking given by the occupier is found false/fictitious/forged in future.**

6. **The Order shall be valid subject to compliance of all other legal requirements applicable to the unit.**

7. **The State Board reserve the right to revoke, withdraw or make any reasonable variation / change / alteration in conditions of this consent.**

This is issued with the approval of the Competent authority

(Yatindra Kumar Das)
Member Secretary

Memo No. : JSPCB/HO/RNC/CTO-13958408/2022/1632

Dated : 2022-11-23

Copy to: M/S Cluster-III Mines with Railway siding, RLS (SILO), At- BCCL, Koyla Bhawan, Koyla Nagar Dhanbad 826005/Director of Industry, Government of Jharkhand, Ranchi/ Deputy Commissioner, Dhanbad/ Chief Inspector of Factories, Government of Jharkhand, Ranchi/ D.F.O., Dhanbad/ Regional Officer, J.S.P.C.B., Dhanbad for information & necessary action.

(Yatindra Kumar Das)
Member Secretary

ANNEXURE-VI

JHARKHAND STATE POLLUTION CONTROL BOARD

TOWNSHIP ADMINISTRATION BUILDING, HEC COMPLEX, DHURWA, RANCHI 834004
Telephone: 0651-2400850 (Fax)/ 2400851/2400852/2401847/2400979/2400139

Ref No. JSPCB/HO/RNC/CTO-13916321/2022/1692 Dated : 2022-12-03

Consent to operate (CTO) under section 25 /26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981

1. Application (s) dated 2022-08-04 of cluster IV group of mines with siding, Occupier Name :SHRI Sudhakar Prasad for consent under section 25 (1)(b)/25 (1) (c)/26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21(1) of the Air (Prevention & Control of Pollution) Act,1981..

2. **Documents Relied Upon:**

(a) The content of Environmental Clearance issued by MoEF, Govt. of India vide Ref. No. J11015/372/20131-IA-II.(M) dated 16.07.2018 for the Cluster IV (Group of 5 mixed mines) Coal mining project from 3.706 MTPA to 9.55 MTPA of M/s Bharat Coking Coal Ltd., in mine lease area of 1123.79 Ha in Dist. Dhanbad, Jharkhand.

(b) The content of Copy of CTO of Cluster IV group of mines vide Ref No. JSPCB/HO/RNC/CTO-11045728/2021/1642 dated 27.12.2021 for capacity of Coal – 7.34 MTPA and Peak-9.55 MTPA (As mentioned in EC) valid up to 31.12.2022 with compliance report.

(c) The content of letter stating that cluster IV group of mines having five nos of mines namely Amalgamated Keshalpur west Mudidih colliery (AKWMC), Amalgamated Angarpathra Ramkanali Colliery (AARC), Katras Choitudih colliery (KCC), Gaslitand colliery (GTC) and Salanpur colliery (SPC) and all the mines comes under the administrative control of Katras Area of M/S Bharat Coking Coal Limited Lakurka siding is also come under Cluster IV which is within the lease boundary of Amalgamated Angarpathra Ramkanali Colliery.

(d) The content of Copy of authorization under Hazardous and other Wastes (Management, and Transboundary Movement) Rules, 2016 vide ref. no. JSPCB/HO/RNC/HWM-10420813/2021/43, dated 20.09.2021.

(f)The content of inspection report (I/R) vide
(i) Ref. No . 984, dated 27.08.2022;
(ii) Memo No. 1211, dated 19.10.2022.

3. The consent is granted under section 25 / 26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981 to operate the project in Mauza -233 , P S -Baghmara , District -DHANBAD , as follows:

Project	Site-Area		Investment (Rs)	Product & Capacity	Period of CTO
	Plot Nos.	Area			Date of issue To

Before Expansion	As per EC	1123.79 Ha [As per previous CTO]	45883 Crores [As per previous CTO and application]	Coal – 7.34 MTPA and Peak-9.55 MTPA (As mentioned in EC and in previous CTO)	31/12/2025

(A) Specific Conditions:

1. That, the occupier shall do Over Burden management properly as per the prescribed guidelines.

2. That, the occupier shall reclaim mined out areas with OB and shall plant trees on them.

3. That, the occupier shall operate & maintain ETP with workshop of heavy vehicles.

4. That, the occupier shall not exceed the production as mentioned in CTO.

5. That, the occupier shall inform to Regional Office-Cum- Lab, Dhanbad and Head Office, JSPC Board, at Ranchi within 24 hrs from the time of closure or opening of the plant.

6. That, the occupier shall if be found violating the Consent to Operate at any point of time during inspection of the plant by the competent authority, the Consent to Operate shall be revoked as per provision of the acts.

7. That, the occupier shall operate crushers at CHP with high efficiency bag filters, water sprinkling system to check fugitive emission.

8. That, the occupier shall if be found violating the Consent to Operate at any point of time during inspection of the plant by the competent authority, the Consent to Operate shall be revoked as per provision of the acts.

9. That, occupier shall maintain proper housekeeping within the premises.

10. That, the occupier shall construct catch drain, siltation pond retaining wall of appropriate size to arrest silt & sediment flows from soil, OB dump and mineral dump.

11. That, the occupier shall carry out transportation of coal in wet conditions i.e. wet transportation must be carried out and submit the photographs to the Board.

12. That, he (they) shall in no case discharge runoff water or waste water of premises outside the railway siding.

13. That, the occupier shall allow transportation of materials either in lumps or in fines only through covered and
leak proof dumpers/trucks within the railway siding area.

14. That, the occupier shall allow transport of materials through the railway siding of such mines/plants which have valid consent to operate order of the State Pollution Control Board and also keep a record thereof and shall make available to the officer (s) concerned during his (their) visits of the site.

15. That, the occupier shall construct permanent boundary/wind breaking wall of at least 20 ft. height all along the railway siding.

16. hat, the occupier shall develop three tier plantation all along the boundary wall with de-silting pit within three months and submit the report to the Board.

17. That, the occupier shall install fixed type water sprinklers/foggers on all roads and sidings to control fugitive emission within four months from the issuance of CTO and submit the report to the Board.

18. That, the occupier shall ensure that vehicle used for transportation must be covered with tarpulin sheets.

19. That, the occupier shall ensure to provide wheel washing facility at entry and existing points.

20. That, the occupier shall operate and maintain the PM 10 analyzer and also ensure data transmission to JSPCB server uninterruptedly.

21. That, the occupier shall install CAAQMS within 2 months from the date of issuance of this CTO failing which your CTO may be revoked and environmental compensation be levied as per applicable norms.

22. That, the occupier shall submit compliance of EC and this CTO conditions on six monthly basis alongwith the analysis reports to the Board and other concerned organizations.

23. That, the occupier shall submit application for renewal of consent under section 25/26 of the Water (prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (prevention & Control of Pollution) Act, 1981 again 120 days prior to the date of expiry of this consent with documents showing compliance of all of the above conditions.

24. That, the occupier shall comply with all the conditions prescribed for siding vide JSPCB letter memo no B-387 dated. 11.04.2019 and the conditions prescribed by concerned authorities for railway siding.

25. That, this CTO supersedes the CTO granted earlier vide ref. no. JSPCB/HO/RNC/CTO-11045728/2021/1642, dated 27.12.2021.

26. That, the occupier shall submit application for renewal of consent under section 25/26 of the Water (prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (prevention & Control of

Pollution) Act, 1981 again 120 days prior to the date of expiry of this consent with documents showing compliance of all of the above conditions.

(B) General Conditions :

(1) That, the occupier shall maintain the **National Ambient Air Quality Standard** given below:

S N	Pollutant	Time Weighted Average	Concentration in Ambient Air	
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Govt.)
(1)	(2)	(3)	(4)	(5)
1.	Sulphur Dioxide (SO2), µg/m3	Annual 24 hours	50 80	20 80
2.	Nitrogen Dioxide (NO2), µg/m3	Annual 24 hours	40 80	30 80
3.	Particulate Matter (size less than 10 µm) or PM10, µg/m3	Annual 24 hours	60 100	60 100
4.	Particulate Matter (size less than 2.5 µm) or PM2.5, µg/m3	Annual 24 hours	40 60	40 60
5.	Ozone(O3), µg/m3	8 hours 1 hour	100 180	100 180
6.	Lead (Pb) µg/m3	Annual 24 hours	0.50 1.0	0.50 1.0
7.	Carbon Monoxide (CO) mg/m3	8 hours 1 hour	02 04	02 04
8.	Ammonia (NH3) µg/m3	Annual 24 hours	100 400	100 400
9.	Benzene (C6H6) µg/m3	Annual	05	05
10.	Benzo(a) Pyrene(BaP) Particulate Phase only ng/m3	Annual	01	01
11.	Arsenic (As) ng/m3	Annual	06	06
12.	Nickel (Ni) ng/m3	Annual	20	20

Note : Serial no. 1 to 4 – Mandatory
Serial no. 5 to 12 As applicable for specific type of industry.

(2) That, the occupier shall maintain the emission quality within the standard and the quantity, as follows:

S N	Parameter	Standard
1	Particulate Matter	150 mg//Nm3

(3) That, the occupier shall keep process effluent in close-circuit and the quality of effluent from other sources in conformity with the standard (s) and the discharge quantity as below:

S N	Parameter	Standard
1	Total Suspended Solids	100 mg/L
2	BOD	30 mg/L
3	COD	250 mg/L
4	Oil & Grease	10 mg/L

(4) That, the occupier shall dispose of solid wastes as follows:

S N	Waste Type	Mode of Disposal
1	Hazardous Carbonaceous Wastes	In co-processing in high temperature furnaces or kilns
2	Hazardous Non-Carbonaceous Wastes	In TSDF
3	Non-Carbonaceous Non-Hazardous solid wastes/ Mine Over Burden	As a substitute of Soil or Mineral

(5) That, the occupier shall keep D G Set(s) within acoustic enclosure and shall keep the height(s) of exhaust pipe(s) as per Central Pollution Control Board norm.

(6) That, the occupier shall install and maintain Central Ground Water Board/ State Ground Water Directorate approved system of rain water harvesting-cum-ground water recharge and submit the photographic view of the structures within a month.

(7) That, the occupier shall grow and maintain greenery of the project in the periphery and other available spaces and shall continue enhancing its plant density and biodiversity.

(8) That, the occupier shall submit environmental statement with supporting stoichiometric calculations analyses reports, every year latest by 30th September of the next financial year.

(9) That, the occupier shall submit report(s) duly monitored and issued by an NABL accredited / ISO 9001:2008 and OHSAS 18001:2007 certified laboratory in compliance sub-para (2), (3), (4) and (5) of paragraph 3 of this CTO yearly at required periodicity.

(10) That, this CTO is valid subjected to the validity of mining Lease/Mining Plan/Ecofriendly/Environmental Clearance, if applicable. In case of no renewal of Mining Lease/Mining Plan, this consent shall be treated as revoked automatically.

(11) That, this CTO is issued from the environmental angle only and does not absolve the occupier from other statutory obligations prescribed under any other law or any other instrument in force. The sole and complete responsibility to comply with these conditions laid down in all other laws for the time-being in force, rests with the industry/ unit/ occupier.

(12) That, this CTO shall not in any way, adversely affect or jeopardize the legal proceeding , if any, instituted in the past or that could be , instituted against you by the State Board for violation of the provisions of the Act or the Rules made there under.

(13) That, the occupier shall comply with all applicable provisions of the Water (Prevention & Control of Pollution) Act, 1974; the Water (Prevention & Control of Pollution) Cess Act, 1977; the Air (Prevention & Control of Pollution) Act, 1981; and the Environment (Protection) Act, 1986 and Rules made there under.

4. **That, this CTO shall not absolve the occupier from making compliance of other statutory prescribed under any law or direction of courts or any other instrument for the time being in force.**

5. **That, this CTO is being issued on the basis of information/ documents/ certificate submitted by the unit. This CTO will be revoked if any of the information/documents/certificates/undertaking given by the occupier is found false/fictitious/forged in future.**

6. **The Order shall be valid subject to compliance of all other legal requirements applicable to the unit.**

7. **The State Board reserve the right to revoke, withdraw or make any reasonable variation / change / alteration in conditions of this consent.**

This is issued with the approval of the Competent authority

(Yatindra Kumar Das)
Member Secretary

Memo No. : JSPCB/HO/RNC/CTO-13916321/2022/1692

Dated : 2022-12-03

Copy to: M/S Cluster IV group of mines with siding, Katras Area office, Bharat Coking Coal Limited, P.O- Sijua, Dist-Dhanbad, Pin-828121/Director of Industry, Government of Jharkhand, Ranchi/ Deputy Commissioner, Dhanbad/ Chief Inspector of Factories, Government of Jharkhand, Ranchi/ D.F.O., Dhanbad/ Regional Officer, J.S.P.C.B., Dhanbad for information & necessary action.

(Yatindra Kumar Das)
Member Secretary

ANNEXURE-VII

JHARKHAND STATE POLLUTION CONTROL BOARD

TOWNSHIP ADMINISTRATION BUILDING, HEC COMPLEX, DHURWA, RANCHI 834004
Telephone: 0651-2400850 (Fax)/ 2400851/2400852/2401847/2400979/2400139

Ref No. JSPCB/HO/RNC/CTO-14052027/2022/1874 Dated : 2022-12-30

Consent to operate (CTO) under section 25 /26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981

1. Application (s) dated 2022-08-23 of Cluster V Bharat Coking Coal Limited, Occupier Name :CLUSTER V BHARAT COKING COAL LIMITED for consent under section 25 (1)(b)/25 (1) (c)/26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21(1) of the Air (Prevention & Control of Pollution) Act,1981..

2. **Documents Relied Upon:**

(a) The content of Copy of Environmental Clearance issued by MoEF, Govt. of India vide Ref. No. J11015/01/2011-IA-II.(M) dated 30.05.2018 for the Expansion of Cluster No. V Coal Mining Project of production capacity of 6.311 MTPA in total lease area of 1957.08 ha of M/s BCCL located in Jharia Coalfield, District of Dhanbad (Jharkhand).

(b) The content of Consent-to-Operate (CTO), vide Ref. No. JSPCB/HO/RNC/CTO-11045603/2021/1643 Dated : 27.12.2021 valid up to 31.12.2022 for Coal - 6.311 MTPA as per EC with loading/unloading facility at SB railway siding with compliance report.

(c) The content of copy of the HWM Authorization granted by the Board vide ref. no. JSPCB/HO/RNC/HWM-10451681/2021/44 dated 20.09.2021 valid till 31.12.2025.

(d) The content of Inspection Report (I/R), vide
(i) ref no.- 1080 dated 22.09.2022;
(ii) memo no. 1343, dated 28.11.2022 of R.O., JSPCB, Dhanbad.

3. The consent is granted under section 25 / 26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981 to operate the project in Mauza -ANNEXED , P S -SIJUA AREA DHANBAD , District -DHANBAD , as follows:

Project	Site-Area		Investment (Rs)	Product & Capacity	Period of CTO
	Plot Nos.	Area			Date of issue To
Before Expansion	As per EC	1957.08 Ha (as per EC)	14644.67 Lacs	Coal - 6.311 MTPA (as per EC) with loading/unloading facility at SB railway siding	31/03/2025

(A) Specific Conditions:

1. That, the occupier shall reclaim mined out areas with OB and shall plant trees on them.

2. That, the occupier shall construct catch drain, siltation pond retaining wall of appropriate size to arrest silt & sediment flows from soil, OB dump and mineral dump.

3. That, the occupier shall do Over Burden management properly as prescribed in environmental clearance.

4. That, the occupier shall operate crushers at CHP with high efficiency bag filters, water sprinkling system to check fugitive emission.

5. That, the occupier shall install ETP for workshop, coal washery & CHP waste water.

6. That, the occupier shall inform to Regional Office-Cum- Lab, Hazaribagh and Head Office, JSPC Board, at Ranchi within 24 hrs from the time of closure or opening of the plant.

7. That, the occupier shall reclaim mined out areas with OB and shall plant trees on them.

8. That, the occupier shall if be found violating the Consent to Operate at any point of time during inspection of the plant by the competent authority, the Consent to Operate shall be revoked as per provision of the acts.

9. That, occupier shall maintain proper housekeeping within the premises.

10. That, the occupier shall not exceed the production as mentioned in CTO.

11. That, the occupier shall do Over Burden management properly as prescribed in environmental clearance.

12. That, the occupier shall construct catch drain, siltation pond retaining wall of appropriate size to arrest silt & sediment flows from soil, OB dump and mineral dump.

13. That, the occupier shall inform to Regional Office-Cum- Lab, Hazaribagh and Head Office, JSPC Board, at Ranchi within 24 hrs from the time of closure or opening of the plant.

14. That, the occupier shall ensure washing of tyres of vehicles used for transportation of coal and also ensure proper covering of the same to avoid any dust emission.

15. That, the occupier shall operate and maintain the STP for the township/colony to treat the domestic

effluents to prescribed standards and for green belt development or reuse in project activities.

16. That, the occupier shall submit compliance of this CTO conditions and EC conditions on six monthly basis alongwith the recent analysis reports successively.

17. That, the occupier shall dispose the hazardous waste in proper manner and shall obtain authorization for the same.

18. That, the occupier shall operate and maintain PM 10 analyzer and ensure connectivity and data transmission to CPCB and JSPCB server.

19. That, the occupier shall construct the Toe wall & Garland drains along the remaining parts of finalized OB dumps by 31.12.2023 and shall submit its status report to the Regional Office, Dhanbad on a quarterly basis for compliance.

20. That, the occupier shall submit the 6 monthly compliance reports to the Regional Office, Dhanbad failing which CTO may be revoked.

21. That, the occupier shall submit applications for renewal of consent under section 25 /26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981 again 120 days prior to the date of expiry of this consent with requisite fee and documents showing compliance of all of the above conditions.

22. That, this CTO supersedes the CTO granted earlier, vide ref. no. JSPCB/HO/RNC/CTO-11045603/2021/1643, dated 27.12.2021.

23. That, the occupier shall carry out the open cast mining activities only on the surface rights area.

(B) General Conditions :

(1) That, the occupier shall maintain the **National Ambient Air Quality Standard** given below:

S N	Pollutant	Time Weighted Average	Concentration in Ambient Air	
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Govt.)
(1)	(2)	(3)	(4)	(5)
1.	Sulphur Dioxide (SO2), µg/m3	Annual 24 hours	50 80	20 80
2.	Nitrogen Dioxide (NO2), µg/m3	Annual 24 hours	40 80	30 80
3.	Particulate Matter (size less than 10 µm) or PM10, µg/m3	Annual 24 hours	60 100	60 100
4.	Particulate Matter (size less than 2.5 µm) or PM2.5, µg/m3	Annual 24 hours	40 60	40 60
5.	Ozone(O3), µg/m3	8 hours 1 hour	100 180	100 180
6.	Lead (Pb) µg/m3	Annual 24 hours	0.50 1.0	0.50 1.0
7.	Carbon Monoxide (CO) mg/m3	8 hours 1 hour	02 04	02 04
8.	Ammonia (NH3) µg/m3	Annual 24 hours	100 400	100 400
9.	Benzene (C6H6) µg/m3	Annual	05	05
10.	Benzo(a) Pyrene(BaP) Particulate Phase only ng/m3	Annual	01	01
11.	Arsenic (As) ng/m3	Annual	06	06
12.	Nickel (Ni) ng/m3	Annual	20	20

Note : Serial no. 1 to 4 – Mandatory
Serial no. 5 to 12 As applicable for specific type of industry.

(2) That, the occupier shall maintain the emission quality within the standard and the quantity, as follows:

S N	Parameter	Standard
1	Particulate Matter	150 mg/Nm3

(3) That, the occupier shall keep process effluent in close-circuit and the quality of effluent from other sources in conformity with the standard (s) and the discharge quantity as below:

S N	Parameter	Standard
1	Total Suspended Solids	100 mg/L
2	BOD	30 mg/L
3	COD	250 mg/L
4	Oil & Grease	10 mg/L

(4) That, the occupier shall dispose of solid wastes as follows:

S N	Waste Type	Mode of Disposal
1	Hazardous Carbonaceous Wastes	In co-processing in high temperature furnaces or kilns
2	Hazardous Non-Carbonaceous Wastes	In TSDF
3	Non-Carbonaceous Non-Hazardous solid wastes/ Mine Over Burden	As a substitute of Soil or Mineral

(5) That, the occupier shall keep D G Set(s) within acoustic enclosure and shall keep the height(s) of exhaust pipe(s) as per Central Pollution Control Board norm.

(6) That, the occupier shall install and maintain Central Ground Water Board/ State Ground Water Directorate approved system of rain water harvesting-cum-ground water recharge and submit the photographic view of the structures within a month.

(7) That, the occupier shall grow and maintain greenery of the project in the periphery and other available spaces and shall continue enhancing its plant density and biodiversity.

(8) That, the occupier shall submit environmental statement with supporting stoichiometric calculations analyses reports, every year latest by 30th September of the next financial year.

(9) That, the occupier shall submit report(s) duly monitored and issued by an NABL accredited / ISO 9001:2008 and OHSAS 18001:2007 certified laboratory in compliance sub-para (2), (3), (4) and (5) of paragraph 3 of this CTO yearly at required periodicity.

(10) That, this CTO is valid subjected to the validity of mining Lease/Mining Plan/Ecofriendly/Environmental Clearance, if applicable. In case of no renewal of Mining Lease/Mining Plan, this consent shall be treated as revoked automatically.

(11) That, this CTO is issued from the environmental angle only and does not absolve the occupier from other statutory obligations prescribed under any other law or any other instrument in force. The sole and complete responsibility to comply with these conditions laid down in all other laws for the time-being in force, rests with the industry/ unit/ occupier.

(12) That, this CTO shall not in any way, adversely affect or jeopardize the legal proceeding , if any, instituted in the past or that could be , instituted against you by the State Board for violation of the provisions of the Act or the Rules made there under.

(13) That, the occupier shall comply with all applicable provisions of the Water (Prevention & Control of Pollution) Act, 1974; the Water (Prevention & Control of Pollution) Cess Act, 1977; the Air (Prevention & Control of Pollution) Act, 1981; and the Environment (Protection) Act, 1986 and Rules made there under.

4. **That, this CTO shall not absolve the occupier from making compliance of other statutory prescribed under any law or direction of courts or any other instrument for the time being in force.**

5. **That, this CTO is being issued on the basis of information/ documents/ certificate submitted by the unit. This CTO will be revoked if any of the information/documents/certificates/undertaking given by the occupier is found false/fictitious/forged in future.**

6. **The Order shall be valid subject to compliance of all other legal requirements applicable to the unit.**

7. **The State Board reserve the right to revoke, withdraw or make any reasonable variation / change / alteration in conditions of this consent.**

This is issued with the approval of the Competent authority

[Y. K. Das]
Member Secretary

Memo No. : JSPCB/HO/RNC/CTO-14052027/2022/1874

Dated : 2022-12-30

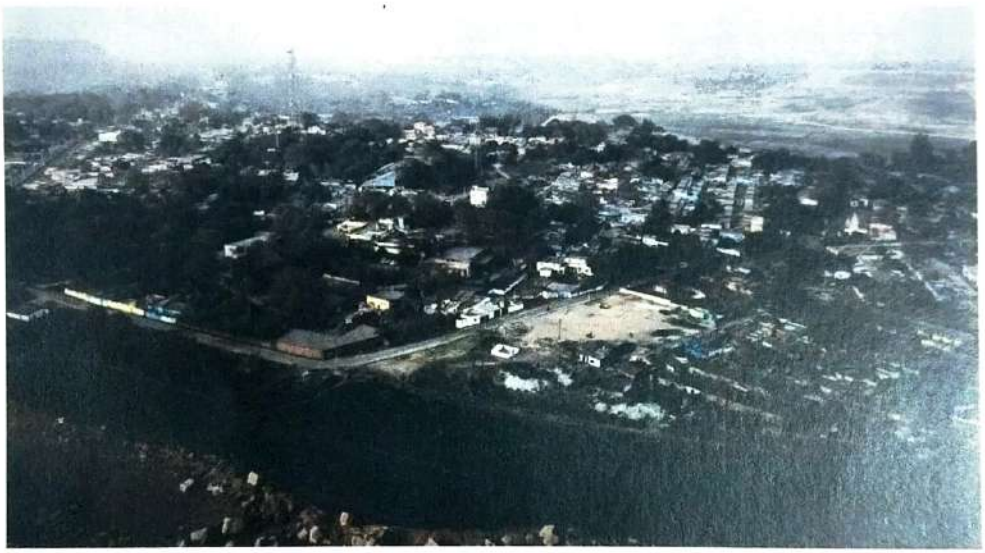
Copy to: M/s Cluster V At- Sijua Area, Bharat Coking Coal Limited, Distt.- Dhanbad/Director of Industry, Government of Jharkhand, Ranchi/ Deputy Commissioner, Dhanbad/ Chief Inspector of Factories, Government of Jharkhand, Ranchi/ D.F.O., Dhanbad/DMO, Dhanbad/Regional Officer, J.S.P.C.B., Dhanbad for information & necessary action

[Y. K. Das]
Member Secretary

"Source apportionment of ambient air particulate matter in Jharia coalfields region, Jharkhand"

Sponsor

Bharat Coking Coal Limited (BCCL)



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Contents

List of Figures

List of Tables

Chapter 1 Introduction

Jharia Coalfield (JCF) is one of the oldest coalfields of India and has been subjected to coal exploitation for more than 100 years. JCF is one of the significant coal-producing areas in the country and occupies an important place in India's industrial and energy scenario by virtue of prime coking coal and is an essential source of coal. Jharia coalfield is crucial and a large coalfield situated in Dhanbad and Bokaro district, Jharkhand. Geographically the JCF is bounded by latitude 23°38' N to 23°49' N and longitude 86°09'E to 86°30'E and encompassing a total area of about 450sq km (Figure 1.1). Jharia is the largest coal producer in India and has an estimated reserved of 19.4 billion tonnes of coking coal. The coalfield contributes to the local economy and directly or indirectly employs the local population.

Bharat Coking Coal Limited, a subsidiary of Coal India Limited, has been operating the majority of the coal mines in the Jharia coalfield regions since its inception in 1972. Jharia, one of the eight blocks in Dhanbad and the main source of metallurgical coal in India can be termed as the country powerhouse since its mines are the only source for the best quality coking coal required by the steel industries and others in the country.

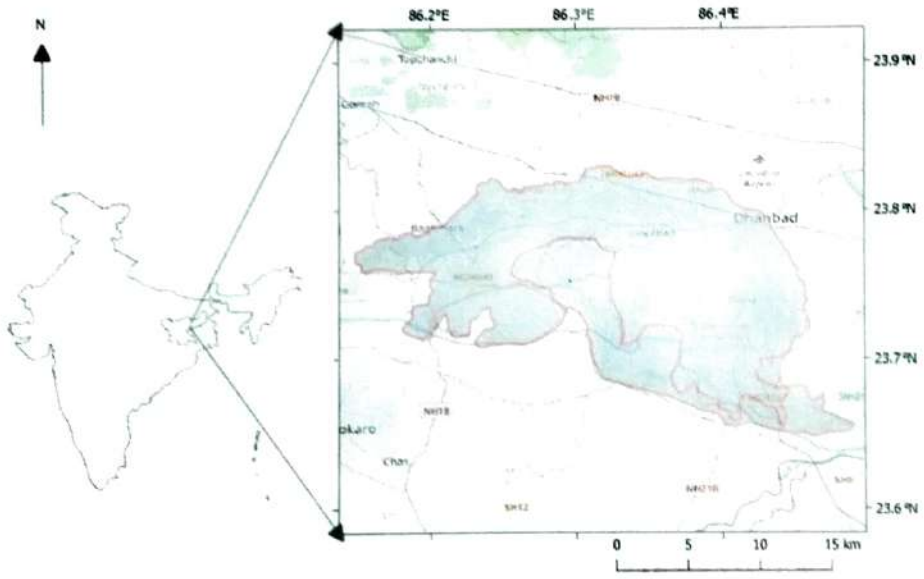


Figure 1.1: Geographical location of Jharia Coalfield in India

1.1. Climate

Dhanbad lies 236 m above the mean sea level and experiences the tropical climate. When compared with the winter, the summers have much more rainfall. The Köppen-Geiger climate classification is Aw (Tropical wet-dry climate) and experiences an average temperature of 25.9 °C and 1203 mm of precipitation falls annually. The driest month is December. There is 3 mm of precipitation in December. In July, the precipitation reaches its peak, with an average of 321 mm. With an average of 32.5 °C, May is the warmest month. At 18.4 °C on average, January is the coldest month of the year. The windrose for the March-June months is presented in Figure 1.2.

1.2. Land use & Land cover

In the present investigation, the Jharia coalfield area (2827.43 sq km) has been undertaken to study the Land use land cover (LULC), For this study, Sentinel-2A satellite image is used in the month of 17 February 2019 having a minimum cloud. These images were downloaded from the United States Geological Survey (USGS) Earth Explorer. Each Sentinel 2A satellite imagery band was geo-referenced to the WGS_84 datum and Universal Transverse Mercator Zone 45 North coordinate system. The Sentinel 2A satellite image stacking of the band-2, band-3, band-4 and band-8 of 10 m resolution was performed on the ArcGIS 10.5 software for studying the LULC of the Jharia coalfield.

For LULC classification, supervised classification was carried out in the study area. Thus allocations of each classified area in sq. km and its percentages are tabulated in Table 1.1. The percentage of areas as classified as; agriculture (74.5%), barren land (7.45%) built-up areas (5.14%), mining (2.64%), vegetation (9.40%) and water body (0.86%) (Figure 1.2).

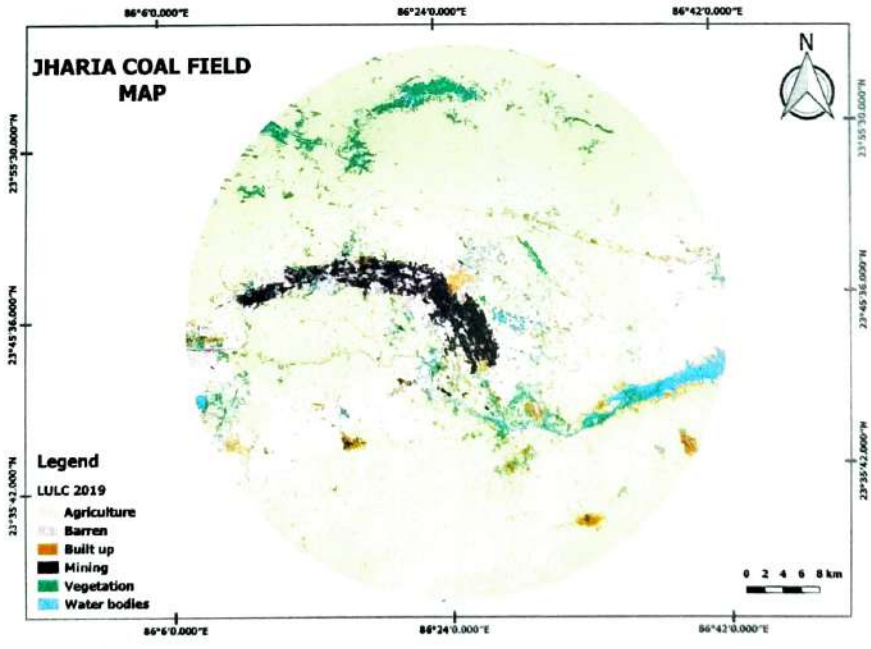


Figure 1.2: Land Use land cover map of Jharia coal field area

Table 1.1: LULC classification of Dhanbad study area

Sr. No	Name	Area in sq. km	Area in %
1.	Agriculture	2106.7	74.51
2.	Barren	210.64	7.45
3.	Built up	145.31	5.14
4.	Mining	74.67	2.64
5.	Vegetation	265.74	9.40
6.	Water bodies	24.37	0.86
Total		**2827.43**	**100**

1.3. Population

The study area covers four district boundaries; namely Dhanbad (1710.2sq km), Bokaro (620.43sq km), Giridih (29.8sq km) in Jharkhand and Puruliya (465.85sq km) district in West Bengal state. The Dhanbad district covers the maximum study area and the population is around 23, 94,434 in the year 2001 and is around 26,84,487 in 2011. The Bokaro district total population is in 2001 is 17, 75,961 and in 2011 it is 20, 62,330. The Giridih district total population is 19, 01,564 in 2001 and is 24,45,474 in 2011. The Puruliya district in West Bengal state total population is in 2001 is 25, 35,233 and in 2011 are 29, 30,115.

Based on the covered study area the total population in the study area is tabulated in Table 1.2. The total population in the study area based on Census book 2001 is 25,32,195 and 2011 is 28,62,600.

Table 1.2: Population in the study area as per 2011 census

District Name	District Area Covered by Study Area	% of Area Covered of District by Study Area	Population of 2001	Population 2001 in Study Area	Population of 2011	Population 2011 in Study Area
Bokaro	620.43	21.50	17,75,961	3,81,791	2,062,330	4,43,353
Dhanbad	1710.2	81.51	23,94,434	19,51,645	2,684,487	21,88,060
Giridih	29.8	0.59	19,01,564	11,275	2,445,474	14,500
Puruliya	465.85	7.40	25,35,233	1,87,484	2,930,115	2,16,686
Total	2826.28		Total Population 2001	25,32,195	Total Population 2011	28,62,600

1.4. Purpose of Study

Urban air pollution is a notable concern across the world. Inferring to the rapid rates of industrialization and urbanization in Indian cities, polluted air quality is considered a key factor in crumbling the quality of life with an adverse effect on the human being. Hence air quality gained a significant role in recent decades since it is worsened by emission from major pollutants including particulate matter (PM_{10} and $PM_{2.5}$), NO_2, SO_2 and O_3 were found to exceed the national ambient air quality standard (NAAQS) limits.

Particulate pollution is a major concern in the field of air pollution. The particulate matter in the air result from dispersion of dust from industrial (mining and non-mining) and allied activities, transportation, local vehicular movement and domestic fuel (Coal, wood-burning etc.) burning. Assessment of the air quality can provide useful insight for the development of the air quality management plan. The database developed on air quality also helps the regulatory agency identify the locations where natural resources and human health could be at risk.

Jharia coal mines having low ash content and high calorific value coals are subjected to intensive mining activities because of the easy availability of coal at shallow depths in thick seams. Therefore, they are often used directly in iron and steel plants for metal oxide reduction after washing. Although these coal mines are highly-priced for their high-quality coal, they are notorious for their mine fires, which cause a lot of fugitive gaseous and PM emissions. Hence, the Jharia region has been under scrutiny by various public authorities and the common public with a vision to improve the ambient air quality.

Various sources contribute to high particular matter concentration in the Jharia region: vehicles, mining activities, re-suspended dust, fugitive emissions, fuel oils, household LPG. The percentage contribution of these factors in the ambient depends exclusively on a particular region's economic activities. To improve the existing ambient air quality, the major sources of PM emissions first need to be identified.

Hence, the environmental clearance committee of MoEFCC has directed BCCL to conduct a source apportionment study for particulate matter. In this context, BCCL has approached CSIR-NEERI to conduct a source apportionment study of ambient air particulate matter in the Jharia coalfields region to quantify the various sources of PM emissions and suggest an effective environmental management plan.

The study's major objective is to assess the current ambient air quality, sources of air pollution, and propose the priorities for the actions for improvement of air quality. The study includes the entire Jharia Coalfield and an area up to 10 Km from the periphery/boundary of BCCL mines.

The detailed objectives are as follows:

i. Ambient Air Monitoring

- Monitoring of ambient air quality at selected receptor locations for pollutants including PM_{10}, $PM_{2.5}$(limited), SO_x, NO_x, PAHs to establish the status of the air quality in Jharia Coalfields and an area up to 10 K.M from the periphery/boundary of BCCL mines. Also, review of the available air quality monitoring data from Central Pollution Control Board (CPCB) /Jharkhand State Pollution Control Board (JSPCB).
- To validate dispersion modelling predictions using measured air quality parameters
- To draw supportive data through the specific site-related monitoring regarding impact causing sources such as kerbside monitoring
- To establish the impact of meteorological conditions on a few select indicator pollutants in different micrometeorological conditions of the Jharia Coalfields

- Emission Inventory related to Jharia Coalfields along with area up to 10 Km from the periphery/boundary of BCCL mines

ii. To identify the pollution load grid wise for point, line and area source

- To establish possibilities of receptor level concentrations of air pollutants by matching dispersion modelling and air quality monitoring data
- Source apportionment
- To identify and apportion the pollution load at receptor level to various sources in the Jharia Coalfields along with an area up to 10 Km from the periphery/boundary of BCCL mines
- To carry out the source apportionment using molecular markers for a limited number of samples through a time-resolved sample collection at various periods of the day and day-of-the-week.
- Any other item in consensus between both BCCL/CIL & NEERI evolved during the study.

1.5. Approach of study

The study approach has many components, each one of them having its importance and interdependence as shown in Figure 1.3. The ultimate objective is source apportionment of ambient air of JCF that primarily requires knowledge of ambient air quality status, sources and emission load. These three objectives were achieved by monitoring air pollutants at 13 locations in Jharia Coalfield using various instruments and multiple analyses. These locations were selected based on land use and activity profile. All monitoring was carried out using varied instruments and all attributes were analysed using standards methodologies. The study's methodology of the study was divided into three parts namely ambient air quality monitoring, sources emission inventory and source apportionment analysis.

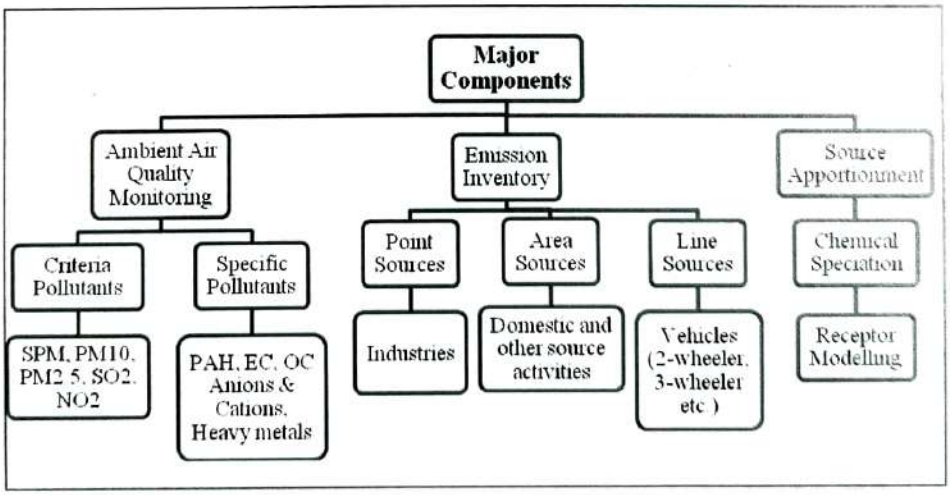


Figure 1.3: Air quality Monitoring & emission source apportionment studies

Chapter 2 Emission Inventory

This section consists of all methodologies that have been applied for the emission inventory and dispersion modelling in the Jharia Coalfield. The emission inventory is the process to identify the possible source and its contribution. Emission inventory and dispersion modelling are based on the primary data collection to calculate emission load from a particular source. It provides fundamental information for air quality modelling and air pollution control strategy development. In the coal mining area, mining, non-mining, industrial, vehicular and other sources are contributing. Air quality monitoring includes the suitable location selected based on the metrological conditions, chemical characterization for identification of the source, CMB model to estimate the source apportionment to $PM_{2.5}$.

Air pollutant emission inventory is a process to identify the possible sources and their contribution. It provides fundamental information for air quality modelling and air pollution control strategy development. Mining, non-mining, industrial, vehicular and other sources are contributing to critical coal mining zone like JCF, India. According to possible emission sources, sources are divided into three categories like point sources, area sources and line sources. The inventory of these sources is important to make a proper source profile.

2.1. Inventory of Point Sources

A point source of pollution is a single identifiable source that is responsible for significant pollution load in the study area, like thermal power stations. A comprehensive list of different point-like industries in the study area was obtained from the regional office of the Jharkhand State Pollution Control Board (JSPCB), at Dhanbad. The industries specific information of includes production capacities, raw material used, manufacturing process, fuel consumption, etc. also collected from the regional office by the CSIR-NEERI team.

2.2. Inventory of Area Sources

Area sources are sources of pollution that emit a substance or radiation from a specified area. Mining activities, domestic/hotel fuel (coal) burning, garbage burning, etc. are the major contributor to area sources. In order to assess the fuel consumption in the study area, the necessary information was collected through surveys at petrol pumps, hotels and restaurants, bakeries, open eat out and crematoria. Also, surveys collected data on the seasonal implication of fuel used particularly wood and coal. The data on trash burning and solid waste generated in the study were collected from Municipal Corporation Dhanbad.

2.3. Inventory of Line Sources

Vehicles contribute a whole range of HCs besides contributing SO_x, NO_x (as NO_2), HC and lead. Diesel vehicles are the primary source of smoke and NO_x in addition to CO and HCs. However, CO and HCs per litre of fuel consumed by diesel vehicles in relatively low compared to gasoline-powered vehicles. In gasoline-powered vehicles, the exhaust is the major source of pollution that contributes 100 % CO and NO_x and 80% of HCs emitted to the atmosphere. The remaining 20% of HCs are emitted from crankcase blow-by and evaporative emissions. In the

two-stroke engine, the crankcase blow-by is absent. The exhaust emissions are the principal sources of pollutants emitting about 40% of fuel supplied without burning due to short circulating, contributing high concentration of HCs. In diesel vehicles, practically all pollutants are emitted through exhaust gases and the contribution to crankcase blow-by and evaporative fuel emission are negligible.

Though the quantity of pollutants emitted by the vehicles is directly proportional to the number of vehicles playing on the road, the intensity of pollution potential depends on several contributory factors such as a geographical location, unplanned development of central business areas, inadequate and ill-maintained road as well as the type of vehicle, unplanned traffic management, meteorological conditions, and non-availability of adequate emission control technology.

Vehicle activity data were collected during the field campaign at 12 road networks in the study area, and the daily average vehicular activity is presented in Table 2.1.

Table 2.1: Daily average vehicle activity on different road network considered during the field survey

Label	Road Network	HDV	LMV	3W	2W	Total
L1	Jharia to Lodna -5 km	1254	1385	3640	9560	15839
L2	Pathardih to Sindri -7 km	1539	5356	4362	15633	26890
L3	Bastacola to Pathardih -13km	2153	8325	3678	10233	24389
L4	Bhuli to Bankmore - 6km	1475	13832	12965	18241	46513
L5	Katras to Harina–12.5 km	1802	7290	3156	15329	27577
L6	Bankmore to Kusunda -5 km	658	2685	1896	10235	15474
L7	Kusunda to Katras - 10 km	1306	4521	5327	15689	26843
L8	Monidih to Kusunda -7 Km	1208	7659	3985	14698	27550
L9	Lohpiti to Mahuda Area Colony - 8 km	1535	4523	2235	6356	14649
L10	Mahuda to Parasia Chowk -7 km	1223	4023	1759	5623	12628
L11	Parasia Chowk To Moonidih - 3 km	269	2159	236	2347	5011
L12	Bhowra to Parbatpur - 13 Km	2135	7856	4258	14578	28827

The vehicle utilization factors (km travelled per day per vehicle type) were adapted from the Auto Fuel Policy Report (Table 2.2). Two-to-four-wheelers Emission factors were taken from various project reports conducted by CPCB and Indian Clean Air Programmed (ICAP) (CPCB 2010; ARAI 2007). The percentage distribution of various types of vehicles moving on the road network considered during the field survey is presented in Fig 2.1. It shows that major numbers of vehicles moving in the considered Road network are two-wheelers (51%), followed by light motor vehicles (26%), three-wheeler (17%) and heavy-duty diesel vehicles (6%).

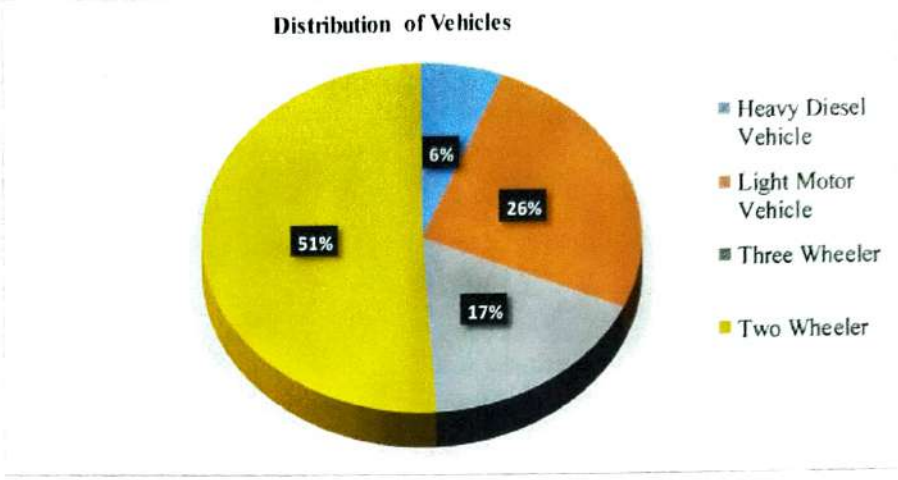


Figure 2.1 Percentage of different types of vehicle surveyed on the road network during the field survey

Table 2.2: Utilization Factors for different types of vehicle

Vehicle Type	km per day
LMV (Car Jeep)	52.6
LMV (Taxi)	77.89
2 Wheeler	25.1
3 Wheeler (Auto)	97.72
HCV	45.5

2.4. Methodology

The following method is adopted to estimate the emission load due to vehicles

$$E_i = N_v \times VKT \times E_f \quad (2.1)$$

Where, E_i is the emission from a particular type of vehicle

N_v is the number of vehicles of a particular type

VKT is the vehicle km travelled

E_i, km is the emission factor for a specific vehicle

Table 2.3: Emission estimate for road transport

Label	Road Network	Emission (kg/day)	
		PM_{10}	$PM_{2.5}$
L1	Jharia to Lodna -5 km	230.12	113.08
L2	Pathardih to Sindri -7 km	379.07	180.37
L3	Bastacola to Pathardih -13km	632.21	451.98
L4	Bhuli to Bankmore - 6km	331.41	187.69
L5	Katras to Harina–12.5 km	719.42	415.63
L6	Bankmore to Kusunda -5 km	308.69	194.34
L7	Kusunda to Katras - 10 km	576.31	277.95
L8	Monidih to Kusunda -7 Km	317.83	114.25
L9	Lohpiti to Mahuda Area Colony - 8 km	360.24	151.99
L10	Mahuda to Parasia Chowk -7 km	241.56	148.24

L11	Parasia Chowk To Moonidih - 3 km	94.26	57.23
L12	Bhowra to Parbatpur - 13 Km	592.82	379.80

Re-suspension of the unpaved and paved roads depends on the 'silt loading' factor and 'vehicles weight' roaming on the road (Table 2.4). The silt loading (S_L) is the mass of the silt-sized material per unit area of the road surface. The amount of dust produces by vehicles movement on a paved road can be appraised by the following equation:

$$E = k. (SL/2)^{0.65} . (W/3)^{1.5} \quad (2.2)$$

Where, 'E' = emission rate of PMs (Table 2.3);

SL is silt load (g/m2);

W is the average weight of the vehicle (Tons);

k is constant (the function of particle size) in g VKT^{-1} (Vehicle Kilometer Travel)

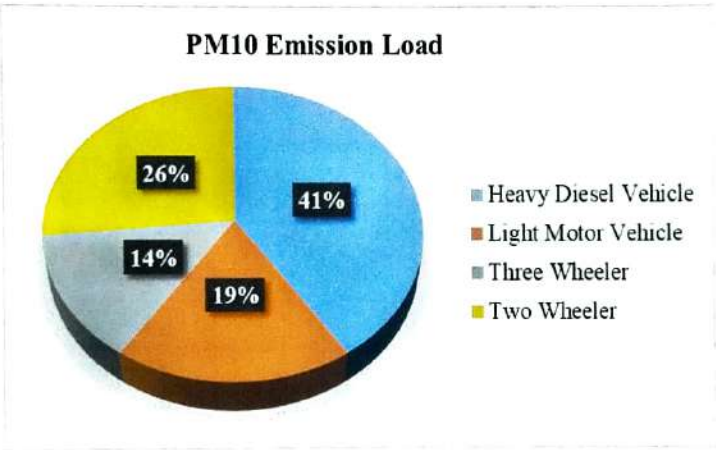


Figure 2.2 PM_{10} emission load for different categories of vehicle

It is observed that 41% of PM_{10} emission is contributed by the Heavy-duty diesel vehicles followed by two-wheelers (26%), Light motor vehicles (19%) and three-wheelers (14%) in the considered road network during the study period.

Table 2.4: Emission rate for the paved and unpaved road

	Emission Rate	
Emission Sector	**PM_{10} (kg/day)**	**$PM_{2.5}$ (kg/day)**
Re-suspension dust from Paved & Unpaved Road	1756	843

2.5. Results

2.5.1. Industrial Emission

Emission inventory estimates are determined based on considering available industrial activity information, emission factors (Table 2.5) and observations. For the current study, industrial and mining information was collected for emission inventory development. Emission inventory information for industries was collected from the regional office of JSPCB. In Dhanbad, the major industries are the power plant and the coking industry. Other

than those are coal mines, thus coal as a fuel is majorly used in industries and households. Emission loads by point source are depicted in Table 2.6 as per emission inventory.

Table 2.5: Emission factor for coal mining activities

EF	TSP	PM_{10}	$PM_{2.5}$	SO_2	NO_2
g/Mg Coal	1914	1864	1176	420	820

Table 2.6: Emission load from Industrial sector in Dhanbad

Sr. No	Name of Industry	Type of Fuel	Fuel consumption	Unit	TSP (Ton/ yr)	PM_{10} (Ton/ yr)	$PM_{2.5}$ (Ton/ yr)	SO_2 (Ton/ yr)	NO_2 (Ton/ yr)
1	M/s Mahalaxmi Industries	Coal	4	MT/Oven/ cycle (24hrs)	2.79	2.72	1.72	0.61	1.20
2	GEETEE Hard Coke Traders	Coal	100	TPD	69.86	68.04	42.92	15.33	29.93
3	M/s Shree Gopal Coke Industries	Coal	77.4	TPD	54.07	52.66	33.22	11.87	23.17
4	M/s Laxmi Hard coke Manufacturing Company	Coal	102	TPD	71.26	69.40	43.78	15.64	30.53
5	M/s - Sanjay Hard Coke Industries	Coal	70	TPD	48.90	47.63	30.05	10.73	20.95
6	M/s Inder Hard Coke Industries	Coal	36	TPD	25.15	24.49	15.45	5.52	10.77
7	M/s Shiv Shakti Coke Industries	Coal	80	TPD	55.89	54.43	34.34	12.26	23.94
8	Khetawat Coke Manufacturing Company	Coal	4.5	MT/ Oven/ Batch (24hrs)	3.14	3.06	1.93	0.69	1.35
9	M/s Pawan Hard Coke Industries	Coal	100	TPD	69.86	68.04	42.92	15.33	29.93
10	M/s Ganapati Udyog	Coal	135	TPD	94.31	91.85	57.95	20.70	40.41
11	M/s Aman Soft Coke Industries	Coal	29.76	TPD	20.79	20.25	12.77	4.56	8.91

2.5.2. Area/Distributed source

An area source emission inventory estimates the pollutant loads emanating from several small but numerous individual sources in a specific geographic area and which cannot be included underline no point sources.

Area sources considered for emission inventory for Dhanbad city are:

- Cooking operations in households: Slum and non-slum
- Cooking operations in hotels, restaurants, open eat-outs and bakeries
- Crematoria

The following sections will detail the methodology adopted for estimating emissions from each of the above-mentioned sources and the results thus obtained.

- **Emission load from mining activities**

The emission loads from coal mine activities are depicted in Table 2.7. The emission load is calculated based on the secondary data collected from the BCCL mines covered in the study. The data includes coal and overburden quantity handled per day during loading and unloading, transfer from pit to stockyard through haul road and conveyor, vehicular movement frequency and diesel consumption for HEMM and DG sets. Emission factors from EEA air pollutant emission inventory guidebook 2019 were considered for the estimations of TSP and PM load.

Table 2.7: Emission load from coal mine activities in Jharia coalfield region

Mine	Area (m^2)	PM_{10} (Tone/y)	$PM_{2.5}$ (Tone/y)
ABOCP	2355283	156.1	78.0
ADI Colliery	1444818	47.9	23.9
ASP Colliery	19540	27.7	13.8
Bhowra south	78079	26.9	13.4
Block IV Govindpur	432827	22.5	11.2
DBOCP	605747	64.7	32.4
East Bassuriya Colliery	576494	24.3	12.2
Gopalichuck Colliery	37573	3.7	1.9
Jeenagora OCP	2079123	208.0	104.0
Kuya OCP	1134723	90.1	45.1
NAKC	245205	78.3	39.1
NGK	261847	126.0	63.0
Nichitpur colliery	791140	61.4	30.7
Phularitand colliery	335887	84.1	42.1
Rajapur OCP	1170784	90.4	45.2
Sendra Bansjora	472760	63.0	31.5
Shatabdi colliery (Muraidhih)	34270	77.0	38.5
Tetulmari	876320	23.3	11.7
Total		**1275.4**	**637.7**

- **Cooking operations in non-slum household**

A survey of 20 non-slum household areas was conducted in randomly selected areas of Dhanbad to understand which fuels are being used in these households and their quantities. The survey results indicated that Liquefied Petroleum Gas (LPG) was the fuel of choice in all the households and that each household used about 1 cylinder per month on average. It was assumed that LPG use remains the same for all 365 days of the year. The results obtained are presented in Table 2.8.

Table 2.8: Emissions from the use of LPG in non-slum households in Dhanbad

LPG Pollutant	PM_{10}	SO_2	NO_2	CO	HC
Emission Factor (g/kg)	2.1	0.4	1.8	0.25	0.07
Emission (T/Year)	0.00575	0.0011	0.0049	0.0007	0.0002

- **Cooking operations in slum households**

A survey of 15 areas having slum households was conducted, spread in Jharia Coalfield which was known to have significant slum populations, to understand which fuels are being used in these households and their quantities. It was seen that a majority of the slum households use coal as a cooking fuel (Table 2.9).

Table 2.9: Emission from coal as fuel

Pollutant	SPM	SO_2	NO_2	CO	HC
Emission Factor (g/kg)	20	13.3	3.99	24.92	0.5
Emission (T/Year)	28.354	18.856	5.657	35.330	0.709

- **Emissions from crematorium**

In order to calculate emission from crematoria data were obtained from crematoriums in Dhanbad. Emission from the burning of bodies using woods mainly produces PM_{10}, CO and HC majorly as depicted in Table 2.10.

Table 2.10: Emission from Crematoria using Wood as fuel

Pollutant	PM_{10}	SO_2	NO_2	CO	HC
Emission Factor (g/Kg)	17.3	0.2	1.3	126.3	114.5
Emission (kg/day)	7.178	0.083	0.537	52.183	47.308

- **Emissions from bakeries**

Data were collected from 34 bakeries operating in Dhanbad in which 12 bakeries were using electrical ovens. The emissions from such bakeries were not considered. All the other bakeries were using coal as fuel. Emissions from such bakeries are given in Table 2.11.

Table 2.11: Emission from Bakeries using Coal as fuel

Pollutant	SPM	SO_2	NO_2	CO	HC
Emission Factor (g/kg)	20	13.3	3.99	24.92	0.5
Emission (T/Year)	6.26	4.16	1.25	7.80	0.16

- **Emissions from hotels and restaurants**

Data were collected from 35 hotels in Dhanbad city. It has been found that most hotels/restaurants were using a combination of coal and LPG as cooking fuel. Emission

from coal and LPG were calculated and depicted in Table 2.12 and 2.13.

Table 2.12: Emission from Hotel & Restaurants using Coal

Pollutant	SPM	SO_2	NO_2	CO	HC
Emission Factor (g/kg)	20	13.3	3.99	24.92	0.5
Emission (T/Year)	8.110	5.393	1.618	10.105	0.203

Table 2.13: Emission from Hotel & Restaurants using LPG

Pollutant	PM_{10}	SO_2	NO_2	CO	HC
Emission Factor (g/kg)	2.1	0.4	0.8	0.25	0.07
Emission (T/Year)	0.136	0.026	0.117	0.016	0.005

- **Emission from open eat-outs**

From the survey it has been observed that most of the open eat-outs were using coal as cooking fuel, only a few were using LPG (Table 2.14).

Table 2.14: Emission loads from open eat-outs

Pollutant	SPM	SO_2	NO_2	CO	HC
Emission Factor (g/kg)	20	13.3	3.99	24.92	0.5
Emission (T/Year)	14.07	9.36	2.81	17.54	0.35

2.5.3. Grid wise emission inventory

The grid-wise particulate emission inventory maps were prepared from the primary and secondary data collected during the field surveys and the information received from the open cast mines, respectively. The PM emissions from restaurants, eat-outs, domestic chullahs, vehicles, crematoria, etc. were estimated based on the primary data obtained from the filed campaigns, whereas, the emissions from the mine operations were estimated based on the data received from the mines and the emission factors reported in the literature. Once the emissions rates were estimated, the cumulative emissions (including all types of sources like line, point, and area) were calculated falling under the grid defined (shown in Figure 2.3 and Figure 2.4). From the figures, it can be interpreted that the PM emissions are high on the northeast side of the study area. Whereas, the actual transport and dispersion of these emissions can be interpreted through the dispersion modelling carried out using the AERMOD model.

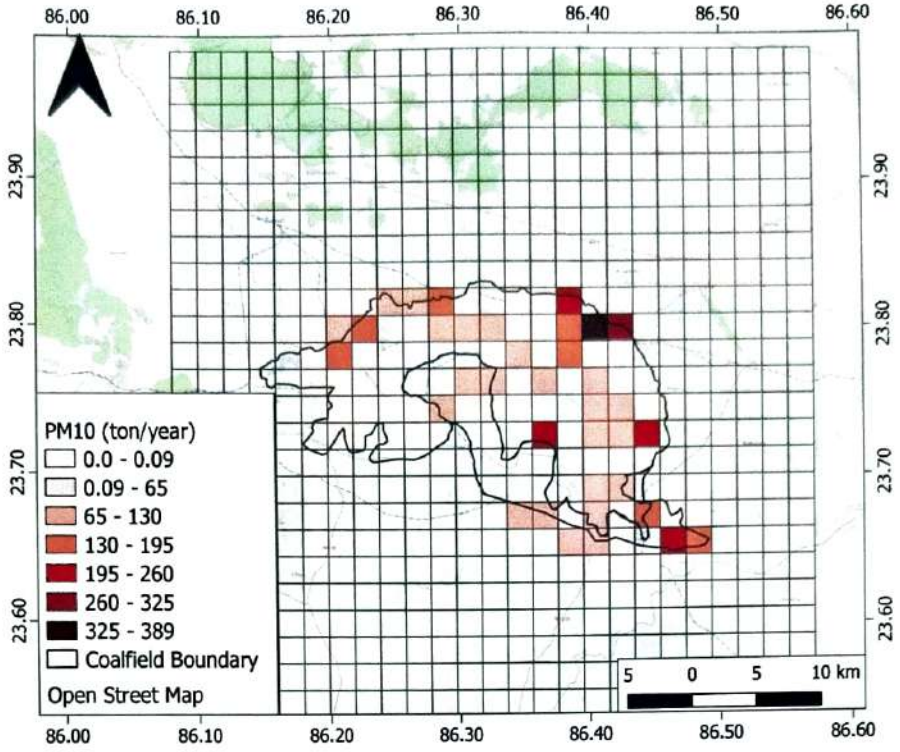


Figure 2.3 Grid-wise emission inventory of PM_{10} in tons/year over the study area

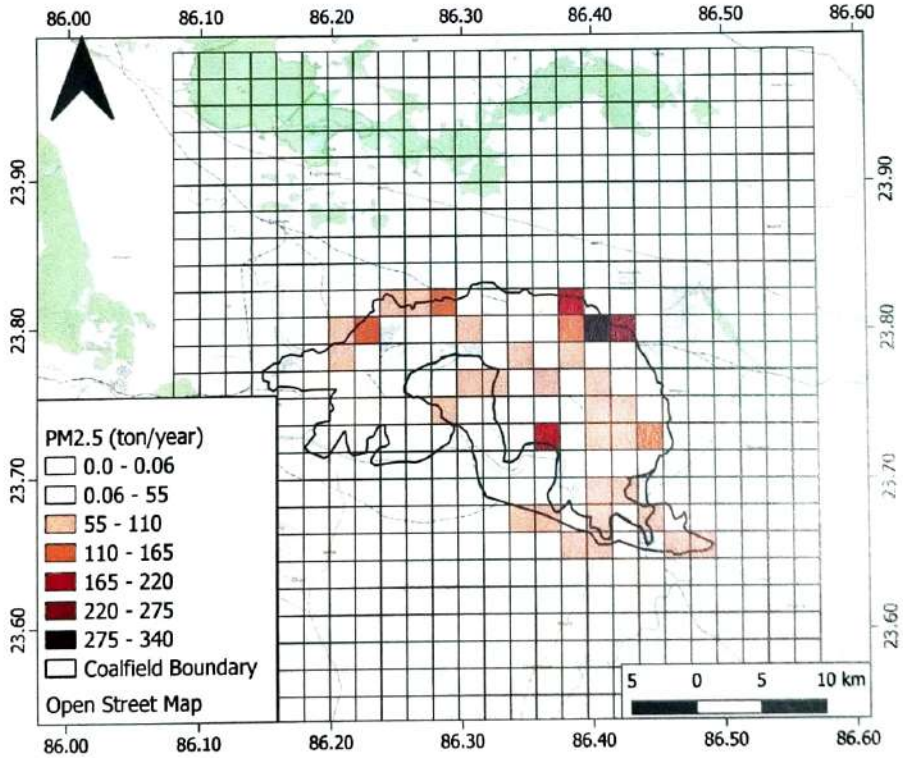
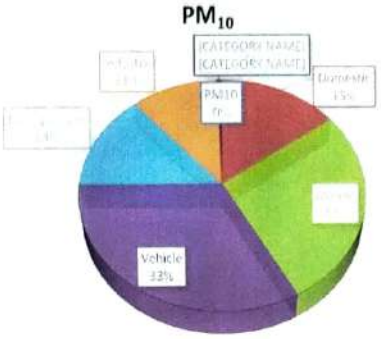


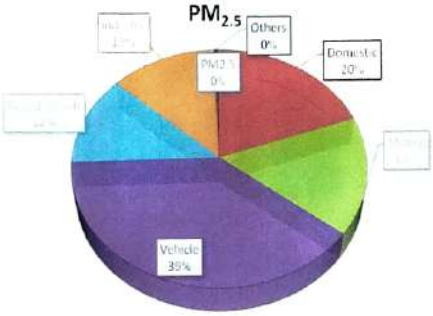
Figure 2.4 Grid-wise emission inventory of PM2.5 in tons/year over the study area

The respective share of various emission sources is represented through pie diagrams shown in Figure 2.5. Data shows that PM_{10} emissions are contributed mostly from vehicular emissions

followed by emissions from the mines whereas, $PM_{2.5}$ emissions are contributed mostly from vehicular emissions, domestic burning and mine activities. The grid-wise emission inventory maps and the information on the pollution sources provide the basis for the policymakers to target the hotspots of pollution generation in order to take effective mitigation actions.



(a)



(b)

Figure 2.5 (a) and (b) represents emission load from various sectors over JCF region for PM_{10} and $PM_{2.5}$ respectively

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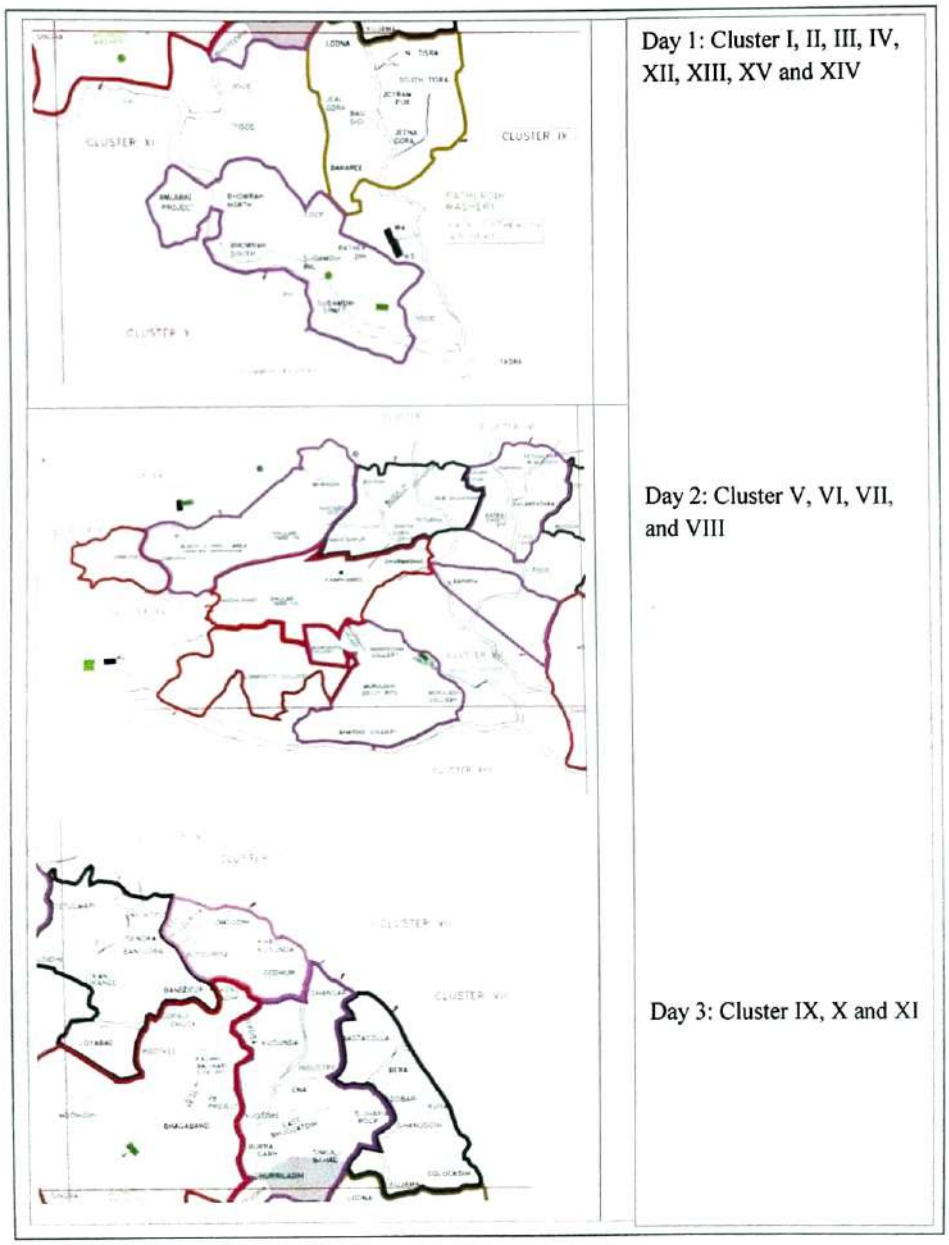
Chapter 3 Air Quality Monitoring and Receptor modelling

BCCL environmental department provided the map of the Jharia region. The site visit was carried out with assistance from BCCL's team. The 15 Jharia mines coal fields were segregated into three parts. The details of the visit and mine cluster names are given in Table 3.3.1. The Entire Jharia Coal Field (JCF) is divided into 16 clusters. Both open cast and underground mines are operational in JCF. Standard mining operations like drilling, blasting, hauling, accumulation, and transfer are the major sources of emissions and air pollution. Apart from that, a typical emission source, mine fire, is prevailing at JCF. Besides, JCF encompasses large non-mining regions with their emission sources like vehicular emission in congested traffics, road dust, Power Plant emission, other industrial emissions (coke oven plants, brick kilns, stone crushers, etc.), crematoria, domestic burning, open burning, etc.

Table 3.3.1: The details of mine cluster in Jharia Coalfield



Based on preliminary field visit by NEERI Scientists along with BCCL staffs, the following locations (Figure 3.1) were selected for the establishment of Air Quality Monitoring Stations for source apportionment study;

- **Core Zone**

1. Cluster XIV Lohapatty– nearby sources: Chandrapura Thermal Power Plant
2. Cluster VII Mine rescue station- nearby sources: Coal Mine, Industry
3. Cluster V- Katras
4. Cluster IX Lodhna
5. Cluster XI Moonidih nearby sources: Coal Mine
6. Cluster X Patherdih: nearby sources: Coal Mine, Steel Industry
7. Cluster VIII Bastacola nearby sources: Coal Mine

- **Buffer Zone**

8. Bank More
9. Harina
10. Bhuli
11. Sindri
12. Parbatpur Electro steel/ Bhaga
13. Background

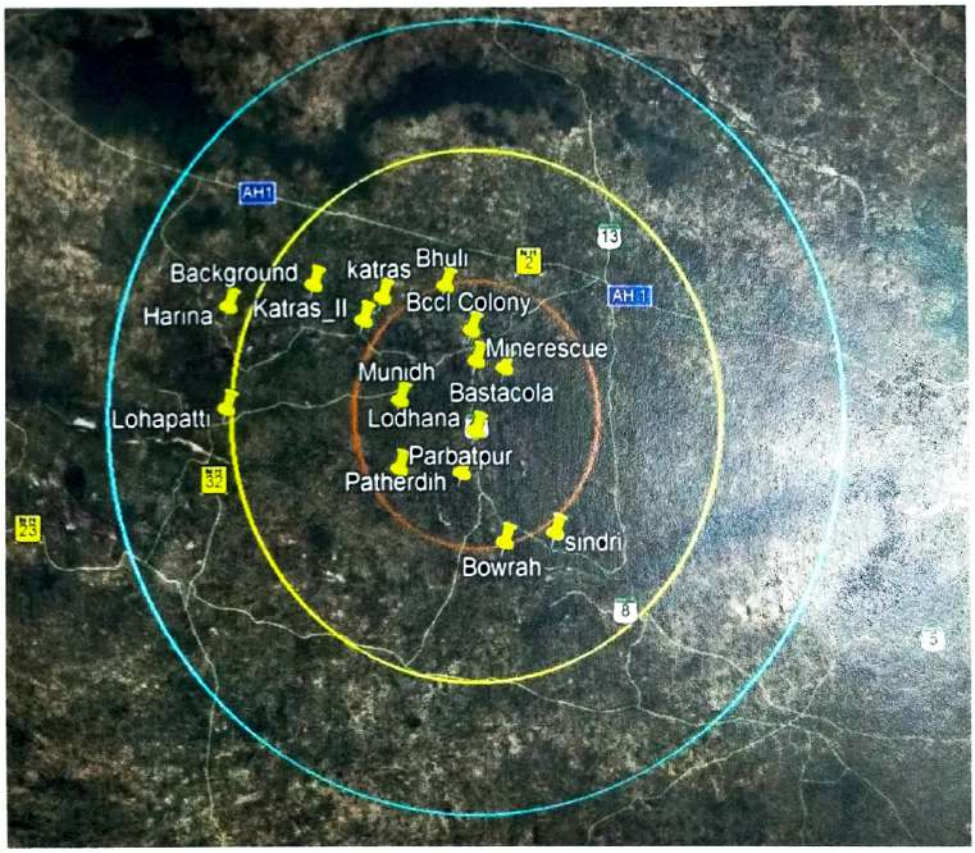


Figure 3.1: Air monitoring sites under 30 km buffer area

3.1. Sampling Method and Schedule

The PM_{10} and $PM_{2.5}$ sampling for Jharia Coalfields was done at all the 13 sampling sites for the period of 24 h using low volume respirable suspended particulate matter samplers (Instrumax, ARA and Envirotech) on Quartz and polytetrafluoroethylene (PTFE) filter paper of 47 mm diameter. Samplers at a flow rate of 16.67 LPM were used. The filter papers were desiccated before and after sampling for 24h at a temperature of 27 ± 3°C and at a relative humidity (RH) of 55 ± 2% to remove the moisture present in them. The PM_{10} and $PM_{2.5}$ field samples were collected periodically throughout the sampling period. The sampling frequency and types of equipment used for monitoring are described in Table 3.3.2 and 3.3.3. The national Ambient quality and Standards for Coal Mines (Stipulated by Ministry of Environment and Forests are depicted in Table 3.3.4. and Table 3.3.5.

Table 3.3.2: Frequency of Air pollutants sampling in Jharia Coalfields

Parameter	Number of Days	Change of Filter/ absorbing media	Reporting
PM_{10}	10	24 hourly, Teflon: 5 Days Quartz: 5 Days	24 hourly
$PM_{2.5}$	10	24 hourly Teflon: 5 Days Quartz: 5 Days	24 hourly
NO_2	10	8 hourly	8 hourly
SO_2	10	8 hourly	8 hourly

Table 3.3.3: Ambient Air Quality Sampling/Analysis Methodology for Target Pollutants

Particulars	Parameters			
	PM_{10}	$PM_{2.5}$	NO_2	SO_2
Sampling Instrument	INSTUMEX and ARA-N-FRM Sampler	INSTUMEX and ARA-N-FRM Sampler	APM sampler	APM sampler
Sampling Principle	Cyclonic Flow Technique	Cyclonic Flow Technique	Chemical absorption in suitable media	Chemical absorption in suitable media
Flow rate	16.7 LPM	16.7 LPM	0.5 LPM	0.5 LPM
Sampling Period	24 hourly	24 hourly	8 hourly	8 hourly
Sampling Frequency	7 days continuous, Teflon and quartz on alternate days	7 days continuous, Teflon and quartz on alternate days	7 days continuous	7 days continuous
Analytical Instrument	Electronic Micro Balance	Electronic Micro Balance	Spectrophotometer	Spectrophotometer
Analytical Method	Gravimetric	Gravimetric	Modified Jacob and Hochheiser method	Colorimetric Improved West & Gaeke Method
Minimum reportable value	5µg/m^3	5µg/m^3	9µg/m^3	4µg/m^3

Table 3.3.4: National Ambient Air Quality Standards (2009)

Sr. No.	Pollutant	Time Weighted Average	Concentration in ambient Air (in µg/m^3) Industrial, Residential Rural & Other Areas	Concentration in ambient Air (in µg/m3) Ecologically Sensitive Area	Concentration In ambient Air (in µg/m^3) Methods of Measurement
1	Sulphur Dioxide (SO_2)	Annual*	50	20	Improved West & Geake, Ultraviolet fluorescence
		24Hours**	80	80	
2	Nitrogen Dioxide (NO_2)	Annual*	40	30	Modified Jacob & Hochheiser (Na-Arsenite) Chemiluminescence
		24Hours**	80	80	
3	Particulate matter (Size less than 10µm) or PM_{10}	Annual*	60	60	Gravimetric, TOEM, Beta attenuation
		24Hours**	100	100	
4	Particulate matter (Size less than 2.5µm) or $PM_{2.5}$	Annual*	40	40	Gravimetric, TOEM, Beta attenuation
		24Hours**	60	60	
5	Ozone (O_3)	8 Hours*	100	100	UV photometric, Chemiluminescence chemical method
		1 Hour	180	180	
6	Lead (Pb)	Annual*	0.5	0.5	ASS / ISP method after sampling on EPM 2000 or equivalent filter paper ED-XRF using Teflon filter
		24Hours**	1	1	
7	Carbon Monoxide (CO)	Annual*	0.2	0.2	Non-dispersive Infra-Red (NDIR) Spectroscopy
		24Hours**	0.4	0.4	
8	Ammonia (NH_3)	Annual*	100	100	Chemiluminescence, Indo-phenol's blue method
		24Hours**	400	400	
9	Benzene (C_6H_6)	Annual*	0.5	0.5	Gas Chromatography based continuous analyzer. Adsorption and description followed by GC analysis
10	Benzo (a) Pyene (BaP)-particulate phase only	Annual*	0.1	0.1	Solvent extraction followed by HPLC / GC analysis
11	Arsenic (As)	Annual*	0.6	0.6	AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni)	Annual*	20	20	

Table 3.3.5 Standards for Coal Mines (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)

Pollutant	Time weighted Average	Concentration in Ambient Air	
		New Coal Mines (commenced after 25.09.2000)	Existing Coal Mines (commenced prior to 25.09.2000)
Suspended Particulates Matter (SPM)	Annual Average 24 hours	360µg/m3 500µg/m3	430µg/m3 600µg/m3
Respirable Particulate Matter (size less than 10 µm) (RPM)	Annual Average 24 hours	180µg/m3 250µg/m3	215µg/m3 300µg/m3
Sulphur Dioxide (SO_2)	Annual Average 24 hours	80µg/m3 120µg/m3	80µg/m3 120µg/m3
Oxides of Nitrogen as NO_2	Annual Average 24 hours	80µg/m3 120µg/m3	80µg/m3 120µg/m3

3.2. Chemical Analysis

3.2.1. Gravimetric analysis

The exposed filters were analysed by gravimetric technique using a weighing balance for PM_{10} particles and using a microbalance for $PM_{2.5}$ particles with a precision of 5µg with automatic (internal) calibration.

3.2.2. Elemental analysis

PM_{10} samples collected on glass fibre filters were digested in a microwave digester. The samples were made up to 50ml using deionized distilled water. Similarly, the exposed filters containing $PM_{2.5}$ particles were cut equally into 2 halves. A part of the exposed filter was used for ions analysis. Whereas, the other half was cut into tiny fragments and digested and made up to 15mL using distilled deionized water. The obtained samples (both PM_{10} and $PM_{2.5}$) after digestion were stored in vials and refrigerated at 4°C until further analysis. These samples were later subjected to estimate the elemental composition using ICP-OES (Thermo Scientific, USA)

3.2.3. Analysis of SO_2 and NO_2

SO_2 analysis: Modified West and Gaeke method was followed for sampling and analysis of Sulfur dioxide in ambient air. SO_2 from the air is absorbed in a solution of potassium tetracholo-mercute (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air was formed. Once formed, that complex was stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex was made to react with pararosaniline and formaldehyde to form the intensely colored pararosanline methylsulphonic acid. The absorbance of the solution was measured by means of a suitable spectrophotometer.

NO_2 analysis: Modified Jacobs and Hochheiser method was followed for sampling and analysis of NO_2 in ambient air. Ambient NO_2 was collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion produced during sampling was determined calorimetrically by the nitrite ion reaction with phosphoric acid, sulphanilamide, and N-(1-napthyl)-ethlylenediamine di-hydrochloride (NEDA) and the absorbance of the highly colored azo dye was measured at 540nm.

3.2.4. Ion analysis

The filter papers containing both PM_{10} and $PM_{2.5}$ samples were extracted and subjected to ion analysis as per standards. The filter papers were divided into tiny fragments and moistened with isopropanol slightly before extraction since the filters are hydrophobic. Further 25 mL of deionized distilled water was added and sonicated using an ultrasonic bath for 60 min at 60°C. The samples were then kept overnight after sonication. Furthermore, the samples were then filtered using nylon filter discs (25mm, 0.45mm) and were refrigerated at 4°C until further analysis. The extracted samples were subjected to IC to analyse the ions (anions and cations) present in them.

3.2.5. Polycyclic Aromatic Hydrocarbons (PAH) analysis

Filter papers were cut into pieces using scissors and transferred to a 100 ml beaker and 50 ml of Dichloromethane (DCM) (GC/HPLC grade) was added. The samples were extracted with DCM using an ultrasonic bath for about 30 minutes. The extracted samples were filtered with Whatman filter paper containing 2gm Anhydrous Sodium Sulphate. After filtration, the filtrate is concentrated using a rotary vacuum evaporator to 2ml final volume. Solid-phase extraction may be used to clean up the impurities of the sample and re-concentrated in a rotary evaporator. The samples were analyzed through GC with conditions as injector 300°C and FID temperature 320°C.

3.2.6. EC & OC analysis

This is a thermal/optical-transmittance (TOT) method that speciates carbon in particulate matter collected on a quartz-fiber filter into OC, EC, and CC. In the first (or non-oxidizing) heating stage, organic and carbonate carbon is thermally desorbed from the filter under a flow of helium with controlled temperature ramps. The oven is then partially cooled, and the original flow of helium is switched to an oxidizing carrier gas (He/O_2). In the second (or oxidizing) heating stage, the original elemental carbon component plus pyrolyzed organic carbon formed during the first heating stage are oxidized/desorbed from the filter with another series of controlled temperature ramps. All carbon evolved from the sample is converted to CO_2 in an oxidizing oven immediately downstream from the desorption oven, and the CO_2 is converted to methane (CH_4) by a methanator oven before being measured with a flame ionization detector (FID). (https://www3.epa.gov/ttnamti1/files/ambient/pm25/spec/RTIOCECSOP.pdf)

3.3. Results

3.3.1. Mass concentration of PM_{10} and $PM_{2.5}$

In summer monitoring, the mean mass concentrations of PM_{10} particles in all 13 sampling sites were found to be in the range of 74-184µg/m^3 with the highest concentration of 184µg/m^3 at mine rescue site and lowest concentration of 74µg/m^3 at Bastacola site. Also, the mean mass concentration of $PM_{2.5}$ particles was found in the range of 49-117µg/m^3 with the highest concentration of 117µg/m^3 and the lowest concentration of 49µg/m^3 recorded at Harina and Lohapatti site respectively.

The average concentrations of PM_{10} and $PM_{2.5}$ in two seasons are described in Table 3.6 and 3.7. Results revealed that the average concentrations of PM_{10} are within the prescribed limits of MoEF notification guidelines for coal mine areas. In the case of $PM_{2.5}$, there is no Govt. notified standard for mining areas but in the case of buffer zones, National Ambient Air Quality Standard, NAAQS, 2009 may be applicable. The highest PM_{10} and $PM_{2.5}$ concentrations were found in Mine rescue and Harina (Figure 3.2 and 3.3).

Table 3.6: Average concentration of PM_{10} and $PM_{2.5}$ in Summer of Jharia Coalfield

Monitoring Sites		Average Concentration (µg/m^3)-Summer	
	Site Description	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
Lohapatti	Core Zone	133.7	49.42
		(83-203)	(44-83)
Mines Rescue	Core Zone	184.8	83.43
		(124-255)	(55-205)
Katras	Core Zone	141.4	80.01
		(100-216)	(42-150)
Lodhna	Core Zone	156.8	63.98
		(100-303)	(32-99)
Moonidih	Core Zone	118.4	62.84
		(80-153)	(34-94)
Patherdih	Core Zone	94.7	67.22
		(50-119)	(37-91)
Bastacola	Core Zone	74.21	62.85
		(52 -209)	(36-96)
BCCL colony	Buffer Zone	157.35	74.37
		(113-222)	(47-103)
Harina	Buffer Zone	177.7	117.3
		(73-265)	(42-175)
Bhuli	Buffer Zone	141.7	105.89
		(85-243)	(44-161)
Sindri	Buffer Zone	122.2	76.05
		(82-139)	(18-127)
Parabatpur	Buffer Zone	122.4	110.98
		(86-171)	(70-150)
Background	Buffer Zone	144.4	57.13
		(24-255)	(23-97)

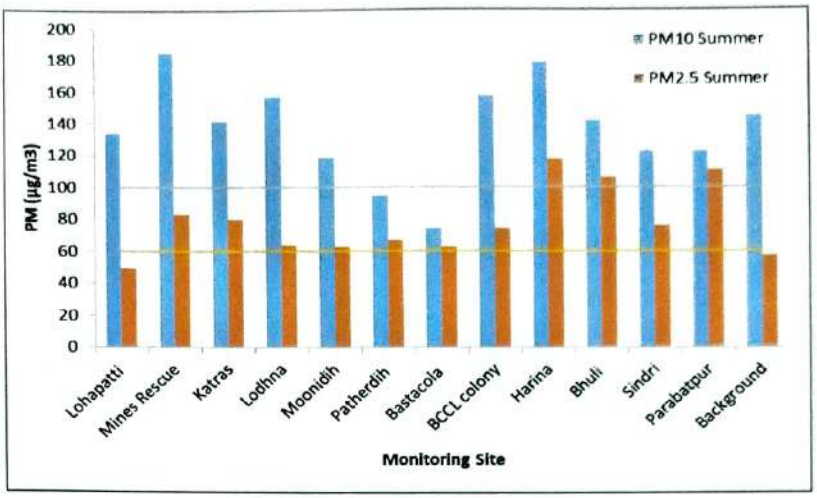


Figure 3.2: Average concentration of PM_{10} and $PM_{2.5}$ in JCF region in summer compared to NAAQS (2009)

Table 3.7: Average concentration of PM_{10} and $PM_{2.5}$ in winter of Jharia Coalfield.

Monitoring Sites	Site Description	Average Concentration (µg/m³)-Winter	
		PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)
Lohapatti	Core Zone	174.28	139.59
		(122-241)	(114-236)
Mines Rescue	Core Zone	303.49	176.97
		(175-350)	(114-233)
Katras	Core Zone	230.06	50.87
		(134-332)	(24-78)
Lodhna	Core Zone	322.8	112.17
		(243-412)	(98-209)
Moonidih	Core Zone	300.16	188.27
		(128-728)	(64-600)
Patherdih	Core Zone	222.71	113.23
		(182-246)	(111-167)
Bastacola	Core Zone	332.05	176.48
		(251-663)	(54-425)
BCCL colony	Buffer Zone	219.98	128.79
		(155-300)	(94-175)
Harina	Buffer Zone	130.73	42.93
		(65-215)	(44-98)
Bhuli	Buffer Zone	174.75	151.66
		(150-200)	(89-180)
Sindri	Buffer Zone	171.82	167.07
		(81-210)	(142-184)
Parabatpur	Buffer Zone	228.76	148.16
		(75-660)	(101-192)
Background	Buffer Zone	233	121.18
		(195-254)	(63-170)
Katras II		107.13	98.42
	Core Zone	(128-181)	(94-104)

Whereas in winter monitoring, the highest PM_{10} mass concentration was found to be 332µg/m^3 at Bastacola site (exceeding the prescribed limit of **GSR 742(E)**) along with other core mining zones like Mines Rescue, Moonidih. The lowest average concentration of PM_{10} was found in Katras II (Table 3.7).

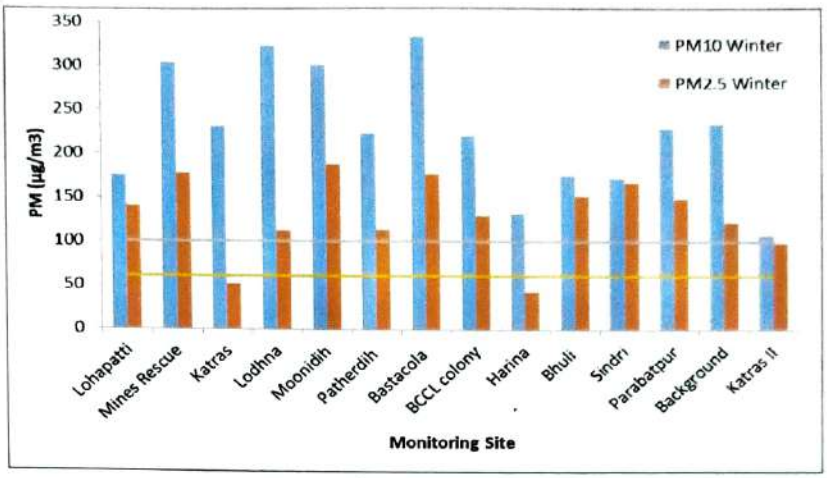


Figure 3.3: Average concentration of PM_{10} and $PM_{2.5}$ in JCF region during Winter compared to NAAQS (2009)

3.3.2. Elemental concentration of PM_{10} and $PM_{2.5}$ in summer

The digested samples of PM_{10} and $PM_{2.5}$ particles from all the 13 sampling sites were subjected to estimate the elemental composition using ICP-OES. The analysis of PM_{10} particles yields 11 different elements such as Al, As, Cd, Co, Cu, M, Ni, Pb, Zn, Fe and Cr. Similarly, the samples containing $PM_{2.5}$ particles revealed the same elements as PM_{10}. It was observed that Al and Fe were found to be higher for both PM_{10} and $PM_{2.5}$ particles. Al is the most abundant element. The concentration of Al was detected in the range of 6.32-14.62µg/m^3. Maximum Al concentrations were found at BCCL colony, Parbatpur, Harina and Background. The concentrations of Fe and Cr were estimated as 0.78-7.74µg/m3 and 0.075-1.32µg/m3 respectively. The highest concentrations of both Fe (7.74µg/m3) & Cr (1.32µg/m3) were found at the Bastacola site Figure 3.4. Similarly, in the case of PM2.5 particles the concentrations of Al (4.87-14.47µg/m3), Fe (0.44-11.77µg/m3) and Cr (0.066-2.17µg/m3) were found higher than other elements. For PM2.5 particles, maximum concentrations of Fe (11.77µg/m3) and Cr (2.17µg/m3) were obtained at the Mine Rescue site and Al (14.47µg/m3) at Katras. Since, the elements such as Al, Fe and Cr possess higher concentrations in the PM10 elemental composition, Al would have been emitted from road dust, whereas Fe would have been emitted from the re-suspension of dust containing deposits from the emissions of vehicular and other anthropogenic activities Figure 3.5.

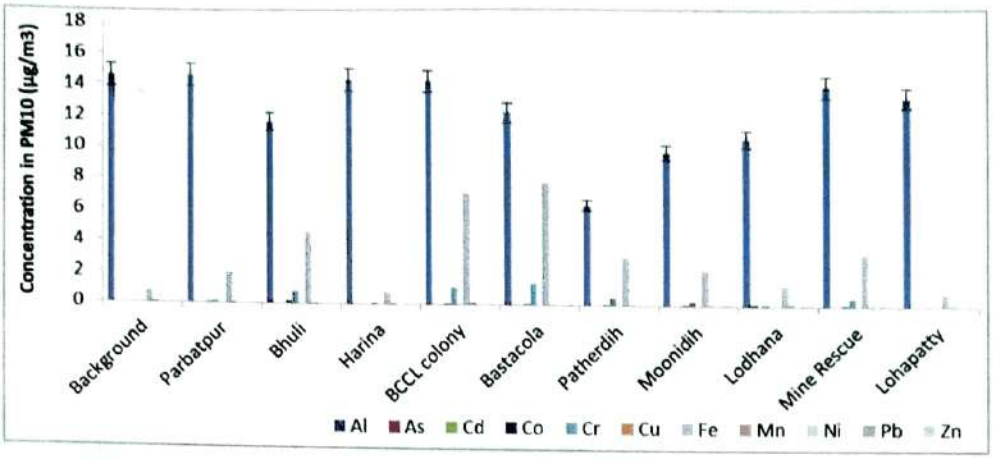


Figure 3.4: Metal concentration of PM_{10} in the summer season

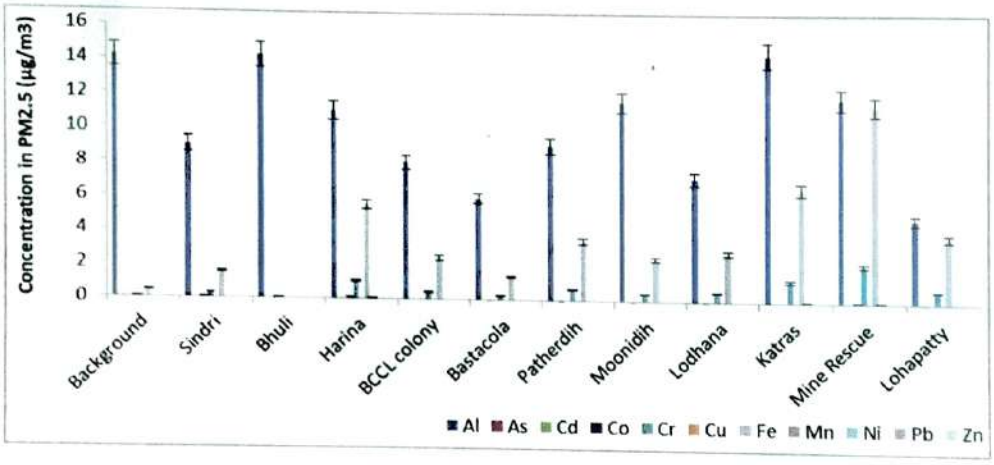


Figure 3.5: Metal concentration of $PM_{2.5}$ in the summer season

3.3.3. Elemental Concentration of PM_{10} and $PM_{2.5}$ in Winter

The elemental analysis was performed using inductively coupled plasma optical emission spectroscopy (ICP-OES). For the air quality assessment, the concentrations of 11 elements i.e. Al, As, Cd, Cr, Cu, Fe, K, Mn, Ni, Pb, and Zn in PM_{10} and $PM_{2.5}$ samples, were measured. Among all the elements, Al, Fe, and K concentrations were found considerably higher for PM_{10} samples in the winter season. Al was observed in the range of 2.02-10.77µg/m3 followed by Fe (0.79-9.26µg/m3) and K (0.90-4.19µg/m3). Maximum Al concentration (10.77µg/m^3) was observed at the BCCL colony, followed by Lodhna (10.29µg/m^3). The Highest Fe concentration (9.26µg/m^3) was observed at Bastacola while K (4.19µg/m^3) at the Lodhna site. This may be due to vehicular emissions, paved roads, construction dust, coal combustion, soil dust, etc. The concentration of As, Ni, Pb was found within the limits of CPCB standards. The remaining elements i.e. Cd, Cr, Cu, Mn, and Zn were found very low (Figure 3.6).

Similarly, in the case of $PM_{2.5}$ samples concentrations of Al, Fe and K were detected higher than other elements. The concentration of Al, Fe, and K was obtained as 0.11-2.91µg/m^3, 0.05-1.93µg/m^3 and 0.08-2.12µg/m^3. For $PM_{2.5}$ particles, maximum Al and K were found at the Munidih site, which were 2.91µg/m^3 and 2.12µg/m^3 respectively. The highest concentration of

Fe i.e. 1.93µg/m^3 was detected at Lodhna site. The concentrations of all other analysed elements were low (Figure 3.7).

From the elemental analysis of the summer and winter seasons, it was observed that the average Al concentration obtained was more in the summer season than in the winter season. In contrast, the average concentration of Cr was more in the winter season.

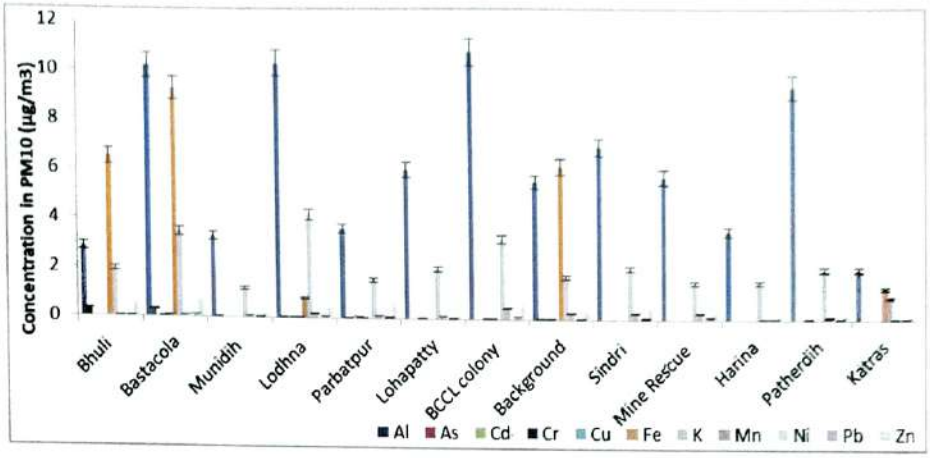


Figure 3.6: Metal concentration of PM_{10} in winter season

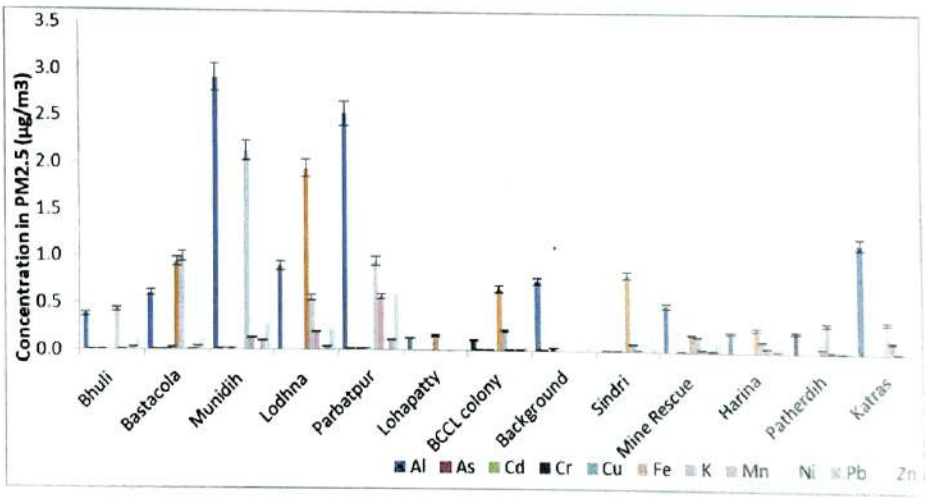


Figure 3.7: Metal concentration of PM 2.5 in winter season

3.3.4. SO_2 and NO_2 concentration in ambient air in the Summer season

The mean average SO_2 concentration in the summer season among all the monitoring stations ranged between 11μg/m^3 (Harina & Bastacola) and 24.5μg/m^3 (Moonidih), being well below the threshold limits of 80μg/m^3 (residential or industrial). The 8-hour average NO_2 concentrations were between 10.3μg/m^3 (Background) and 40.9μg/m^3 (Lodhana), well within the standard limits of 80μg/m^3 (residential or industrial) Figure 3.8. The SO_2 in the residential areas may be received from the open burning of raw coal and other domestic and commercial activities.

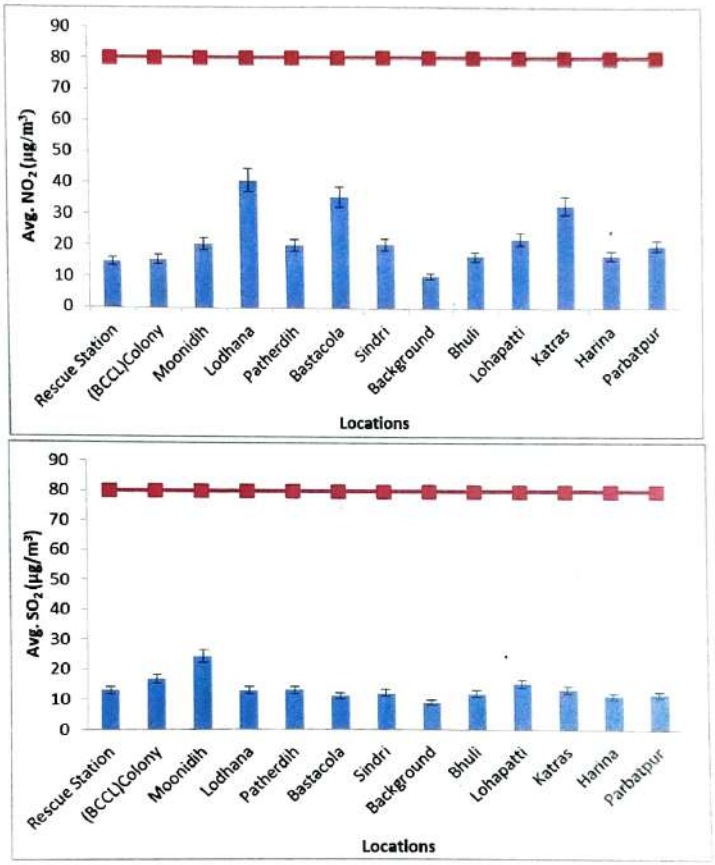


Figure 3.8: NO_2 and SO_2 Concentration of all monitoring sites in summer season

3.3.5. SO_2 and NO_2 concentration in ambient air in Winter season

The mean concentration of NO_2 and SO_2 in the winter season was found below the threshold limit i.e. 80μg/m^3. The concentration of SO_2 was below 10μg/m^3 in Katra, BCCL colony, Mine Rescue, Bastacola, Lodhana and Munidih. Bastacola and Bhuli site has a NO_2 concentration above 10μg/m^3 (Figure 3.9). It has been observed that the concentration of NO_2 and SO_2 in the winter and summer seasons were below the standard limit. But the average concentration of NO_2 and SO_2 in the summer season was higher than in the winter season.

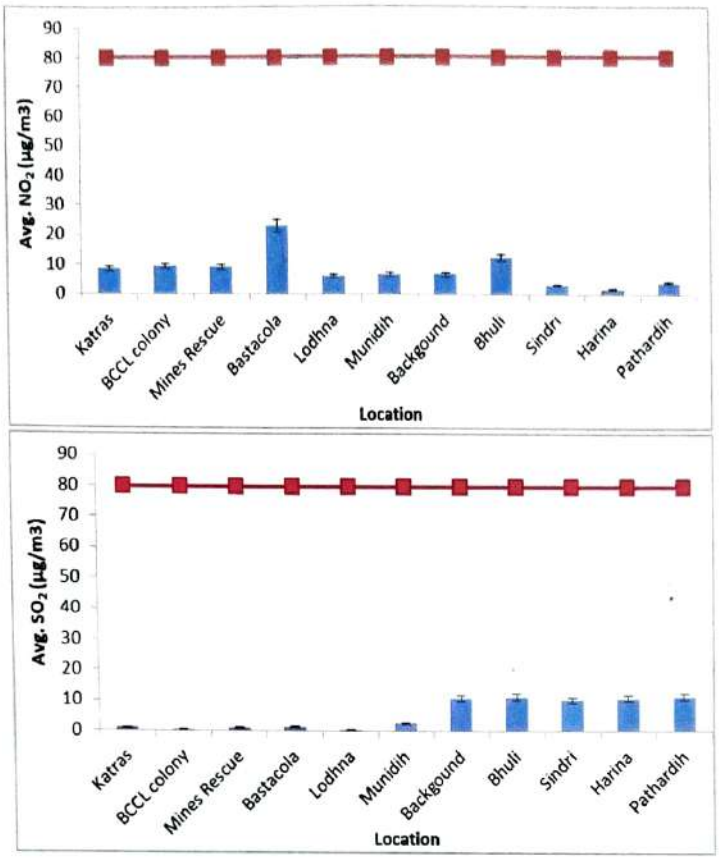


Figure 3.9: NO_2 and SO_2 Concentration of all monitoring sites in Winter season

3.3.6. Carbonaceous Aerosol/EC & OC in Summer

Data were obtained for four OC fractions (OC1, OC2, OC3 and OC4 in He atmosphere at 140, 280, 480 and 580°C, respectively) and three EC fractions (EC1, EC2, and EC3 in a 2% O2/98% He atmosphere at 580, 740 and 840°C, respectively). The IMPROV protocol defines OC as OC1 + OC2 + OC3 + OC4 and EC as EC1 + EC2 + EC3. The mass concentration of organic matter (OM) in the atmosphere was estimated by multiplying OC by 1.6 (conversion factor for urban aerosol). The total carbonaceous aerosol (TCA) was calculated as the sum of OM and EC. The highest concentration of OC and EC in $PM_{2.5}$ was found in the BCCL colony site i.e. 37.85 and 42.33µg/m^3, respectively, and the lowest OC concentration was 15.36µg/m^3 and EC was 13.08µg/m^3 in Sindri site. In comparison, the concentration of OC (67.35µg/m3) and EC (81.67µg/m^3) in PM_{10} were higher in the BCCL colony among all the sites. The lowest OC concentration as 17.95µg/m^3 was in Bastacola and EC in Parbatpur i.e. 15.44µg/m^3 (Figure 3.10).

3.3.7. Carbonaceous Aerosol/EC & OC in winter

The mass concentration of EC and OC in PM_{10} and $PM_{2.5}$ are more significant than 100µg/m^3 and 70µg/m^3, respectively in Bastacola, Katras, Mine Rescue, Background, and Sindri. The highest concentration of EC in PM_{10} and $PM_{2.5}$ was observed in the Sindri site, whereas OC was found higher in Sindri and Bastacola. OC contributing to PM_{10} mass concentration was lowest in

Harina followed by Lohapatti and Patherdih. In the case of $PM_{2.5}$, Parbatpur was found to have the lowest concentration among other sites.

The higher mean concentration of EC and OC in winter were likely related to the influence of emissions from residential heating (in addition to traffic source) and, on the other hand, to the unfavourable meteorological conditions leading to more excellent dispersion of pollutants in the atmosphere during this season. Elemental carbon is emitted directly into the atmosphere during incomplete combustion emissions, such as motor vehicle exhaust, fuel burning, and biomass burning (Figure 3.11).

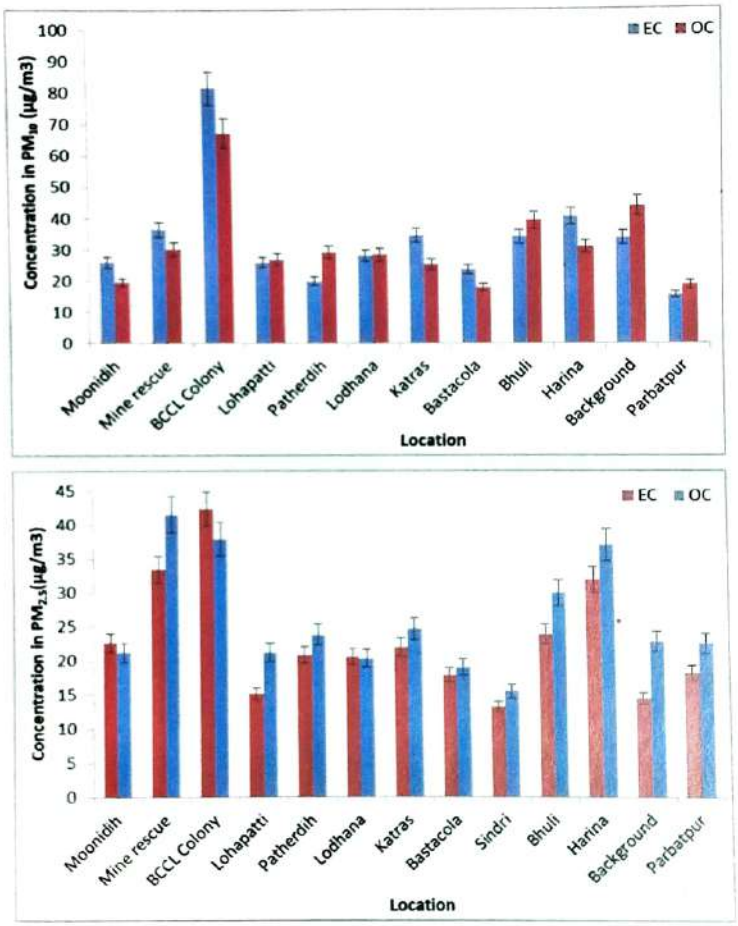


Figure 3.10: EC & OC concentration in PM_{10} and $PM_{2.5}$ in Summer season

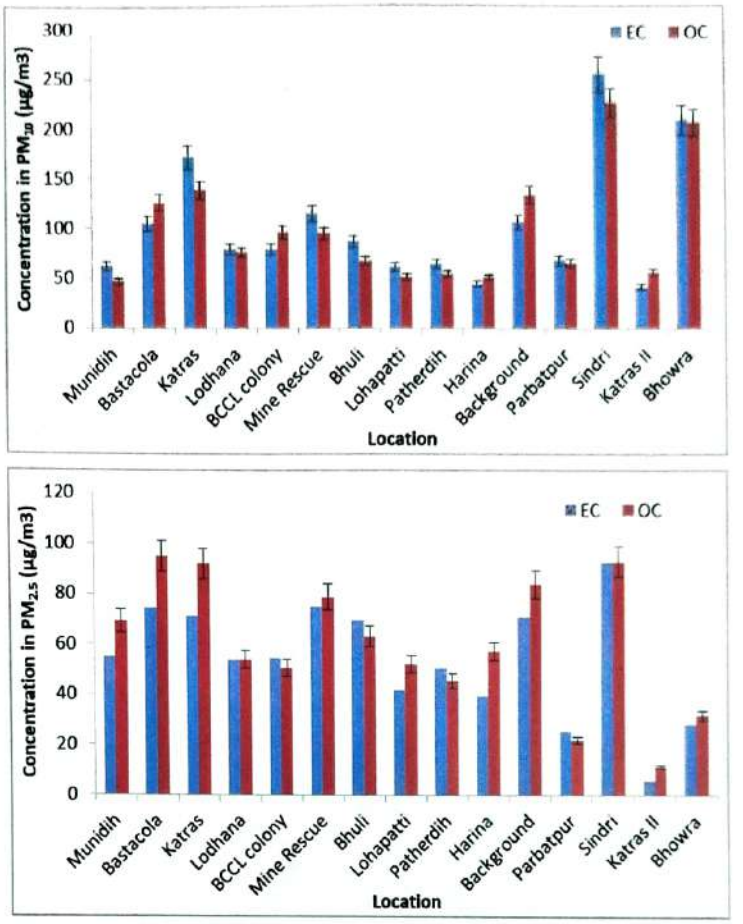


Figure 3.11: EC & OC concentration in PM_{10} and $PM_{2.5}$ in Winter Season

3.3.8. Ionic composition of PM_{10} and $PM_{2.5}$ in Summer season

The anions (SO_4^{2-}, NO_3^- and Cl^-) and cations (NH_4^+, Na^+, Ca^{2+}, K^+) are the water-soluble inorganic ions found in abundance. In summer, the mass concentration of SO_4^{2-} in PM_{10} was in the range of 1.06-20.17µg/m^3 where a higher concentration was observed in Harina, BCCL colony, and Lodhana sites. Likewise, NO_3^- was in the range of 0.32-19.2µg/m^3 with the highest in the Harina site. PO_4^{3-} and Cl^- concentration was highest in Harina and < 2µg/m^3 in other locations. NH_4^+ was in the range of 0.75-16.24µg/m^3, Harina with the highest concentration, and Bastacola with the lowest concentration. Na^+ concentration (0.18-8.6µg/m^3) was highest in Harina followed by BCCL colony and less than 2µg/m^3 in remaining sites. Ca^{2+} concentration (1.5-11.77µg/m^3) was highest in Lohapatti and BCCL colony while lowest in Katras. K^+ ion was also observed in the Harina site with a concentration of 5.85µg/m^3 (Figure 3.12).

The mass concentration of SO_4^{2-} in $PM_{2.5}$ was highest in Patherdih with a concentration of 15.13µg/m^3 and lowest in Bhuli. In Bastacola site, the concentration of NO_3^- (2.85µg/m^3), Cl^- (2.04µg/m^3), K^+ (1.84µg/m^3) were the highest among the other sites. Ca^{2+} (6.17µg/m^3) and Mg^{2+} (0.57µg/m^3) concentration was highest in Lohaptti site (Figure 3.13).

3.3.9. Ionic composition of PM_{10} and $PM_{2.5}$ in Winter season

PM_{10} ions concentration in Bastacola and Background were highest among all the monitoring

sites which followed the increasing order of $Na^+ < Mg^{2+} < F^+ < K^+ < Ca^{2+} < Cl^- < NH_4^+ < SO_4^{2-} < NO_3^-$. It has been observed that SO_4^{2-}, NO_3^- and NH_4^+ ions were present in abundant in PM_{10} mass concentration, and concentration of NO_3^- in these sites contributes majorly to PM_{10}. Ions concentration in Katras, Lohapatti, and Bhuli sites were observed having lower ionic concentration Figure 3.14.

The ionic composition of $PM_{2.5}$ comprises mainly of SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Ca_2^+ and K^+ ions. Locations such as Bastacola and Parbatpur have higher concentration of ions compared to remaining sites in following order: $Mg^{2+} < Na^+ < Ca^{2+} < K^+ < Cl^- < NH_4^+ < SO_4^{2-} < NO_3^-$. The same trend has been observed i.e. SO_4^{2-}, NO_3^- and NH_4^+ ions contribute mainly in $PM_{2.5}$ mass concentration. The average concentration of SO_4^{2-} and NO_3^- in winter was higher than in summer.

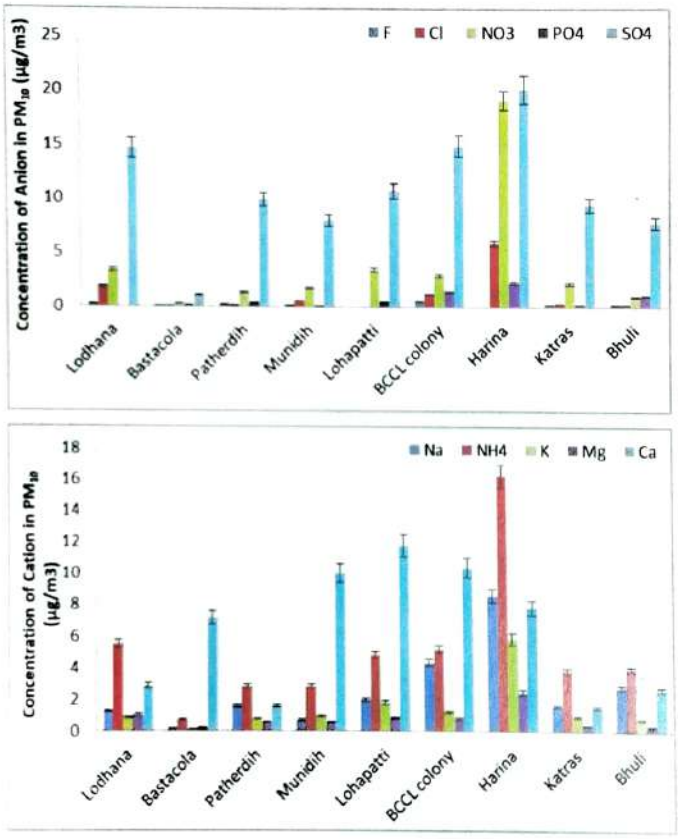


Figure 3.12: Anion and Cation concentration in PM_{10} in summer

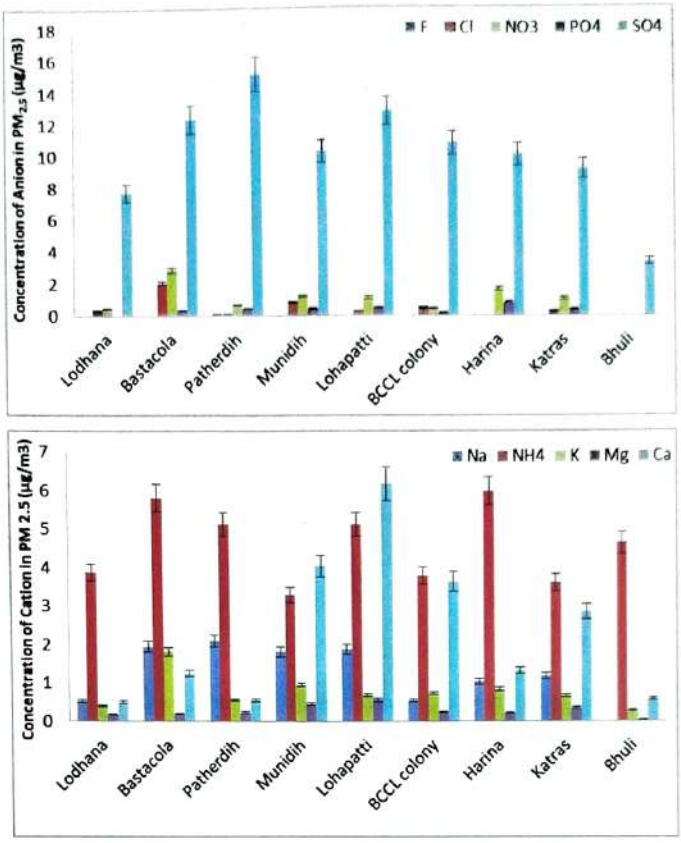


Figure 3.13: Anion and Cation concentration in $PM_{2.5}$ in summer

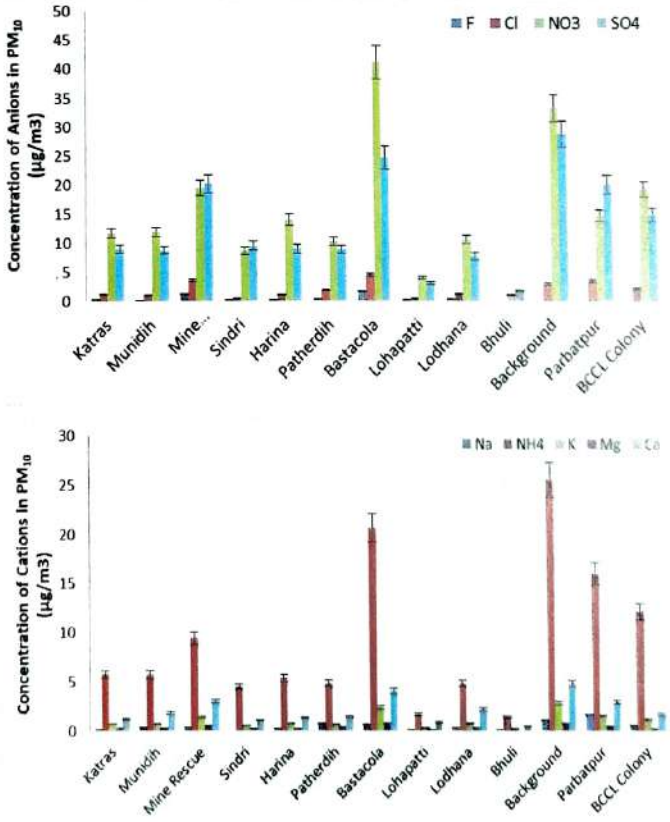


Figure 3.14: Anion and Cation concentration in PM_{10} in winter

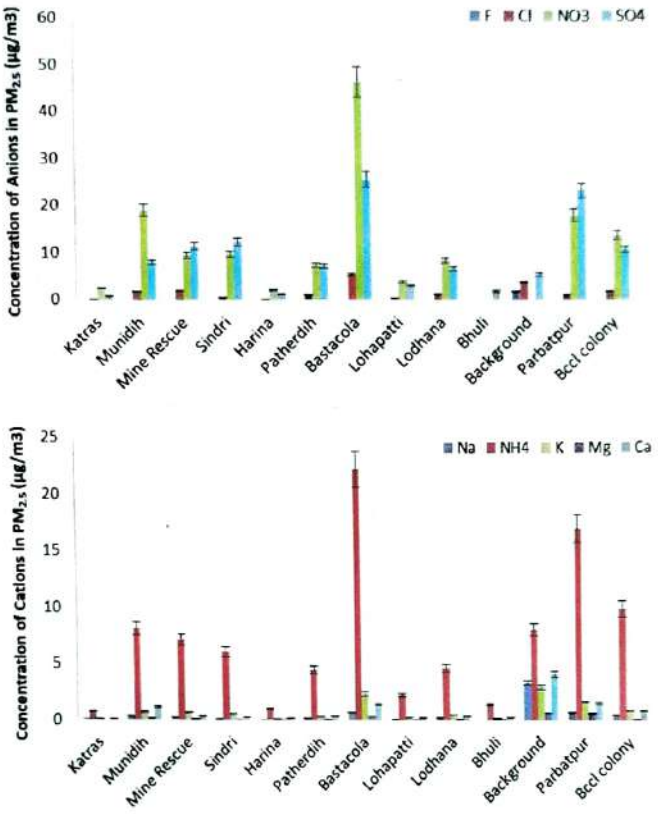


Figure 3.15: Anion and Cation concentration in $PM_{2.5}$ in winter

Chapter 4 Receptor modelling

4.1. Source Apportionment

The source apportionment study was carried out to identify the potential sources contributing to the particulate matter of aerodynamic size less than 10 µm in the Jharia coalfield (JCF) using a receptor modelling approach. In receptor modelling, the particulate matter (PM_{10}) characterization in terms of metal, ions, elementary and organic carbon profiles is statistically matched with that of various source profiles in the study area. For the source apportionment study of JCF, the area is divided into various zones (buffer, core and background zone). And the ambient PM_{10} characterization obtained from the multiple monitoring locations in the study area is conflated and compared with source profiles viz. industrial (mining and non-mining) and allied industrial activities, transportation, local vehicular movement and domestic fuel (coal wood burning, etc.). The chemical mass balance (CMB) model EPA-CMB v8.2 is one of the several receptor models and is most trusted for coarse and fine particulate matter source apportionment. The CMB model estimates source contributions by determining the best linear combination of emission source profiles and the chemical composition of ambient particulate, aerosol, and volatile organic compound samples. The study is studying the apportionment of particulate matter is considered owing to the nature of high particulate matter pollution in the study area. The source apportionment study is useful for devising an effective action plan for abatement of emission load in the region; thereby the region's overall air quality can be improved.

Jharia is one of the eight blocks in Dhanbad and is the main source of metallurgical coal in India, and is termed as the powerhouse of the country owing to its best quality coking coal, which is required by the steel and other industries in India. Dhanbad lies between 23°37'3" N and 24°4' N latitude and between 86°6'30" E and 86°50' E longitude with an average elevation of 222 m. Its geographical length, extending from North to South, is 43 miles and width 47 miles, stretching across East to West. It shares its boundaries with West–Bengal in the Eastern and Southern parts, Dumka and Giridih in the North, Bokaro in the west. It is the administrative headquarter of the district and Dhanbad Municipal Corporation (DMC).

The air quality status is determined by dividing the study area into background, core, and buffer zones. Thirteen sites were selected to represent various regions, including two references or background sites. The sampling locations are shown in Figure 3.1.

4.1.1. Chemical Mass Balance (CMB)

A mass balance equation can be written to account for all the chemical species in the samples as contributions from independent sources:

$$C_i = \sum_j m_j X_{ij} a_{ij} \qquad 4.1$$

C_i is the concentration of species i measured at a receptor site (derived from the chemical analysis), X_{ij} is the i^{th} elemental concentration measured in the j^{th} sample, and m_j is the airborne mass concentration of material from the j^{th} source contributing to the j^{th} sample. The term a_{ij} is

included as an adjustment for any gain or loss of species i between the source and receptor. The term is assumed to be unity for most of the chemical species.

The CMB 8.2 software (USEPA 1997) is used in this study. It is windows-based software that requires input data on ambient (at receptor locations) and source profiles of PM characterization. The model runs multiple iterations to provide optimum goodness of fit among the sources and receptors and verifies the model with various checks viz. Chi-square statistic, t-tests, mass percentage, and correlation coefficient. The following assumptions should be understood before proceeding with the CMB analysis.

The CMB model assumptions are:

- The concentration of emissions sources is constant throughout ambient and source sampling;
- Chemical species do not react with each other (i.e., they add linearly);
- All sources with potential for contributing to the receptor have been identified and have had their emissions characterized;
- The number of sources or source categories is less than or equal to the number of species;
- The source profiles are linearly independent of each other; and
- Measurement uncertainties are random, uncorrelated, and normally distributed.

The following steps are followed for running the CMB model:

- Identification of the contributing emission source types based on primary survey and emission inventory data collected around the monitoring sites.
- The selection of chemical species to be included in the CMB modelling calculation is based on the Central pollution control board (CPCB) guidelines.
- The source profiles with the fraction of each chemical species and uncertainty are withdrawn from the SPECIATE 5.1 database. SPECIATE 5.1 is US-EPA's repository of organic gas and particulate matter (PM) speciation profile of air pollution sources.
- Estimate ambient concentration (ambient data) is based on chemical analysis of the PM samples collected at the respective site during monitoring. The uncertainty of the chemical species is mainly based on the instrument uncertainty.
- The CMB 8.2 model run provides the solution of the chemical mass balance equation.

For source apportionment of PM_{10}, CMB 8.2 software (USEPA 1997) provides many goodness's of fit tests to verify the accuracy of the model. The normal checks, as specified in the manual by USEPA (1997) to accept the model are; t-statistics i.e., source contribution divided by the error of source contribution should be greater than 2, χ^2 (chi-square) is the weighted sum of squares of the differences between calculated and measured fitting species concentrations divided by the effective variance and the degrees of freedom, it should be less than 4. The weighting is inversely proportional to the squares of the precision in the source profiles and ambient data for each species. Ideally, χ^2 would be zero, there would be no difference between calculated and measured species concentrations. The χ^2 less than one indicate a very good fit for the data. Values greater than 4 indicate that one or more of the fitting species concentrations are

not well-explained by the source contribution estimates (SCE). The source contribution estimate approximates the total mass concentration which is a convenient check on the %mass explained value. When the SCE is less than its standard error, the source contribution is undetectable. Two or three times the standard error may be taken as the upper limit of the SCE in this case. Assuming that the errors are normally distributed, there is about a 66% probability that the true source contribution is within one standard error and about a 95% probability that the true concentration is within two standard errors of the SCE.

R^2 is determined by the linear regression of the measured versus model-calculated values for the fitting species. R^2 ranges from 0 to 1. The closer the value is to 1.0, the better the SCEs explain the measured concentrations. When R^2 is less than 0.8, the SCEs does not explain the observations very well with the given source profiles. The percentage mass explained should be between 80% and 120%, the ratio of the computed and the measured concentration of each element (C/M ratio) should be close to 1 and R/U ratio, i.e., the ratio of residuals to uncertainty should be less than 2. As the model requires the source contribution estimates and receptor concentrations in ambient air, the significant sources in the area need to be identified first. The investigation of sources of PM_{10} to be accounted for in the CMB model is carried out using emission inventory studies.

4.1.2. Source profiling

The Chemical profile needs to be developed for the air-polluting source as input to the receptor-oriented source apportionment models like CMB8.2 (chemical mass balance). The U.S Environmental Protection Agency's (EPA) SPECIATE database and several studies carried out in other parts of the world provide an extensive collection of source profiles. The source profiles required in this study are extracted from SPECIATE5.1 the database.

The source of the particulate matter in JCF accompanies various coal handling activities such as opencast coal mining and its associated activities, thermal power stations, automobiles, generator sets fuel burning, construction activities, domestic coal, cooking gas burning, etc. and even the background contribution of natural dust (crustal origin) cannot be ruled out, particularly, in the zones having loose topsoil (Roy and Singh 2014). So, the sources profiles considered here are coal dust, coal combustion, road dust, heavy vehicle diesel, light vehicle gasoline, etc.

4.1.3. Ambient profiling

As discussed in Chapter 3, the samples collected from the sampling location undergo chemical characterization. The species obtained from the chemical analysis used in ambient profile structuring and the uncertainty is based on the instrument.

The overall methodology used in the source apportionment study is depicted by the flow diagram as follows:

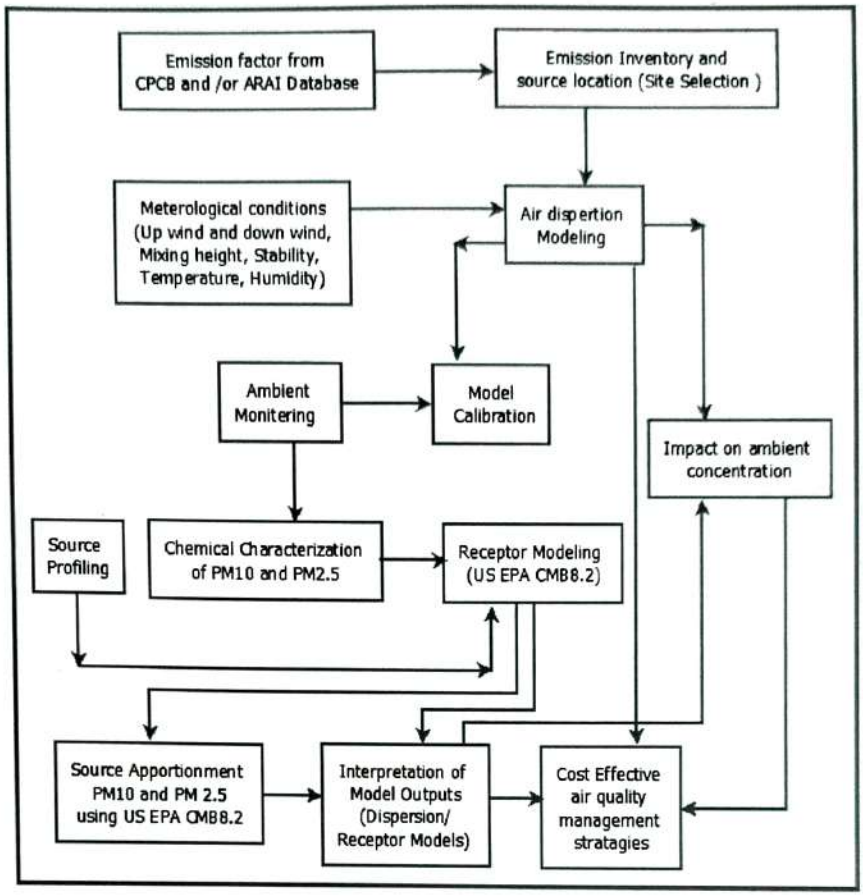


Figure 4.1: General methodology followed in the source apportionment studies

4.2. Results of the Chemical Mass Balance

CMB8.2 is performed for all the air quality monitoring locations. The significant sources in the area are identified first based on the field surveys. The general category of sources included in the model for all the sites are composites of all the vehicular sources, domestic combustion, road dust, agricultural waste burning, Industries, etc (Summary of relevant air quality studies from major Indian cities is given in Table 4.1). However, the choice of sources varies concerning the activities prevailing in the area and CMB model performance. A similar approach also applies to the selection of species. Efforts were made to include as many species in the model as possible. The choice was, however, restricted based on model performance. The source contributions are shown in the following Figures 4.3. The CMB model performance with respect to various sources is shown in Annexure 1.

4.2.1. Domestic combustion

In the summer season, the foremost emission source was domestic combustion for PM_{10} and $PM_{2.5}$. The domestic combustion percentage was observed at 22% and 25% for PM_{10} and $PM_{2.5}$ in the summer season. In the winter season, domestic combustion contribution was the second most percentage contributor for PM_{10} and $PM_{2.5}$. The PM_{10} percentage was 23% while the $PM_{2.5}$

percentage contribution was 28% in this season. The higher concentration of Cl^-, F^-, Cr, and Br. Cl^- and F^- are the markers of coal-burning and wood-burning (Jain et al., 2020). High Br along with Cl^- suggests the contributions from coal combustion.

4.2.2. Industrial Emission

The industrial combustion percentage contribution observed 16% in PM_{10} and 13% in $PM_{2.5}$ in the summer season. In the winter season, contribution to industries is determined to be 15% in PM_{10} and 24% in $PM_{2.5}$. The abundances of elements like As, Zn, Fe, Cu, Cr, Pb, and S indicate the industrial source's emissions. Kumar et al. (2001) used Cu, Mn, and Ni as tracers for industrial emissions in Mumbai; Sharma et al. (2014b) used Cu, Cr, Mn, Ni, Co, and Zn as industrial emission tracers for metal manufacturing plants in Delhi; Kulshrestha et al. (2009) used a combination of Ni, Cu, Fe, and Cr as a marker for construction activities in Agra; and Karet al. (2010) used Zn, Cu, and Ni as tracers of galvanizing, metallurgy, and electroplating industries while Cr from tannery industry in Kolkata.

4.2.3. Coal Mining

Opencast coal mining activity comprises heavy-duty diesel vehicle usage, blasting, Coal handling and overburden management. During the summer season, the coal mining activity in PM_{10} and $PM_{2.5}$ is observed to be 8% and 7% respectively while in the winter season it contributes somewhat 6% and 5% in PM_{10} and $PM_{2.5}$ respectively.

4.2.4. Transportation

The overall transportation contribution is 25% for PM_{10} and 32% for $PM_{2.5}$ in the summer season. In the winter season, the transportation emission contribution is examined at 16% for PM_{10} and 18% for $PM_{2.5}$. The OC/EC ratio is a convenient diagnostic tool for investigating the sampling site and its emission sources. In the present study, the OC/EC ratio shows significant seasonal variations for a coarser fraction of PM than for a finer fraction. It is well established that OC/EC ratio values between 1.4 and 4 indicate emissions from gasoline catalyst vehicles and 0.3 to 1 suggest diesel vehicle emissions (Amato et al., 2016; Cesari et al., 2018). Assessing the ratio of nss-K+/EC is another diagnostic check for estimating the relative loading of vehicular emissions, where nss-K+ is a non-sea-salt water-soluble potassium ion (calculated as K+- 0.129Na+) (Andreae and Merlet, 2001).

4.2.5. Secondary Inorganic Aerosol

During summer, the secondary inorganic aerosol contribution to PM_{10} and $PM_{2.5}$ is about 8% and 16%, respectively. Secondary inorganic aerosols contribution found in winter is about 14% and 17%, respectively for PM_{10} and $PM_{2.5}$. The secondary inorganic aerosol source is a high concentration of nitrate (NO_3^-), sulphate (SO_4^{2-}), and ammonium ((NH_4^-). These secondary products are formed in the atmosphere, being emitted either by natural or anthropogenic sources. The oxidation of NO_x forms the secondary nitrate. It is favoured by low temperature (Li et al.2004), while high temperature and strong solar radiations favour the formation of secondary sulfates through photochemical reactions (Seinfieldand Pandis, 2016). Secondary inorganic aerosol formation from precursors (SO_2 and NO_2) enhances the pollution burden over the

vicinity. Biomass burning, the presence of metal traces (Fe, Al, Mn, Zn, Cr etc.) from vehicular or industrial emission play a key role to neutralise the oxides of nitrogen and sulphur and thus raises the amount of secondary inorganic aerosols in the atmosphere.

4.2.6. Agriculture

The agriculture contribution observed that 5% for PM_{10} and 2% for $PM_{2.5}$ in the study period during the summer season. In the winter season, the contribution is 3% and 2% for PM_{10} and $PM_{2.5}$ respectively. Agricultural activities contribute ammonium to the atmosphere (Pant and Harrison, 2012; Jain et al., 2019). The OC and EC are also significant agricultural activity sources (Ram and Sarin 2011; Sharma et al.2016a).

4.2.7. Open burning

The contribution of open burning in the summer season is 5% for both PM_{10} and $PM_{2.5}$. In winter, the garbage burning contribution is 6% and 2% for PM_{10} and $PM_{2.5}$ respectively during study time. The abundance of tracers like K^+, Pb, Br and consider-able Cl^- marks this garbage/biomass burning source. K^+ and levoglucosan are globally employed as biomass burning markers. Biomass consists of residential and agricultural wastes, post-harvest residue, cow dung, dry leaves, fuelwood, and wildfires (Almeida et al., 2006; Khare and Baruah, 2010; Shridhar et al., 2010). The OC and EC are also traced insignificant amounts along with K+, indicating the biomass burning emanations (Cesari et al., 2018; Sharma et al., 2014; Jain et al., 2018).

4.2.8. Road Resuspension dust

The re-suspension dust is a significant contributor to PM_{10}. The contribution of resuspension dust is during the summer season 12% while in the winter season the emission contribution is 10% for PM_{10}. In the summer season, resuspension dust's contribution is higher because of the high wind velocity and dry condition. The lower percentage contribution of road dust to fine particulate matter is attributed to substantial road dust particulates in coarse mode, found in other studies (Gupta et al., 2007; Masri et al., 2015). Crustal elements are significant constituents of airborne soil and re-suspension road dust. Generally, they contribute to coarse aerosols, including Al, Si, Ca, Ti, Mg, Fe, and Na used as tracers for soil dust or crustal re-suspension (Lough et al.2005; Begum et al. 2011). The marker elements that have been used in India for the identification of soil dust include Al, Si, Ca, Ti, Fe, Pb, Cu, Cr, Ni, Co, and Mn (Sharma et al., 2017). Cu, Zn, and Ba are associated with road dust/re-suspension dust due to the release of these marker elements from cars and non-exhaust sources.

4.2.9. Other emission Contribution

Other area sources contributed in the summer season is 12% for PM_{10} and 7% for $PM_{2.5}$ during the study period. In the winter season, emission contribution is 14% for PM_{10} and 9% for $PM_{2.5}$.

4.3 Inferences

The receptor modelling (CMB) results (Figure 4.3) revealed that the transport sector and domestic combustion are the predominant emission sources contributing to the receptor levels. During the summer season, the contribution of the transport sector was found maximum in both PM_{10} (23%) and $PM_{2.5}$ (30%) followed by the contribution of domestic combustion (17% and 23% for PM_{10} & $PM_{2.5}$ respectively). While in the winter season, the contribution of domestic combustion outruns the contribution of the transport sector. During the winter season, domestic combustion has contributed 22% (PM_{10}) and 28% ($PM_{2.5}$) whereas the transport sector has contributed 16% (PM_{10}) and 21% ($PM_{2.5}$) of the total emission.

After transport sector and domestic combustion, Industrial emission (12% of PM_{10} emission) and Road Resuspension (12% of PM_{10} emission) followed by Coal mining activity and secondary inorganic aerosol formation (both 8%) are contributing majorly to PM_{10} emission at receptor during the summer season.

In $PM_{2.5}$ source contribution, secondary inorganic aerosol formation contributed majorly (16% & 15% in summer and winter seasons respectively) after domestic combustion and transport sector. Secondary inorganic aerosol formation from precursors (SO_2 and NO_2) enhances the pollution burden over the vicinity. Biomass burning, the presence of metal traces (Fe, Al, Mn, Zn, Cr etc.) from vehicular or industrial emission play a key role to neutralise the oxides of nitrogen and sulphur and thus raises the amount of secondary inorganic aerosols in the atmosphere.

Industrial activity contributed 12% and 11% of total PM_{10} load in summer and winter respectively but in the case of finer dust ($PM_{2.5}$), it contributed 17% in the winter season at the receptor level. This may be due to the calm winter conditions that allow finer dust ($PM_{2.5}$) to settle near to ground than that of summer conditions that allow more turbulence mixing in the atmosphere.

Road re-suspension of dust contributes significantly in PM_{10} load at receptor both in summer (12%) and in winter (8%). As these are larger and heavier particles, they contribute to PM_{10} fraction and are not found in $PM_{2.5}$ fraction at the receptor.

After the contribution of the industrial sector, coal-mining activity contributed around 8% and 6% of the total PM_{10} receptor dust load during summer and winter respectively. In the case of $PM_{2.5}$ dust load at the receptor, coal-mining activity contributed 7% and 5% during summer and winter respectively.

From the results and analysis of receptor modelling, it can be summarised that mitigation and abatement of the emissions from domestic combustion and transport sector alone may reduce receptor dust load by 40% (approx.).

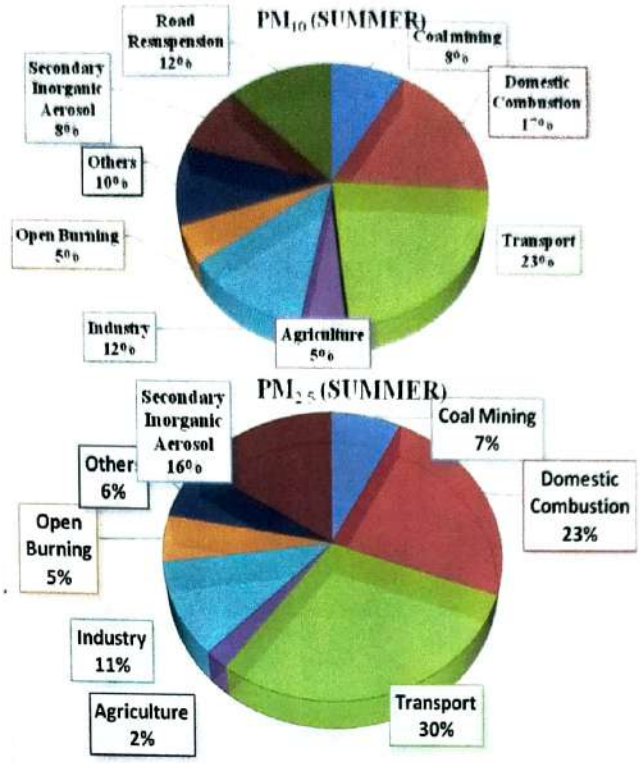


Figure 4.2: Source contribution at receptor locations of PM_{10} and $PM_{2.5}$ in summer

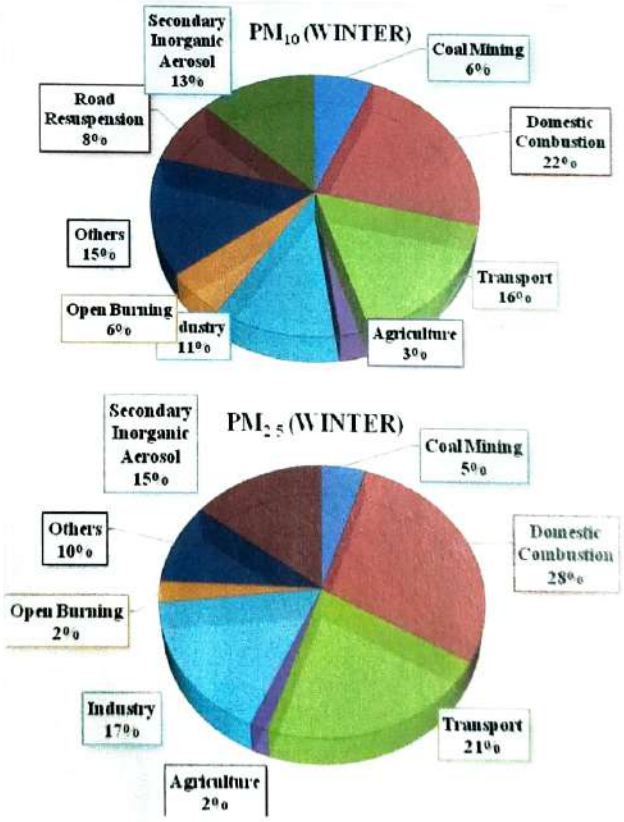


Figure 4.3: Source contribution at receptor locations of PM_{10} and $PM_{2.5}$ in winter

Table 4.1: Summary of relevant air quality studies from major Indian cities.

Area/Location	Particle size	Sources	Elements and Ions	References
Delhi	PM_{10} and $PM_{2.5}$	Secondary Nitrate, Secondary Sulfate, Vehicular emission, Biomass burning, Soil dust, Fossil fuel combustion, Sodium and magnesium salt, Industrial emission	Al, Mg, Ca, Ti, Fe, Cr, Mn, Zn, As, Pb, Br, M, F^-, Cl^-, NO_3^-, SO_4^{2-}, K^+, NH_4^+, and Na^+	Jain et. Al., 2020
Mangalore	PM_{10} and $PM_{2.5}$	Construction dust, Diesel generator, Tyre wear emission, Brake lining emission, Sand dust emission, gasoline vehicle emission, Diesel vehicle emission, Unpaved and paved road emission, Biomass burning, LPG stove emission, Solid fuel emission, Ferrous and steel industries emission, Fabrication and welding emission, Kerosene stove emission	As, Ba, Cd, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Sr, Zn, F^-, Cl^-, NO_3^-, PO_4^{3-}, SO_4^{2-}, Na^+, K^+, Mg^{2+} and Ca^{2+}	G. Kalaiarasan et al. 2018
Delhi NCR	PM_{10} and $PM_{2.5}$	Dust construction, Vehicle emission, Biomass Burning, Industrial emission, Secondary Pollutants, DG sets emission,	Al, Si, P, S, Cl, Br, V, Mn, Fe, Co, Ni, Cu, Zn, As, Ti, Ca, F^-, Cl^-, NO_3^-, Br^-, NO_2^-, SO_4^{2-}, Na^+, K^+, Mg^{2+} and Ca^{2+}	Report No. ARAI/16-17/DHI-SA-NCR/Final Report August 2018
Delhi	$PM_{2.5}$	Secondary Aerosol, Vehicular emission, Biomass burning, Soil dust, Fossil fuel combustion, Sea salt, Industrial emission	Al, Mg, S, Si, Cl, K, Ca, Ti, Cu, Mn, Fe, Zn, Br, Cr, As, Pb, F^-, Cl^-, NO_3^-, SO_4^{2-}, K^+, NH_4^+, and Na^+	Jain et. Al., 2017
Nagpur	$PM_{2.5}$	DG sets, biomass burning, resuspended dust, secondary aerosol and mobile sources.	Al, Ba, Cd, Cr, Cu, Fe, Mg, Mn, Ni, Pb, Si, Zn. F^-, Cl^-, NO_3^-, PO_4^{3-}, SO_4^{2-}, Na^+, K^+, Mg^{2+} and Ca^{2+}	Pipalatkar et al., 2014
Raipur	$PM_{2.5}$	Brick kiln process, steel re-rolling mills, steel processing industries, biomass burning, metallurgical industrial emissions and coal burning	Al, As, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, S, Sb, Se, V, Zn, Na^+, K^+, Mg^{2+} NH_4^+, F^-, Cl^-, NO_3^-, SO_4^{2-}, and Ca^{2+}	Matawle et al., 2014
Hyderabad	PM_{10} and $PM_{2.5}$	Vehicles exhaust, resuspension of dust, secondary sulfates, secondary nitrates, biomass	Na, Mg, K, Al, Si, Ca, Fe, Cl, SO_4^{2-}, NO_3, NH_4^+	Guttikunda et al., 2013

		burning, coal burning.		
Pune	PM_{10} and $PM_{2.5}$	Vehicles, DG sets, construction dust, solid fuels emissions, resuspended dust	Al, Pb, Cu, Zn, As, Se, Br, Ni, Fe, Mn, Mg, Cr, Ti, Ca, Cd, S, Si, Na, Ba, Sb, Cd, Sr, Cl^-, NO_3^-, SO_4^{2-}, K^+, NH_4^+	ARAI, 2010
Kanpur	PM_{10} and $PM_{2.5}$	Vehicles, open burn, road dust, domestic wood, coal and LPG, metal smelting, DG sets.	Cl^-, NO_3^-, SO_4^{2-}, K^+, NH_4^+, Na^+, Ca^{2+}, Mg^{2+} Si, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Cd, Sn, Sb, Pb	CPCB, 2010b
Mumbai	PM_{10} and $PM_{2.5}$	Wood combustion, Fuel oil combustion, kerosene combustion, biomass burning, LPG, ammonium sulfate, ammonium nitrate, heavy duty diesel vehicles emissions, soil dust.	Na, Mg, Al, Si, P, S, Cl, Ca, Br, V, Mn, Fe, Co, Ni, Cu, Zn, As, Ti, Ga, Rb, Y, Zr, Pd, Ag, In, Sn, La, Se, Sr, Mo, Cr, Cd, Sb, Ba, Hg, and Pb. F^-, Cl^-, Br., NO_2^-, NO_3^-, SO_4^{2-}, K^+, NH_4^+, Na^+, Ca^{2+}, Mg^{2+}	CPCB, 2010a
Chennai	PM_{10} and $PM_{2.5}$	Vehicles, DG sets, bakeries, soil dust, construction dust, paved road dust, kerosene and LPG emissions.	As, Ag, Ca, Na, Fe, Mg, Cu, Zn and other metals. Cl^-, $NO3^-$, $SO4^{2-}$, K^+, NH_4^+, Na^+, Mg^{2+}	IIT Madras, 2010
Bangalore	PM_{10} and $PM_{2.5}$	Petrol vehicles, diesel vehicles, secondary particulates, fuel oil burning, wood domestic wood burning, DG set, kerosene generator set, paved road dust re suspension, soil dust.	Na, Mg, Al, Si, P, S, Cl, Ca, Br, V, Mn, Fe, Co, Ni, Cu, Zn, As, Ti, Ga, Rb, Y, Zr, Pd, Ag, In, Sn, La, Se, Sr, Mo, Cr, Cd, Sb, Ba, Hg, and Pb. F^-, Cl^-, Br^- NO_2^-, NO_3^-, SO_4^{2-}, Na^+, K^+, Mg^{2+} and Ca^{2+}	TERI, 2010

DG - Diesel generators; LPG - Liquefied petroleum gas; OC - Organic carbon; EC - Elemental carbon.

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Chapter 5 Dispersion Modelling

Air quality modeling includes four major processes (a) emission of pollutants, (b) transportation of the pollutants due to mean wind profile (c) chemical transformations and (d) deposition/removal. In the present study the particulate matter emissions, transportation and dispersion are carried out using the AERMOD model, which is developed by USEPA. AERMOD model estimates the spatial profile of pollutants based on the Gaussian plume equation, which is an analytical solution to the steady-state approximation of the advection-diffusion phenomenon. The boundary conditions about the atmospheric mixing height and other thermodynamic vertical profiles for the simulations are derived from the mesoscale model. The model relies on the atmospheric stability classes for deriving the dispersion coefficients across the multiple dimensions with respect to the distance away from the sources. In this study, only the ground level concentrations of the particulate matter are simulated during the study period. The study domain envelops the Jharia Coal Fields situated in the Jharkhand state of India. The methodology followed in the present study is shown in Figure 5.1. The southwest part of the Dhanbad City shares borders with the study area, but the majority of emission load used in the study is included from the JCF.

5.1. Wind data analysis

The nearest IMD (India Meteorological Department) observations are at Patna and Kolkata, which are approximate >150km from the study area. Hence, hourly meteorological observations required for the study for the AERMOD dispersion model were simulated through the Weather Research and Forecast, version-3.9 (WRF), which is a meteorological model that dynamically downscales the global NCAR/UCAR meteorological data to the regional level data (www.mmm.ucar.edu). Nested domains of grid resolution 12km and 4km, respectively were laid over the study area for simulation of hourly meteorological variables using the WRF model (Figure 5.2). Hourly meteorological data, including both the surface variables and upper atmosphere variables, were simulated for the study period viz. 23 May to 12 June 2019 and 23 January to 12 February 2020, representing the summer and winter seasons, respectively.

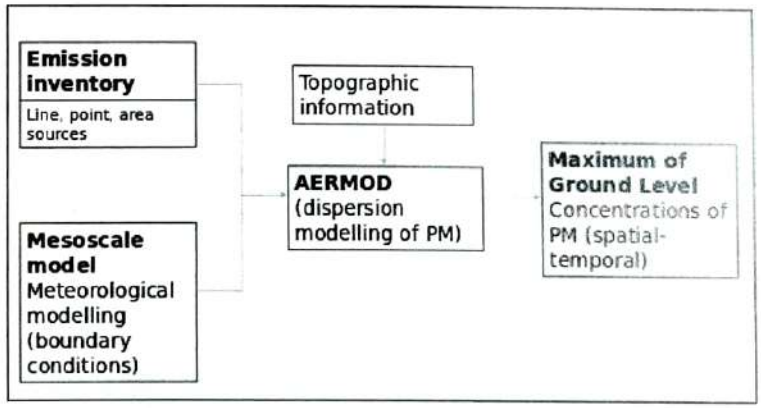

Figure 5.1: Methodology followed in the study.

The mesoscale model interface program MMIF (https://www.epa.gov/) converter tool was used

to convert the inner domain's gridded WRF model simulated meteorological data into a format suitable for the AERMOD model. The AERMOD receptor grid covering the study area is shown in Figure 5.3. A Cartesian receptor grid having 21 rows and 21 columns with a resolution of 2000 m was laid for the simulation of particulate matter dispersion /concentration at the receptor locations. Overall there are 20 grids in each direction covering an area of 40 km by 40 km enveloping the JCF.

The spatial pattern of the predominant wind profile over the study area is plotted using the windrose diagrams for the summer (March to May 2019) and winter season (November 2019 to February 2020), shown in Figures 5.2 and 5.3, respectively. Results show that the study area is experiencing the predominant wind (having high frequency) flow from east to west direction followed by north-west to south-east direction during summer, while in winter the predominant wind direction is from north to south. The wind speeds vary in the range of 0.5 to 11.1m/s during the summer predominantly in the range of 2.1 to 3.6m/s whereas wind speeds vary in the range of 0.5 to 8.8m/s during the winter, predominantly in the range of 2.1 to 3.6m/s.

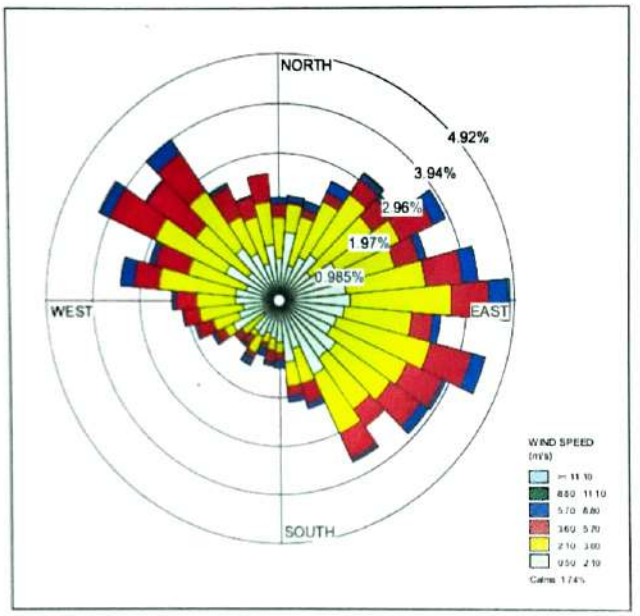

Figure 5.2: Windrose of the study area during March-June, 2019 (wind direction blowing towards the center)

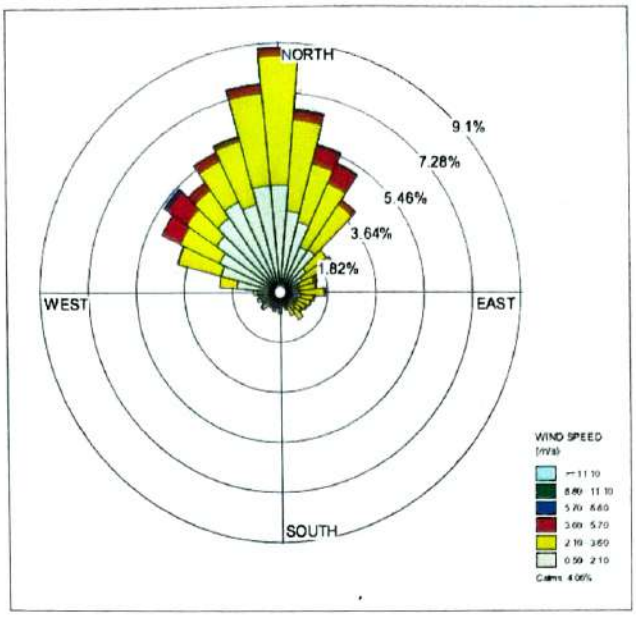

Figure 5.3: Windrose of the study area during November-December 2019 (wind direction blowing towards the centre)

5.2. Dispersion of Particulate matter

Spatial profiles of maximum ground-level concentrations of 24-hour average values of PM_{10} and $PM_{2.5}$ were simulated using the AERMOD Gaussian plume model. The emission rates of particulate matter from multiple source types including the point, line, and area were derived from the field monitoring of the emission inventory. Point sources mainly include the emissions from the industries situated in the study area that mainly use coke/coal as the fuel. The line sources include the emissions from the vehicular exhaust. Emission inventory of traffic pollution was carried out in the study area by noting down the vehicular activity. The vehicular activity of different vehicular types such as trucks, light motor vehicles, three-wheeled vehicles, motorbikes, etc. was multiplied by the corresponding emission factors for the estimation of gaseous pollution. The summation of emissions from all vehicle types adds to the overall line sources contributing to the pollution load in the study area. The area sources include emissions from the open cast mining emissions (including all the activities in the mine premises) and domestic burning (including emissions from crematoria, bakeries, open eat-outs, restaurants, chulha burning from the slum, etc.).

The emissions in grams per second were calculated from the emission inventory survey, for the line and point sources. Whereas, the emission rates in $g/s/m^2$ were calculated for the area sources including mining. These emission rates from each source type have been computed in the study area and fed into the AERMOD model domain for the simulation of spatial average concentrations of PM_{10} and $PM_{2.5}$. In the present study, the maximum GLC (ground level concentrations, in $\mu g/m^3$) was simulated at several receptor grid locations in AERMOD domains. The AERMOD model was run during the sampling period in May 2019 and November 2019, representing the pre-monsoon and post-monsoon seasons, respectively.

Analysis of WRF model simulated wind speed and direction data shows that the wind is

predominantly flowing from south-east direction to north-west direction, followed by the reversal in the direction, during the monitoring in summer, representing pre-monsoon conditions (Figure 5.5). The wind speeds during the monitoring period in summer month varied between 0.5 and 8.8m/s. During the monitoring period in winter (post-monsoon), the wind predominantly flowed from the north-east to south-west direction having wind speeds in the range of 0.5 to 3.6m/s (Figure 5.5).

The wind blowing from different directions in the study area determines the direction of pollution dispersion. The Gaussian plume equation used in the AERMOD model estimates the diffusion and advection of the pollutants concerning the emission rates and meteorology (wind speed, direction and atmospheric stability categories). The model simulated maximum ground level concentration of the particulate matter (PM_{10} and $PM_{2.5}$) in the study area covering the JCF is shown through the isopleths. The isopleths (contours connecting the regions with the same ground level concentration in the context of the present study) of maximum GLC of PM_{10} and $PM_{2.5}$ were observed to form a pattern according to the predominant wind directions flowing in different monitoring seasons. It is observed that the line sources in the study area have contributed the maximum to the surface GLC of PM_{10}, following the open cast mines. The AERMOD model simulated the value of GLC of PM_{10} due to line sources, open cast mines, and all sources are 927, 286, and 978$\mu g/m^3$, respectively, for the summer season. The $PM_{2.5}$ maximum GLC contributed by the line sources, open cast mines, and all sources included are 809, 143, and 835$\mu g/m^3$, respectively. It is evident from the result that the line sources are significantly contributing to the overall particulate pollution in the study area during summer.
The analysis of the PM_{10} and its maximum GLC simulated by the AERMOD model for the winter season also follows a similar pattern as of summer. The contribution of line sources, open cast mines, and all sources included are 1565, 597, and 1679$\mu g/m^3$, respectively. The $PM_{2.5}$ maximum GLCs during the winter are 1004, 299, 1167$\mu g/m^3$ as contributed by line, open cast mines, and all sources including, respectively. Based on the emission inventory and the prevailing meteorological conditions during the winter season have in general contributed to the higher particulate matter than that of the summer season.

Pockets of maximum concentrations of PM_{10} (200-1000 $\mu g/m^3$ and above) are observed in the vicinity to roads nearer to the open cast mines south of Dhanbad City during the winter (Figure 5.5). The localities of the high concentrations of PM_{10} are Sabji Patti road and Sudamdih mine area, which is reflected in the figure. The area covering the Dhanbad city and the mines situated in the southwest have PM_{10} concentrations in the range of 200-900$\mu g/m^3$. The fringes of the JCF have recorded the PM_{10} concentrations in the range of 100-250$\mu g/m^3$. In contrast, the PM_{10} concentrations for the summer season have significantly lower and the majority of the study area have $PM_{10} < 100\mu g/m^3$, however, the area extending from south of Dhanbad City and Sudamdih mine have relatively high PM_{10} concentration in the range of 100-500$\mu g/m^3$. Baghmara and Sonardih mine area in the west of Dhanbad City have also been observed to have high GLC of PM_{10} in the range of 100-500$\mu g/m^3$.

A similar pattern of the spatial distribution of $PM_{2.5}$ is reflected as of PM_{10}. As the underlying meteorological conditions are the same for both the PM_{10} and $PM_{2.5}$ simulations the

spatial pattern is nearly similar. High concentrations of $PM_{2.5}$ (100-500µg/m^3) are observed in the southwest direction of Dhanbad City (Figure 5.6). The maximum GLC of PM_{10} is found to be higher than $PM_{2.5}$ during both the monitoring seasons, and higher concentrations are observed during the winter season. The prevailing winter meteorology in the region has lower wind speeds and mixing heights, which poses an unfavorable situation for the dispersion of particulate matter, hence containing a high chance of accumulation of airborne pollutants. The significant contribution of particulate matter from the line sources is observed in the study area, followed by the area sources (from open cast mining, domestic burning, bakeries, open eat-outs, and restaurants). The locations of the highly polluted can be interpreted from the images shown in Figures 5.6 (a) and 5.6 (b) for devising realistic and grass-root level mitigation strategies.

Figure 5.4: AERMOD grid covering the Jharia Coal Fields (JCF). The line, area, and point sources covered in the study are indicated in red color. The UTM coordinates of the left bottom point are x=406111 and y=2603492, and the coordinates of the right top point are x=456248 and y=2653417.

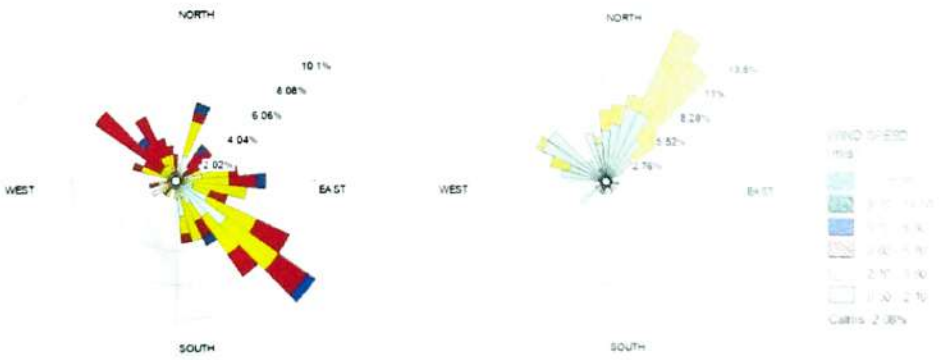

Figure 5.5: Windrose diagram for the summer (left) and winter seasons (right) at Jharia Coal Fields during the sampling period. Wind direction is flowing towards the centre.

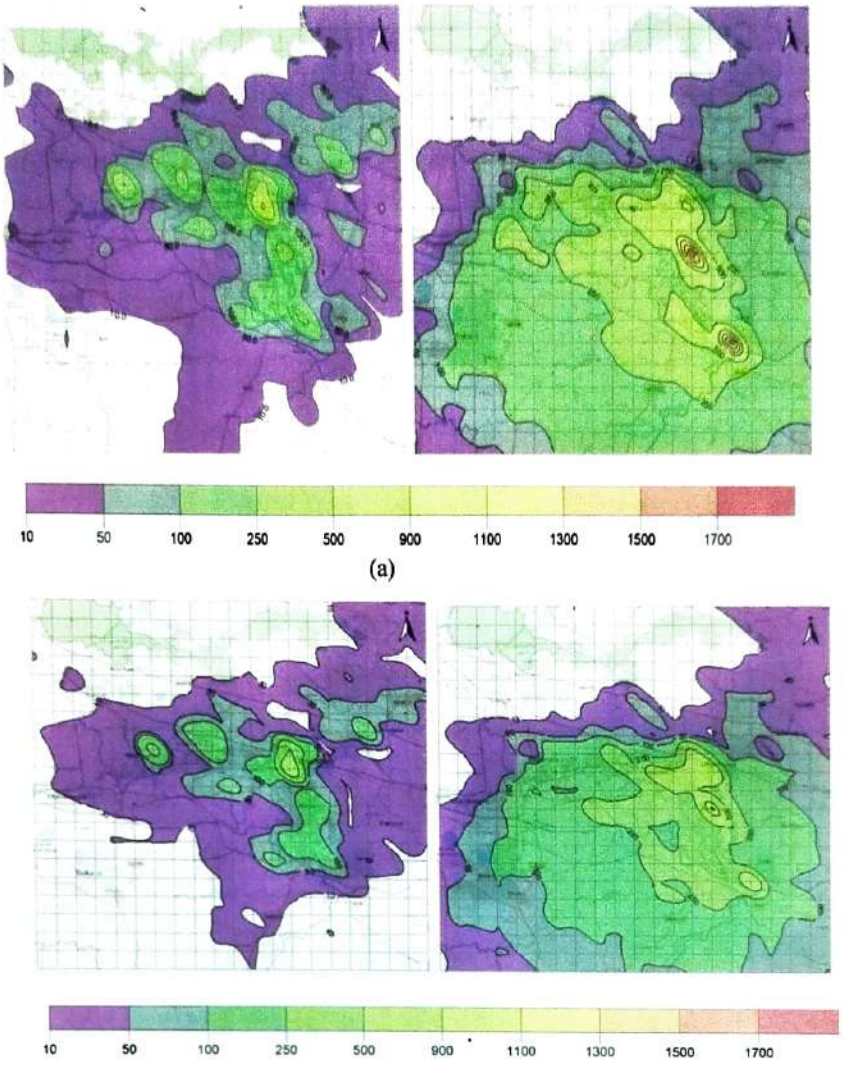

Figure 5.6: 24-hour average maximum ground level concentration of PM contours in the study area simulated during the study periods in summer (left) and winter (right) seasons (a) PM_{10} ($\mu g/m^3$) and (b) $PM_{2.5}$ ($\mu g/m^3$)

5.3 Validation of the model

Comparison between the model simulated period average PM and the measured PM concentrations was made to determine the overall efficiency of the dispersion model. In the present study, the model validation metrics viz. mean bias (MB), normalized mean bias (NMB), mean gross error (MGE), normalized mean gross error (NMGE), and Pearson's correlation (r) were calculated for PM_{10} and $PM_{2.5}$ separately including data of both seasons. At some of the monitoring locations like Mines Rescue, Katras, Patherdih, Harina, Lodhna, and Lohapatti the discrepancies between the modeled and observed data were found to be high, for both summer and winter seasons. At remaining locations for both seasons, the results indicate an acceptable/fair degree of model performance in simulating the particulate dispersion. Results show that the correlation coefficient between the measured and modeled PM_{10} is 0.6, which is

fair enough in environmental open systems, similarly, for $PM_{2.5}$ the correlation value is around 0.7 (Table 5.1).

Table 5.1 Performance Stimulation Metric

Model metric	PM_{10}	$PM_{2.5}$
MB	-19.46	20.67
NMB	-0.11	0.24
NMGE	0.32	0.37
Correlation Coefficient	0.6	0.7

The NMB values are observed to be lower for PM_{10} (-0.11) than $PM_{2.5}$ (0.24), which indicates the slight negative bias in PM_{10} simulations (under-prediction of the concentrations) and positive bias in $PM_{2.5}$ (over-prediction of the concentrations). Whereas, the NMGE for both PM_{10} and $PM_{2.5}$ are 0.32 and 0.37, respectively, which indicates the variation in the model simulations deviate around 30% from the mean values on average (which is a result due to some extreme values in the simulations). However, this discrepancy could be minimized if long-term simulations are carried out, which is highly computationally intensive. Nevertheless, the model performance metrics in terms of correlation and normalized mean gross error infer that the model could capture the spatial profile of the particulate matter distribution to a good extent.

Chapter 6 Recommendation

6.1. Mine industries

1. The project proponent might consider installing conveyor systems for transporting the coal from the coal handling plant to the railway siding or to the nearest thermal power plant (if feasible).
2. A sufficient number of plants should be planted around the mine pit to arrest the movement of particulate matter or dust into the surrounding areas.
3. Scientific studies might be necessary to design a green belt with an optimized dimension of plot size and direction as per the prevailing meteorology. Similar studies are required to design a wind barrier for optimized benefits.
4. Adequate dust control measures should be in place, like mechanized sweeping, water sprinkling or mist spraying systems on the haul roads and at loading sites. Long-range misting or fogging canons are also should be in place.
5. Dust suppression measures at all operations of mining should be ensured.
6. Ensuring the complete coverage of the trucks and railway wagons that carry coal with a tarpaulin sheet is necessary.
7. In the long-run mobilization of closed trucks to carry the coal is preferable.
8. The coal transport roads should not be left with open curb sides. End to end covering up of curb side is essential to avoid the re-suspension of coal due to the truck movement.

6.2. Area Sources

Area sources are mainly domestic sources of fuel (coal, wood, kerosene, LPG) burning, trash/MSW combustion, bakeries, hotels/restaurants etc. and re-suspension of dust. Based on the survey and assessment, the following recommendations emerge:

1. Construction and demolition of buildings in the urban area give high local dust contribution resulting health problems. These practices need to follow compliance guidelines to reduce emissions.
2. Road and pavement should be well constructed to suppress road dust. The standard specifications and code of practice for road construction should be followed and implemented as per the Indian Road Congress (IRC) guidelines or international standard guidelines.
3. Strategically placed green cover in urban and semi-urban areas can help to improve local air quality.
4. Manage agricultural residues, including strict enforcement of bans on open burning
5. Strictly enforce bans on the open burning of household waste.
6. Use clean fuels – electricity, natural gas, liquefied petroleum gas (LPG) in cities, and LPG and advanced biomass cooking and heating stoves in rural areas; substitution of coal by briquettes
7. Use incentives to improve the energy efficiency of household appliances, buildings, lighting, heating and cooling; encourage roof-top solar installations
8. Promote the use of electric vehicles

9. Encourage centralized waste collection with source separation and treatment, including gas utilization.
10. There is a substantial population that also uses available coal. These houses could be given a combination of improved chulla or free/subsidised power for cooking purposes.
11. Hotels and dhabas need to be educated and compulsorily asked to use LPG for its cooking purposes.
12. The trash and MSW burning is very common. Some of the places contain a mix of plastics and thermocol. The combustion of these materials is very harmful to human health.
13. Coal depot pollution is due to open storage and unregulated buying, selling and transportation. These coal depots are responsible for nearby air pollution peaks. However, the contribution of the same need to be assessed.

6.3. Line Source

The vehicular sector in cities has been seen to be a major source of gaseous and fine particulate matter. The action plan for this sector would need a combination of efforts:

1. Vehicle inspection and maintenance: Enforce mandatory checks and repairs for vehicles.
2. Improved public transport: Encourage a shift from private passenger vehicles to public transport.
3. Set up a mechanism of Inspection and Maintenance programme for all vehicles in the district through RTO with automated system assessment.
4. The Inspection & Maintenance (I & M) centre shall also test all vehicles for their inbuilt emission tests.
5. All commercial vehicles should be phased out after 8 years of age or subjected to two years extension after rigorous I&M tests
6. All private vehicles should be subjected to proper assessment and fitness tests through I&M centres.
7. All autos and buses shall also be subjected to I&M tests
8. Dhanbad city does not have a designated place for truck parking and maintenance related activities. A separate designated place should be allocated to prevent illegal parking and repair shops on the roads and kerbside.
9. Dhanbad city does not have a designated place for Auto-rikshaw. A separate designated place should provide to prevent traffic congestion and control vehicle emission.
10. Major haul trucks with heavy loads should not pass through the main city. The plan being made should be implemented in the next 1-1.5 years.
11. Overloading is a common phenomenon in the region resulting in poor road quality. This can be avoided through online checking when vehicles leave industries with a guarantee that the vehicle is not carrying more material than its designated loads.

6.4. Others

- There is a need to explore various options for controlling air pollutants to tackle increased emissions in future.
- The local authority should stress sustainable and affordable public transport keeping clean air goals in mind.
- Frequent (time to time) arrangement of campaign/awareness programmes for lawmakers, stakeholders, health professionals, academicians to brainstorm about the future scenario and importance of clean air.
- Strategic installation of continuous air quality monitoring systems at various locations of urban, semi-urban and rural areas to check the existing air quality and information dissemination to the general public.

Annexure -1

[A] Cumulative receptor sample of PM_{10} for source profiling with fitting parameters

Source contribution estimate	Source profiles	Std Error	R-square	Chi-square
82.7% mass	Unpaved road	0.056	0.96	2.41
	Coal combustion	0.643		
	Light Duty vehicle	1.60		
	Heavy Diesel vehicle	2.19		
	Residential combustion	5.59		
	Iron and steel industry	7.16		
	Agriculture soil dust	0.212		
	Solid waste	1.37		

[B] Cumulative receptor sample of $PM_{2.5}$ for source profiling with fitting parameters

Source contribution estimate	Source profiles	Std Error	R-square	Chi-square
88.1% mass	Residential combustion	3.34	0.98	2.44
	Coal combustion	0.094		
	Light Duty vehicle	0.30		
	Heavy Diesel vehicle	1.91		
	Agriculture soil dust	0.10		
	Flyash	0.51		

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अधिसूचना

नई दिल्ली, 21 मई, 2020

का.आ. 1561(अ).—जबकि केन्द्रीय सरकार ने पर्यावरण (संरक्षण) नियमावली, 1986 के नियम 5 के साथ पठित पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 3, धारा 6 और धारा 25 के तहत अपनी शक्तियों का प्रयोग करते हुए, ऐश सामग्री (ऐश कंटेंट) को 34% तक की सीमा सहित कोयले का उपयोग करने के लिए ताप विद्युत संयंत्रों की कतिपय श्रेणियों को अधिदेशित करते हुए भारत के राजपत्र, असाधारण में सा.का.नि. 02 (अ), तारीख 2 जनवरी, 2014 द्वारा पर्यावरण (संरक्षण) नियमावली, 1986 के नियम 3 के उपनियम 8 का संशोधन प्रकाशित किया।

और जबकि सा.का.नि. 02 (अ), तारीख 2 जनवरी, 2014 द्वारा उक्त अधिसूचना द्वारा निम्नलिखित समय-सीमा तक कच्चे अथवा मिश्रित अथवा लाभकारी कोयले (बेनिफिसिएटिड कोल), जिसमें ऐश सामग्री चौंतीस प्रतिशत (34%) से अधिक ना हो, का उपयोग करने के लिए त्रैमासिक आधार पर कोयला आधारित ताप विद्युत संयंत्रों को अधिदेशित किया गया है :

क्रम सं.	विद्युत संयंत्र की श्रेणी	गर्तमुख(पिट-हैड)/कोयला खान से ताप विद्युत संयंत्र के अवस्थान की दूरी	समय-सीमा
(क)	एकल ताप विद्युत संयंत्र (किसी भी क्षमता के) और कैटिप्ट ताप विद्युत संयंत्र (100 मेगावाट और अधिक क्षमता सहित)	गर्तमुख विद्युत संयंत्रों को छोड़कर गर्तमुख से दूरी पर ध्यान दिए बिना शहरी क्षेत्रों,या परिस्थितिकीय रूप से संवेदनशील क्षेत्रों या अत्यधिक प्रदूषित क्षेत्रों में अवस्थित	2 जून, 2014 से प्रभावी।
(ख)		1000 किमी से अधिक दूर	2 जून, 2014 से प्रभावी।
(ग)		750-1000 किमी के बीच	1 जनवरी, 2015 से प्रभावी।
(घ)		500-749 किमी के बीच	5 जून, 2016 से प्रभावी।

और जबकि, केंद्रीय सरकार ने पर्यावरण (संरक्षण) नियमावली के नियम 5 के उप-नियम (3) के साथ पठित पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 6 और धारा 25 के अधीन अपनी शक्तियों का प्रयोग करते हुए भारत के राजपत्र, असाधारण में स.का.आ. 3305 (अ), तारीख 7 दिसंबर, 2015 और सा.का.नि.593 (अ), तारीख 28 जून, 2018 द्वारा विद्युत उत्पादन की क्षमता और विद्युत संयंत्र की संस्थापना की तारीख और समय-बद्ध रीति से प्राप्त किए जाने के आधार पर ताप विद्युत संयंत्रों की विभिन्न श्रेणियों के लिए उत्सर्जन मानकों और विनिर्दिष्ट जल उपभोग को प्रकाशित किया था।

और जबकि, पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय ने विद्युत मंत्रालय द्वारा दिनांक 13 अक्तूबर, 2017 को प्रस्तुत की गई यथा संशोधित योजना के अनुसार विभिन्न ताप विद्युत संयंत्रों को वर्ष 2022 तक प्रदूषण नियंत्रण उपकरण संस्थापित करने के लिए पर्यावरण (संरक्षण) अधिनियम, 1986 की धारा 5 के तहत निर्देश जारी करने के लिए केंद्रीय प्रदूषण नियंत्रण बोर्ड को दिनांक 7 दिसंबर, 2017 के फा.सं. क्यू-15017/40/2007-सीपीडब्ल्यू द्वारा निदेश दिए।

और जबकि, विद्युत मंत्रालय ने अन्य बातों के साथ-साथ यह अभ्यावेदन किया है कि प्रदूषण नियंत्रण प्रौद्योगिकियों के उन्नत होने के साथ ही ताप विद्युत संयंत्र दहन प्रक्रिया से उत्पन्न फ्लाई-ऐश का पता लगाने में बेहतर उपकरणों से सुसज्जित हुए हैं और बिना धुला कोयला अधिक कुशलता और मितव्ययता से प्रयोग किया जा सकता है; ताप विद्युत संयंत्रों को राख अवयवों की विभिन्न किस्मों के साथ कोयले के लिए डिजाइन किया गया है और इनमें सूखी राख (ड्राई ऐश) निकालने, उसका रखरखाव करने और राख के उपयोग के लिए आपूर्ति प्रणालियों को उपलब्ध कराया गया है; धुले कोयले के उपयोग से बिजली उत्पादन महंगा हो जाता है; ताप विद्युत संयंत्रों में उत्पन्न फ्लाई-ऐश सीमेंट निर्माण, ईंटें बनाने, सड़क बिछाने, खनन के उपरांत रिक्त हुए स्थलों और निचले क्षेत्रों को भरने के लिए बैक-फिल सामग्री जैसे कई लाभकारी उपयोगों के लिए प्रयोग की जा रही है; औसतन ऐश की मात्रा 34% तक बनाए रखने की आवश्यकता उद्योगों को कोयले का आयात करने के लिए प्रेरित करती है जिससे विदेशी मुद्रा इत्यादि का बहिर्वाह (आऊटफ्लो) होता है।

और जबकि, कोयला मंत्रालय ने अन्य बातों के साथ-साथ अभ्यावेदन किया है कि कोयला खानें वर्षों से कच्चे कोयले की गुणवत्ता, आकार और बाहरी सामग्री में सुधार के लिए निरंतर कड़े प्रयास कर रही हैं जिससे सभी संबंधित उपकरणों की टूट-फूट में उल्लेखनीय कमी आई है, कोयला धुलाई प्रक्रिया में कई प्रकार का रखरखाव होता है और कोयला खानों से धुलाई-स्थलों (वाशरीज़) तक कोयले की बड़ी मात्रा को सड़क द्वारा ले जाने और फिर आगे

विद्युत संयंत्रों तक ले जाने के लिए रेल साइडिंग्ज़ तक ले जाने से बचना; धुलाई की प्रक्रिया केवल कोयले को धुले हुए कोयले और वाशरी अवशिष्ट में बाँटती है जबकि खनित कोयले की राख की मात्रा वही रहती है; निम्न श्रेणी कोयला वाशरी अवशिष्ट कई छोटे उपयोगकर्ता उद्योगों में, अधिक प्रदूषण आदि सृजित करते हैं।

और जबकि, कोयला मंत्रालय और विद्युत मंत्रालय ने इसलिए अनुरोध किया है कि दिनांक 2 जनवरी, 2014 की अधिसूचना पर पुन: विचार द्वारा, विद्युत संयंत्रों को धुले हुए कोयले के प्रयोग के लिए अधिदेशित करने पर गौर किया जाना अपेक्षित है जिससे पर्यावरण पर प्रतिकूल प्रभाव डाले बिना कोयले की लंबी दूरी की ढुलाई के लिए बिजली के उत्पादन में आसानी होगी।

और जबकि, नीति आयोग ने अपनी रिपोर्ट में वाशरीज़, कोयला खनन, परिवहन और विद्युत संयंत्रों में कोयले की खपत की दृष्टि से इस विषय का विश्लेषण करने के बाद अन्य बातों के साथ-साथ संक्षिप्त में यह अभ्यावेदन किया है कि समीपवर्ती उद्योगों में वाशरी अवशिष्ट का इस्तेमाल अधिक प्रदूषण पैदा करता है; चूंकि वाशरी अवशिष्ट अनेक छोटे उद्योगों में वितरित होते हैं, इसलिए विद्युत संयंत्र पर उत्पन्न प्रदूषण की तुलना में अनेक स्थलों पर उत्पन्न प्रदूषण को नियंत्रित करना अधिक कठिन होता है; धुलाई प्रक्रिया में उत्पन्न राख (ऐश) कोयला कणों के साथ-साथ पानी को भी प्रदूषित करती है और इसका लाभकारी उपयोग नहीं किया जा सकता, कोयला धुलाई प्रक्रिया में पानी का अधिक प्रयोग होता है, अपशिष्ट सृजन होता है; वाशरी अवशिष्ट के निपटान का पर्यावरण पर प्रतिकूल प्रभाव होता है क्योंकि इसमें बड़ी मात्रा में निम्न श्रेणी कोयला अवशिष्ट, तरल अपशिष्ट प्रवाह, कोयला भण्डारण, कोयला मिट्टी का रखरखाव, अपवाह और उड़ने वाली धूल का रखरखाव और निपटान करना होता है, कोयला धुलाई का स्थलाकृति, जल निकास स्वरूप और गुणवत्ता, जल निकायों, बड़े पैमाने पर प्रतिवेशी वायु गुणवत्ता पर भी प्रतिकूल प्रभाव पड़ता है; धुलाई प्रक्रिया से विद्युत उत्पादन की लागत में भी वृद्धि होती है जिसका कोई पर्यावरणीय लाभ इत्यादि भी नहीं होता।

और जबकि, नीति आयोग ने इसलिए सिफारिश की है कि पर्यावरणीय और प्रदूषण मानकों का निर्धारण करना और उन्हें लागू करना विवेकपूर्ण होगा, जिन्हें कोयले में ऐश की मात्रा प्रतिबंधित किए जाने के बजाए, परिवहन दूरी के आधार पर विद्युत उत्पादकों के साथ जोड़ा जाना चाहिए।

और जबकि, पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय ऊर्जा मंत्रालय, कोयला मंत्रालय के अभ्यावेदनों, नीति आयोग और कई हितधारकों की रिपोर्ट पर विवेचन करने तथा सावधानीपूर्वक विचार करने के बाद एवं जनहित में निम्नलिखित निष्कर्ष पर पहुंचा है—

i) खनित कोयले में ऐश सामग्री की मात्रा समान रहती है। वाशरी से ऐश सामग्री दो स्थानों (वाशरी और विद्युत संयंत्र) में विभाजित हो जाती है जबकि बिना धुला कोयला विद्युत संयंत्र में प्रयोग किया जाता है, ऐश सामग्री का निपटान केवल एक स्थान अर्थात विद्युत संयंत्र में किया जाता है;

ii) ताप विद्युत संयंत्र प्रदूषण नियंत्रण, ऐश प्रबंधन के लिए तकनीकी रूप से सुसज्जित होते हैं क्योंकि उनमें फ्लाई-ऐश का निराकरण करने के लिए उच्च क्षमता वाले उपकरण होते हैं, ड्राई ऐश निष्क्रमण और हैंडलिंग सिस्टम, ऐश उपयोग के लिए सप्लाई सिस्टम और फ्लू गैसों को तितर-बितर करने के लिए बड़े टाल (स्टैक) होते हैं;

iii) पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय ने उत्सर्जन मानक अधिसूचित किए हैं जिनमें क्रमश: ताप विद्युत संयंत्रों को समयबद्ध रीति से इन मानकों का पालन करने के लिए अधिदेशित किया गया है;

और जबकि, फ्लाई ऐश प्रबंधन और विभिन्न स्तरों पर बिना धुले कोयले के संसाधन के दौरान उत्पन्न अन्य संबंधित पर्यावरणीय पहलुओं सहित बिना धुले कोयले की हैंडलिंग के लिए यथासंभव उत्कृष्ट कार्यढांचे को अपनाना समयोचित है।

और जबकि, कोयला मंत्रालय ने अभ्यावेदन किया है कि मौजूदा अप्रत्याशित कोविड-19 महामारी और इसके फलस्वरूप देश में ऊर्जा उत्पादन के लिए कोयला क्षेत्र की मांग को प्रोत्साहित कर घरेलू कोयले के उपयोग की तत्काल आवश्यकता को देखते हुए यह वांछनीय है कि तत्काल अधिसूचना जारी की जाए।

अब, इसलिए, केंद्रीय सरकार पर्यावरण (संरक्षण) नियमावली, 1986 के नियम 5 के उपनियम (4) के साथ पठित पर्यावरण संरक्षण अधिनियम, 1986 (1986 का 29) की धारा 3, धारा 6 और धारा 25 के तहत अपनी शक्तियों का प्रयोग करते हुए, उक्त नियमावती के नियम 5 के उपनियम (3) के भाग (अ) के तहत सूचना देने की अनिवार्यता को हटा देने के उपरांत जनहित में पर्यावरण (संरक्षण) नियमावली, 1986 को आगे संशोधित करते हुए एतद्वारा निम्नलिखित नियम बनाती है, अर्थात्:

1. (1) इन नियमों को पर्यावरण (संरक्षण) संशोधन नियमावली, 2020 कहा जाएगा।

(2) ये सरकारी गज़ट में प्रकाशित होने की तारीख से लागू होंगे।

2. पर्यावरण (संरक्षण) नियमावली, 1986 में, नियम 3 में, उपनियम (8) के लिए निम्नलिखित उपनियम प्रतिस्थापित होगा, अर्थात् :-

"(8) ताप विद्युत संयंत्रों को, ऐश सामग्री अथवा दूरी संबंधी अनुबंधों के बिना, निम्नलिखित शर्तों के अध्याधीन कोयले के प्रयोग की अनुमति होगी:

(1) उत्सर्जन मानदण्डों के लिए प्रौद्योगिकीय समाधान निर्धारित करना:

i. वर्तमान अधिसूचनाओं और केंद्रीय प्रदूषण नियंत्रण बोर्ड द्वारा समय-समय पर जारी अनुदेशों के अनुसार विविक्त सामग्री के लिए विनिर्दिष्ट मानदंडों का अनुपालन करना।

ii. वाशरी के मामले में मिडलिंग और अवशिष्टों का एफबीसी(तरलीकृत तल दहन) प्रौद्योगिकी आधारित विद्युत संयंत्रों में उपयोग किया जाए। एफबीसी संयंत्रों में मिडलिंग और अवशिष्टों के लिए वाशरी में संयोजन (लिंकेज) होना चाहिए।

2. ऐश पॉन्ड का प्रबंधन:

i. ताप विद्युत संयंत्र धुले हुए कोयले से बिना धुले हुए कोयले पर स्विच करने के कारण फ्लाई-ऐश पॉन्ड(मौजूदा विद्युत उत्पादन क्षमता) की अतिरिक्त क्षमता की पात्रता प्राप्त किए बिना, समय-समय पर जारी की गई अधिसूचनाओं में यथा-अधिसूचित शर्तों का पालन करें।

ii. ऐश प्रबंधन के लिए जल की खपत को अनुकूल करने हेतु समुचित प्रौद्योगिकी समाधान लागू हों;

iii. यदि आवश्यक हो तो फ्लाई-ऐश का अधिकतम उपयोग सुनिश्चित करने के लिए स्थल विशिष्ट स्थितियों के आधार पर ऐश का पृथक्करण इलैक्ट्रो-स्टेटिक अवक्षेपक (प्रेसीपिटेटर) स्तर पर किया जाए।

iv. ताप विद्युत संयंत्र उपर्युक्त 2(i) के अध्याधीन, छोड़ी हुई अथवा चालू खानों (वर्किंग माइन्स) में (खान मालिकों द्वारा सुविधाजनक बनाया जाए) पर्यावरणीय सुरक्षा उपायों के साथ फ्लाई-ऐश का निपटान करें।

3. परिवहन:

i. ढके हुए रेलवे वैगन (तिरपाल अथवा किसी अन्य माध्यम से ढके हुए रेलवे वैगन) और/अथवा खान-क्षेत्र से परे ढके हुए वाहक (कन्वेयर) द्वारा ही कोयले का परिवहन किया जाए। तथापि, जब तक रेल परिवहन/वाहक इन्फ्रास्ट्रक्चर उपलब्ध नहीं हो जाता, सड़क परिवहन ट्रकों द्वारा किया जाए जो तिरपाल अथवा किसी अन्य माध्यम से ढके हुए हों।

ii. ताप विद्युत संयंत्र द्वारा सुनिश्चित किया जाए कि

(क) रेल अथवा कन्वेयर द्वारा परिवहन के लिए विद्युत संयंत्र में अथवा इसके समीप रेल साइडिंग सुविधा अथवा कन्वेयर सुविधा स्थापित हो; और

(ख) यदि रेल अथवा कन्वेयर सुविधा की अनुपलब्धता के कारण परिवहन न हो पाए, तो यह सुनिश्चित किया जाए कि संबंधित खान के डिलीवरी स्थान से कोयले का परिवहन ढके हुए ट्रकों (तिरपाल अथवा किसी अन्य माध्यम द्वारा), अथवा किसी अन्य यंत्रीकृत बंद ट्रक से सड़क द्वारा हो।

(4) इसे वित्तीय वर्ष 2020-21 और उसके बाद के लिए संबंधित परियोजनाओं हेतु संगत पर्यावरणीय स्वीकृति की अतिरिक्त शर्तें भी समझा जाएगा। मौजूदा पर्यावरणीय स्वीकृतियों को संशोधित किया जाएगा ताकि संगत क्षेत्रों के लिए उपरोक्त शर्तों को प्रवर्तनशील बनाया जा सके। तदनुसार संबंधित राज्य प्रदूषण नियंत्रण बोर्ड द्वारा प्रचालन की अनुमति जारी की जाएगी।

[फा.सं. 13014/01/2020–आईए-I(टी)]

गीता मेनन, संयुक्त सचिव

टिप्पण—मूल नियम भारत के राजपत्र में सं.का.आ. 844(अ), तारीख 19 नवंबर 1986 द्वारा प्रकाशित किए गए थे और पश्चातवर्ती संशोधन सं.का.आ. 82(अ), तारीख 16 फरवरी, 1987; का.आ. 64(अ), तारीख 18 जनवरी, 1988; सा.का.नि. 931(अ), तारीख 27 अक्तूबर,1989; का.आ. 23(अ), तारीख 16 जनवरी, 1991; सा.का.नि. 95(अ), तारीख 12 फरवरी, 1992; सा.का.नि. 329(अ), तारीख 13 मार्च, 1992; सा.का.नि. 562(अ), तारीख 27 मई, 1992; सा.का.नि. 884(अ), तारीख 20 नवंबर, 1992; सा.का.नि. 386 (अ), तारीख 22 अप्रैल, 1993; सा.का.नि. 422 (अ), तारीख 19 मई, 1993; सा.का.नि. 801 (अ), तारीख 31 दिसंबर, 1993; सा.का.नि. 320 (अ), तारीख 16 मार्च, 1994; सा.का.नि. 560 (अ), तारीख 19 सितंबर, 1997; सा.का.नि. 378 (अ), तारीख 30 जून, 1998; सा.का.नि. 07 (अ), तारीख 22 दिसंबर, 1998; सा.का.नि. 407 (अ), तारीख 31 मई, 2001; सा.का.नि. 826 (अ), तारीख 16 नवंबर, 2009; सा.का.नि. 513 (अ), तारीख 28 जून, 2012; सा.का.नि. 02 (अ), तारीख 02 जनवरी, 2014; का.आ. 3305 (अ), तारीख 07 दिसंबर, 2015; सा.का.नि. 593 (अ), तारीख 28 जून, 2018; और का.आ. 236 (अ), तारीख 16 जनवरी, 2020 द्वारा किए गए।

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 21st May, 2020

S.O. 1561(E).—Whereas the Central Government had, in exercise of its powers under Section 3, Section 6 and Section 25 of Environment (Protection) Act, 1986 (29 of 1986) read with rule 5 of Environment (Protection) Rules, 1986, published draft rules further to amend sub-rule (8) of rule 3 of Environment (Protection) Rules, 1986, in the Gazette of India, Extraordinary, *vide* number G.S.R. 02(E), dated the

2nd January, 2014 mandating certain categories of thermal power plants to use coal with ash content restricted to 34%.

And whereas, the said Notification *vide* number G.S.R. 02(E) dated the 2nd January, 2014, mandated coal based thermal power plants to use raw or blended or beneficiated coal with ash content not exceeding thirty-four percent (34%), on quarterly basis, by the time lines given below:

Sl. No.	Category of Power Plant	Distance of location of Thermal Power Plant from pit-head/coal mine	Time lines
(a)	Stand-alone Thermal Power Plants (any capacity), and Captive Thermal Power Plants (with capacity of 100 MW and above)	Located in urban areas, or ecologically sensitive areas or critically polluted areas, irrespective of distance from pit-head, except pit-head power plants.	With effect from 2nd June, 2014.
(b)		beyond 1000 km	With effect from 2nd June, 2014.
(c)		between 750-1000 km	With effect from 1st January, 2015.
(d)		between 500-749 km	With effect from 5th June, 2016.

And whereas, the Central Government had, in exercise of its powers under sections 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986) read with sub-rule (3) of rule 5 of the Environment (Protection) Rules, in the Gazette of India, Extraordinary, *vide* number S.O. 3305 (E), dated the 7th December, 2015 and G.S.R. 593 (E), dated the 28th June, 2018 published the emission standards and specific water consumption for various category of thermal power plants, based on capacity of power generation and date of installation of power plant and to be achieved in time bound manner.

And whereas, the Ministry of Environment, Forest and Climate Change directed the Central Pollution Control Board vide F.No.Q-15017/40/2007-CPW dated the 7th December, 2017 to issue Directions under Section 5 of Environment (Protection) Act, 1986, to various Thermal Power Plants to install pollution control equipment as per the revised plan submitted by the Ministry of Power dated the 13th October, 2017 by 2022.

And whereas, the Ministry of Power has, *inter alia*, represented that with advancement in pollution control technologies, thermal power plants are better equipped to capture fly-ash generated in combustion process and unwashed coal can be used more efficiently and economically; thermal power plants are designed for coal with wide variety of ash content and are equipped with dry ash evacuation, handling and supply systems for ash utilisation; using washed coal makes power generation costlier; fly ash generated in thermal power plants is being used in several beneficial uses like cement manufacturing, brick making, road laying, back-fill material for reclamation of mine voids and low lying areas; requirement of maintaining average ash content to 34% prompts industries to undertake import of coal, resulting in outflow of foreign exchange etc.

And Whereas, the Ministry of Coal has, *inter alia*, represented that the coal mines are constantly striving to improve raw coal in terms of quality, size and extraneous material over the years which has considerably reduced wear and tear of all related equipment, coal washing process involves multiple handling and avoidable road transportation of huge quantities of coal from coal mines to washeries and then to rail sidings for onward transport to power plants; the washing process only divides the coal into washed coal and washery rejects while the ash content of mined coal remains the same; use of low grade coal washery rejects, in the multiple small user industries, generates more pollution etc.

And Whereas, the Ministry of Coal and Ministry of Power have, therefore, represented that the mandating power plants to use washed coal requires to be revisited by reconsidering the notification dated the 2nd January, 2014 which will help ease power generation for long distance haulage of coal without adverse impact on the environment.

And Whereas, the **NITI Aayog**, in its report after analysing the issue from the perspective of washeries, Coal mining, transportation and consumption of coal at power plants has, *inter alia*, summed up that use of washery rejects in nearby industries generates more pollution; since washery rejects are distributed in number of smaller industries, the pollution control at numerous points is more difficult than controlling the

pollution at power plant end; Ash generated in the washing process pollutes water along with coal particles and cannot be gainfully utilised; Coal washing process involves increased water use, effluent generation; Disposal of washery rejects has negative environmental impact as it has to handle and dispose huge quantity of low grade coal washery rejects, liquid effluent streams, coal storage, handling coal dust, runoff and fugitive dust; Coal washing also adversely impacts topography, water drainage pattern and quality, water bodies, surrounding air quality at large scale; Washing process increases the cost of power generation with no commensurate environmental advantages etc.

And Whereas, NITI Aayog has, therefore, recommended that it may be prudent to determine and enforce the environmental and pollution norms, to be complied with by the power generators, rather than restricting the ash content in coal, based on distance of transportation.

And Whereas, the Ministry of Environment, Forest and Climate Change, after deliberating the representations from Ministry of Power, Ministry of Coal, report of NITI Aayog and various stakeholders and after careful considerations & in larger public interest, arrived at the following:

(i) The extent of ash content in mined coal remains the same. With washeries, the ash content gets divided at two places (washeries and the power plant), whereas if unwashed coal is used in power plant, the ash content is handled at only one place viz. the power plant;

(ii) Thermal power plants are technologically equipped to address pollution control, ash management as they have high efficiency equipment to capture fly ash, dry ash evacuation and handling systems, ash supply systems for ash utilisation and tall stacks for wider dispersal of flue gases;

(iii) The Ministry of Environment, Forest and Climate Change has notified emission norms, mandating respective thermal power plants to adhere to such norms in a time bound manner;

And Whereas, it is expedient to adopt best possible framework towards handling of unwashed coal including management of fly ash and other associated environmental aspects arising out of processing of unwashed coal at different stages.

And Whereas, the Ministry of Coal has represented that in view of the existing unprecedented COVID-19 pandemic and the resultant immediate requirement of utilization of domestic coal by stimulating coal sector demand for power generation in the country, it is desirable to issue the notification at the earliest.

Now, therefore, in exercise of the powers conferred by Section 3, Section 6 and Section 25 of the Environment Protection Act, 1986 (29 of 1986) read with sub-rule (4) of rule 5 of the Environment (Protection) Rules, 1986, the Central Government, after having dispensed with the requirement of notice under clause (a) of sub-rule (3) of rule 5 of the said rules, in public interest, hereby makes the following rules to further amend the Environment (Protection) Rules, 1986, namely :-

1. (1) These rules may be called the Environment (Protection) Amendment Rules, 2020

   (2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Environment (Protection) Rules, 1986, in rule 3, for sub-rule (8), the following sub-rule shall be substituted, namely :-

"(8) Use of coal by Thermal Power Plants, without stipulations as regards ash content or distance, shall be permitted subject to following conditions:

(1) **Setting Up Technology Solution for emission norms:**

(i) Compliance of specified emission norms for Particulate Matter, as per extant notifications and instructions of Central Pollution Control Board, issued from time to time.

(ii) In case of washeries, Middling and rejects to be utilized in FBC (Fluidised Bed Combustion) technology based thermal power plants. Washery to have linkage for middling and rejects in Fluidised Bed Combustion plants.

(2) **Management of Ash Ponds:**

(i) The thermal powers plants shall comply with conditions, as notified in the Fly Ash notification issued from time to time, without being entitled to additional capacity of fly ash pond (for existing power generation capacity) on ground of switching from washed coal to unwashed coal.

(ii) Appropriate Technology solutions shall be applied to optimise water consumption for Ash management;

(iii) The segregation of ash may be done at the Electro-Static Precipitator stage, if required, based on site specific conditions, to ensure maximum utilization of fly ash;

(iv) Subject to 2(i) above, the thermal power plants to dispose flyash in abandoned or working mines (to be facilitated by mine owner) with environmental safeguards.

(3) **Transportation:**

(i) Coal transportation may be undertaken by covered Railway wagon (railway wagons covered by tarpaulin or other means) and/or covered conveyer beyond the mine area. However, till such time enabling Rail transport/conveyer infrastructure is not available, road transportation may be undertaken in trucks, covered by tarpaulin or other means.

(ii) It shall be ensured by the thermal power plant that

a. Rail siding facility or conveyor facility is set up at or near the power plant, for transportation by rail or conveyor; and

b. If transportation by rail or conveyor facility is not available, ensure that the coal is transported out from the Delivery Point of the respective mine in covered trucks (by tarpaulin or other means), or any mechanized closed trucks by road.

(4) This shall also be deemed to be additional conditions of the relevant Environmental Clearances for respective projects for financial year 2020-21 and onwards. The existing Environmental Clearances shall stand modified so as to make the above conditions operative for relevant sectors. The Consent to Operate shall be issued by respective State Pollution Control Boards accordingly."

[F.No.13014/01/2020-IA.I(T)]

GEETA MENON, Jt. Secy.

Note:-The principal rules were published in the Gazette of India *vide* number S.O. 844(E), dated the 19th November,1986 and subsequently amended *vide* numbers S.O. 82(E), dated 16th February, 1987; S.O. 64(E), dated18th January, 1988; G.S.R. 931(E), dated 27th October, 1989; S.O. 23(E), dated 16th January, 1991; G.S.R. 95(E), dated 12th February, 1992; G.S.R.329(E), dated 13th March, 1992; G.S.R. 562(E), dated 27th May, 1992; G.S.R. 884(E), dated 20th November, 1992; G.S.R. 386(E), dated 22nd April, 1993; G.S.R. 422(E), dated 19th May, 1993; G.S.R. 801(E), dated 31st December, 1993; G.S.R. 320(E), dated 16th March, 1994; G.S.R. 560(E), dated 19th September, 1997; G.S.R. 378(E), dated 30th June, 1998;G.S.R. 7(E), dated 22nd December, 1998; G.S.R. 407(E), dated 31st May, 2001; G.S.R. 826(E), dated 16th November, 2009; G.S.R. 513(E), dated 28th June, 2012; G.S.R. 02(E) dated 2nd January, 2014; S.O. 3305 (E), dated 7th December, 2015; G.S.R. 593(E), dated 28th June, 2018 and S.O. 236 (E), dated 16th January, 2020.

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[1][90. STANDARDS FOR COAL MINES

1. AIR QUALITY STANDARDS

The Suspended Particulate Matter (SPM), Respirable Particulate Matter (RPM), Sulphur dioxide (SO_2) and Oxides of Nitrogen (NOx) concentration in downwind direction considering predominant wind direction, at a distance of 500 metres from the following dust generating sources shall not exceed the standards specified in the Tables I, II and III given below:

Dust Generating Sources

Loading or unloading, Haul road, coal transportation road, Coal handling plant (CHP), Railway sliding, Blasting, Drilling, Overburden dumps, or any other dust generating external sources like coke ovens (hard as well as soft), briquette industry, nearby road etc.

Table-I

Category	Pollutant	Time weighted average	Concentration in Ambient Air	Method of Measurement
1	2	3	4	5
I New Coal Mines (Coal Mines commenced operation after the date of publication of this notification)	Suspended Particulate Matter (SPM)	Annual Average * 24 hours **	360 µg/m^3 500 µg/m^3	- High Volume Sampling (Average flow rate not less than 1.1 m^3/min)
	Respirable Particulate Matter (size less than 10 µm) (RPM)	Annual Average * 24 hours **	180 µg/m^3 250 µg/m^3	Respirable Particulate Matter sampling and analysis
	Sulphur Dioxide (SO_2)	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	- Improved west and Gaeke method - Ultraviolet fluorescene
	Oxide of Nitrogen as NO_2	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	- Jacob & Hochheiser Modified (Na-Arsenic) Method - Gas phase Chemiluminescence

[1] Serial No 90 to 93 and entries relating thereto were inserted by Rule 2(1) of the Environment (Protection) Amendment Rules, 2000 notified vide notification G S R. 742(E), dated 25 9 2000

Table-II

Category	Pollutant	Time weighted average	Concentration in Ambient Air	Method of Measurement
1	2	3	4	5
II Existing coal fields/mines given below: Karanpura, Ramgarh, Giridih, Rajhara, Wardha, Nagpur, Silewara, Pench Kanhan, Patharkhera, Umrer, Korba, Chirimiri, Central India Coalfields, (including Baikunthpur, Bisrampur), Singrauli, Ib Valley, Talcher, Godavary Valley and any other	Suspended Particulate Matter (SPM)	Annual Average * 24 hours **	430 $\mu g/m^3$ 600 $\mu g/m^3$	- High Volume Sampling (Average flow rate not less than 1.1 m^3/minute)
	Respirable Particulate Matter (size less than 10 µm) (RPM)	Annual Average * 24 hours **	215 $\mu g/m^3$ 300 $\mu g/m^3$	Respirable Particulate Matter sampling and analysis
	Sulphur Dioxide (SO_2)	Annual Average * 24 hours **	80 $\mu g/m^3$ 120 $\mu g/m^3$	1. Improved west and Gaeke method 2. Ultraviolet fluorescene
	Oxide of Nitrogen as NO_2	Annual Average * 24 hours **	80 $\mu g/m^3$ 120 $\mu g/m^3$	1. Jacob & Hochheiser Modified (Na-Arsenic) Method 2. Gas phase Chemilumine-scence

Table-III

Category	Pollutant	Time weighted average	Concentration in Ambient Air	Method of Measurement
1	2	3	4	5
III Coal mines located in the coal fields of • Jharia • Raniganj • Bokaro	Suspended Particulate Matter (SPM)	Annual Average * 24 hours **	500 µg/m^3 700 µg/m^3	- High Volume Sampling (Average flow rate not less than 1.1 m^3/minute)
	Respirable Particulate Matter (size less than 10 µm) (RPM)	Annual Average * 24 hours **	250 µg/m^3 300 µg/m^3	Respirable Particulate Matter sampling and analysis
	Sulphur Dioxide (SO_2)	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	1.Improved west and Gaeke method 2.Ultraviolet fluorescene
	Oxide of Nitrogen as NO_2	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	1. Jacob & Hochheiser Modified (Na-Arsenic) Method 2. Gas phase Chemilumine-scence

Note:

* Annual Arithmetic mean for the measurements taken in a year, following the guidelines for frequency of sampling laid down in clause 2.

** 24 hourly / 8 hourly values shall be met 92% of the time in a year. However, 8% of the time it may exceed but not on two consecutive days.

Unauthorised construction shall not be taken as a reference of nearest residential or commercial place for monitoring.

In case any residential or commercial or industrial place falls within 500 metres of any dust generating sources, the National Ambient Air Quality Standards notified under schedule VII shall be applicable.

2. FREQUENCY OF SAMPLING

- Air quality monitoring at a frequency of once in a fortnight at the dust generating sources given in clause 1 shall be carried out.

- As a result of monthly monitoring, if it is found that the value of the pollutant is less than 50% of the specified standards for three consecutive months, then the sampling frequency may be shifted to two days in a quarter year (3 months).

- In case, the value has exceeded the specified standards, the air quality sampling shall be done twice a week. If the results of four consecutive weeks indicate that the concentration of pollutants is within the specified standards, then fortnight monitoring may be reverted to.

3. EFFLUENT STANDARDS

The standards for effluent discharge into sewer or stream or land, are given below:

pH	–	5.5 to 9.0
Chemical Oxygen Demand (COD)	–	250 mg/l
Total Suspended Solids (TSS)	–	100 mg/l
		200 mg/l (Land for irrigation)
Oil & Grease (O & G)	–	10 mg/l

(Monitoring frequency of these parameters shall be once in a fortnight)

Optional parameters : All other parameters indicated in the general standards for discharge of environment pollutants under Schedule VI, shall be in addition to the effluent standards specified under clause 3. (Monitoring frequency shall be once in a year for the optional parameters)

4. NOISE LEVEL STANDARDS

	6.00 AM – 10.00 PM	**10.00 PM – 6.00 AM**
Noise level	**Leq 75 dB(A)**	**Leq 70 dB(A)**

(Monitoring frequency for noise level shall be once in a fortnight)
Occupational exposure limit of noise specified by Director General of Mines Safety (DGMS) shall be complied with by the local mines.