भारत कोकिंग कोल लिमिटेड
(कोल इण्डिया लिमिटेड की एक अनुषंगी कंपनी)
Bharat Coking Coal Limited
(A Subsidiary of Coal India Limited)
(एक मिनीरत्न कंपनी / A Miniratna Company)
(भारत सरकार का उपक्रम / A Government of India Undertaking)

Ref: BCCL/GM/Ar.III/ 25-26/ 2961

Date: 25.11.2025

To
The Director
Ministry of Environment, Forest & Climate Change
2nd Floor, Headquarter- Jharkhand State Housing Board
Harmu Chowk
Ranchi, Jharkhand-834002

Subject: Six monthly reports on implementation of Environmental measures for the period from April 2025 to September 2025 in respect of Cluster –III, BCCL

Ref.: -EC File No. : J-11015/213/2010-IA.II(M) dated 03.03.2025

Dear Sir,

Kindly find herewith the enclosed six-monthly report on implementation of Environmental measures for the period from **April 2025 to September 2025 in respect of Cluster –III, BCCL.**

This is for your kind information, please.

Yours faithfully

General Manager
Govindpur Area
(Cluster-III), BCCL

महाप्रबन्धक
General Manager
गोविन्दपुर क्षेत्र /Govindpur Area
भा.को.कों.लि /B.C.C.L

Six Monthly EC Compliance Report for Cluster-III Coal Mine BCCL, File no: J-11015/213/2010-IA.II(M) Proposal No. IA/JH/CMIN/513800/2024, Date of EC grant: 03.03.2025

Sl no	EC Condition	EC Compliance Status
	1. A. Specific Conditions:	
1.1	The project proponent shall abide by all orders and judicial pronouncements, made from time to time by the Hon'ble High Court of Jharkhand in Writ Petition No. 4944 of 2011.	Writ Petition No. 4944 of 2011 has been disposed of by Hon'ble High Court of Jharkhand. Copy is enclosed herewith.
1.2	Project proponent shall ensure that diversion of water body, if any, in Cluster III Coal Mine Project shall be done with prior approval of State Government and prior amendment in EC will be sought from MoEF&CC for the same.	Agreed. Necessary prior approval shall be taken from State Government and MoEF&CC.
1.3	3756 Project Affected Families (PAF) will be affected due to the proposed project. The affected families should be rehabilitated as per R & R plan to be approved by the State Government. Compliance status in this regard shall be submitted to the concerned Regional Office of MoEF&CC along with the six-monthly compliance report.	The rehabilitation of Project-Affected Families (PAFs) is an ongoing process jointly conducted by BCCL and the Jharia Rehabilitation Development Authority (JRDA). The initiative has already begun, and 200 families have been relocated to date.
1.4	Rapid Loading System with Silo arrangement (RLS) within the lease area shall become operational by 30/06/2025 as committed. Coal from mine to the RLS shall be transported by covered dumpers. Road transportation of coal outside the lease area is not permitted beyond 30/06/2025.	Agreed. Shall be complied.
1.5	Four numbers of Continuous Ambient Air Quality monitoring system shall be set up to monitor common/criteria pollutants such as PM10, PM2.5, SO2, NOX within the lease area in consultation with concerned SPCB within six months from the date of EC amendment. The monitoring of other locations (at least three locations outside the lease area covering upwind and downwind directions at an angle of 120° each) shall be carried out manually.	Being complied. Purchase order has been placed for procurement and installation of 4 nos. CAAQMS. (copy of GeM Purchase order is enclosed herewith)
1.6	The budget proposed to address the issues raised during PH is Rs. 7.45 crores. Compliance status in this regard shall be submitted to the concerned Regional Office along with the six-monthly compliance report and also be uploaded on the web portal of the company	Being complied. Details of expenditure incurred on issues raised during public hearing is enclosed herewith as **Annexure-I.**
1.7	PP shall implement the protective measures proposed in EMP in a time-bound manner. The budget earmarked is Rs 276.27 crores (Capital) (including R&R cost) and Rs 344.45 lakhs (recurring) and should be kept in separate accounts and audited annually. The implementation status along with the amount spent with documentary proof shall be submitted to the concerned Regional Office for the activities carried out during the previous year	Being complied. Details of expenditure incurred as per EIA/EMP is enclosed herewith as **Annexure-II.**
1.8	PP shall ensure that no OB dumping is done outside the mine lease area.	Being complied. OB dumping is being done within leasehold of Cluster-III.
1.9	PP shall emphasize for using and developing Renewable Energy for its consumption in its utilities/machinery/equipment instead of using electricity from Grid/generated from Thermal Power Plants. PP shall install solar power generation units. Compliance	Being complied. 88 KWP roof top solar power plant has been set up at CISF Camp, NAKC. Photographs are enclosed herewith.

	status in this regard shall be submitted to the concerned Regional Office along with the six-monthly compliance report and also be uploaded on the web portal of the company.	
1.10	PP shall minimize mine voids in the post mining phase so that maximum area postmining is under green belt or agriculture/ grazing land	Includes post mining condition. Shall be complied.
1.11	Project proponent shall prepare Watershed management plan through a reputed government agency. Project proponent shall submit the same along with the matrix containing action plan to comply with the recommendations of the study report with physical & financial outlay to the concerned Regional Office of the MoEF&CC within six months from the date of grant of EC amendment. Compliance to the action plan shall be monitored by the concerned Regional Office of the MoEF&CC.	Being complied. watershed management plan for cluster-III has been prepared by IIT (ISM), Dhanbad. Copy of the plan is enclosed herewith as **Annexure-III.**
1.12	Afforestation shall be done progressively covering an area of: 795.54 ha at the end of mining. This will include Reclaimed external OB dump (in ha): 36.68, internal dump (in ha): 690.17, Green belt (in ha): 68.69 (Safety Zone and existing). Local and fruit bearing species are being/ will be planted in consultation with state forest department. In addition to this, Agro forestry shall be encouraged in consultation with the land owners. Further, PP shall provide 50,000 plant saplings with 4 feet tall fruit bearing plants to farmers for plantation in barren and agriculture lands in the study area every year for 5 years with incentive to improve the green cover in and around the mine lease area.	Being complied. Plantation is being done regularly on available spaces. Copy of work order issued to DFO, Dhanbad for plantation in FY 25-26 is enclosed herewith as **Annexure-IV. Total Plantation in FY 25-26 is 4.75 ha.**
1.13	PP shall conduct Carbon Sequestration Study including carbon emissions from coal mining. Compliance status in this regard shall be submitted along with the six monthly compliance to the concerned Regional Office and also kept on the web portal of the company.	Being complied. Work Order for conducting "Carbon Sequestration Study including carbon emissions from coal mining" has been issued to IIT Kharagpur. Copy of the work order is enclosed herewith as **Annexure-V.**
1.14	The proposed project shall be operated on closed water circuit with a concept of 'Zero Liquid Discharge' (ZLD). 100% water will be recycled and no treated & untreated wastewater shall be discharged outside the boundaries of mine lease area	Being complied.
1.15	PP shall carry out a survey of the impact of blasting in the nearby area/villages by involving a reputed institute and take remedial measures as proposed by the respective institute. Further, provide compensation if any for any damage caused. PP must give crop compensation to the farmers in case there is decrease in the production due to the mining activities. Compliance status in this regard shall be submitted along with the six monthly compliance to the concerned Regional Office.	Being complied. Work order has been issued to BIT Sindri (copy of work order is enclosed herewith).
1.16	To control the production of dust at the source, the crusher shall be equipped with mist-type sprinklers. PP shall install fixed fog cannon (mist spayer) and fixed sprinkler all along the haul road/ CHP, and OB dump till Railway siding is completed. The sufficient number of fog cannons with 40 mts jet length shall be installed within	Being complied. 3 nos. trolley mounted fog cannon (100 mtr range), 1 no. Truck Mounted fog cannon system have been installed in cluster-III in addition to water sprinklers.

	6 months from the date of grant of EC amendment. It should be ensured that air pollution level confirm to the standards prescribed by the MOEFCC/CPCB. Also PP shall install Mist Cannon Dust Suppression Systems (80-100 mtrs.) at Coal Stock Yard to suppress the dust particles.	
1.17	PP shall make use of advanced computer simulation techniques for design and execution of blasting operation in the mine. PP shall make use of Electronic Delay Detonators for optimal blasting in coal and OB rock to minimize the environmental impacts of blasting such as ground vibration, fly rocks and excessive dust generation.	Being complied. Electronic detonators are being used for blasting to minimize impacts of blasting such as ground vibration, fly rocks and excessive dust generation.
1.18	PP shall create a "Public Grievance Redressal and Monitoring System" for resolving any issues related to the pollution of mines and complaint has to resolve as soon as possible not beyond 30 days. In this regard, adequate awareness to be spread among the public to address their grievance to company with simple and easy manner and for which company needs to devise the mechanism. The same shall be reported to IRO within 3 months. A logbook to be maintained by PP on "Public Grievance Redressal and Monitoring System.	Being complied. Public Grievance Redressal and Monitoring System exist in BCCL and link of portal is available on BCCL website vide https://www.bcclweb.in/?page_id=4133&lang=en
1.19	Third-party audit (by NEERI/CIMFR/IIT/NITs) for air & water quality shall be carried out annually to keep a check on the same. PP shall implement the recommendations of the audit and submit the outcome of the audit to the concerned RO of MoEF&CC	Being Complied. LOA has been issued to IIT (ISM), Dhanbad for conducting the third party audit (copy enclosed herewith).
1.20	The status of mine closure activities must be included in every six months compliance report submitted to the state pollution control board and RO of MoEF&CC.	Progressive mine closure activities are being implemented as per approved mine closure plan. Status of the same is enclosed herewith as **Annexure-VI**.
1.21	Hon'ble Supreme Court in an Writ Petition(s) Civil No. 114/2014, Common Cause vs Union of India &Ors vide its judgement dated 8th January, 2020 has directed the Union of India to impose a condition in the mining lease and a similar condition in the environmental clearance and the mining plan to the effect that the mining lease holders shall, after ceasing mining operations, undertake re grassing the mining area and any other area which may have been disturbed due to their mining activities and restore the land to a condition which is fit for growth of fodder, flora, fauna etc. Compliance of this condition after the mining activity is over at the cost of the mining lease holders/Project Proponent". The implementation report of the above said condition shall be sent to the Regional Office of the MoEF&CC.	Grassing on OB dumps is being taken up regularly. Photographs of seed ball distribution on OB dumps is enclosed herewith.
1.22	PP should establish in house (at project site) environment laboratory for measurement of environment parameter with respect to air quality and water (surface and ground. A dedicated team to oversee environment management shall be setup which should comprise of Environment Engineers, Laboratory chemist and staff for monitoring of air, water quality parameters on routine basis. Any non- compliance or infringement should be reported to the concerned authority.	Regular monitoring of ambient air and water (surface and ground) quality is being done by RI-II, CMPDIL Dhanbad (A NABL Accredited Lab).

<table>
<tr><td>1.23</td><td>PP shall ensure that all types of plastic waste generated from the plant shall be stored separately in isolated area and disposed of strictly adhering to the Plastic Waste Management Rules 2016 (as amended). In pursuant to the Ministry's OM dated 18/07/2022. PP shall also create awareness among the people working in the project area as well as in its surrounding area on the ban on Single Use Plastic (SUP) in order to ensure compliance of Ministry's Notification published by the Ministry on 12/08/2021. A report along with photograph on the measures taken shall also be included in the six monthly compliance report being submitted by PP.</td><td>Being complied.</td></tr>
<tr><td>1.24</td><td>Total water requirement for the project is 17477 KLD and the same shall be met from groundwater and mine water. PP shall obtain requisite NoC for withdrawal of Groundwater from CGWA prior to the commencement of mining operations.</td><td>Complied. NoC has been obtained from CGWA dated 21.02.2025. Copy of the same is enclosed herewith.</td></tr>
<tr><td>1.25</td><td>Project proponent is advised to implement the 'Ek Ped Maa Ke Naam' Campaign which was launched on 5thJune 2024 on the occasion of the World Environment Day to increase the forest cover across the Country. This plantation drive is other than green belt development. The action in this regard shall be submitted concerned RO in six monthly report.</td><td>Being complied.</td></tr>
<tr><td></td><td>Standard EC Conditions for (Mining of minerals)</td><td></td></tr>
<tr><td colspan="2">1. Statutory Compliance</td><td></td></tr>
<tr><td>1.1</td><td>The Environmental clearance shall be subject to orders of Hon'ble Supreme Court of India, Hon'ble High Courts, NGT and any other Court of Law, from time to time, and as applicable to the project</td><td>Agreed to comply.</td></tr>
<tr><td>1.2</td><td>The project proponent shall obtain clearance from the National Board for Wildlife, if applicable.</td><td>Not applicable for Cluster-III.</td></tr>
<tr><td>1.3</td><td>Solid/hazardous waste generated in the mines needs to addressed in accordance to the Solid Waste Management Rules, 2016/Hazardous & Other Waste Management Rules, 2016.</td><td>Being complied.</td></tr>
<tr><td>1.4</td><td>The maximum production or peak production at any given time shall not exceed the limit as prescribed in the EC.</td><td>Agreed to comply. Coal Production from Cluster-III is within EC limit as mentioned below:
<table>
<tr><th rowspan="2">Sl No</th><th rowspan="2">EC Production Capacity (MTPA)</th><th colspan="3">Actual Production (Million Te)</th></tr>
<tr><th>FY 23-24</th><th>FY 24-25</th><th>FY 25-26 (up to 30.09.25)</th></tr>
<tr><td>1</td><td>3.600</td><td>0.976296</td><td>1.241</td><td>0.0272882</td></tr>
</table></td></tr>
<tr><td>1.5</td><td>Validity of EC would be governed by the existing EC dated 06/02/2013</td><td>Agreed.</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

	2. Air Quality Monitoring And Mitigation Measure	
2.1	Project proponent shall obtain requisite consent from State Pollution Control Board for amalgamated mine with a production capacity of 3.6 MTPA.	Complied. CTE has been granted by JSPCB (copy is enclosed herewith).
2.2	Adequate ambient air quality monitoring stations shall be established in the core zone as well as in the buffer zone for monitoring of pollutants, namely particulates, SO2 and NOx. Location of the stations shall be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive receptors in consultation with the State Pollution Control Board.	Complied. Monitoring stations have been set up in consultation with JSPCB
2.3	The Ambient Air Quality monitoring in the core zone shall be carried out to ensure the Coal Industry Standards notified vide GSR 742 (E) dated 25th September, 2000 and as amended from time to time by the Central Pollution Control Board. Data on ambient air quality and heavy metals such as Hg, As, Ni, Cd, Cr and other monitoring data shall be regularly reported to the Ministry/Regional Office and to the CPCB/SPCB	Being complied. CMPDIL (A NABL Accredited Lab) carries out AAQM at locations fixed by JSPCB. Monitoring reports are enclosed herewith as **Annexure-VII.**
2.4	Effective control measures such as regular water sprinkling/rain gun/ Fog cannon /mist sprinkling etc., shall be carried out in critical areas prone to air pollution with higher level of particulate matter all through the coal transport roads, loading/unloading and transfer points. Fugitive dust emissions from all sources shall be controlled regularly. It shall be ensured that the ambient air quality parameters conform to the norms prescribed by the Central/State Pollution Control Board.	Being complied. Regular water sprinkling is being done on dust prone areas. CMPDIL (A NABL Accredited Lab) carries out AAQM at locations fixed by JSPCB. Monitoring reports are enclosed herewith as **Annexure-VII.**
2.5	Major approach roads shall be black topped and properly maintained.	Being complied. Public coal transportation roads are being converted into PQC roads (Copy of work order issued is enclosed in Annexure-I).
2.6	Vehicular emissions shall be kept under control and regularly monitored. All the vehicles engaged in mining and allied activities shall operate only after obtaining 'PUC' certificate from the authorized pollution testing centres.	Coal transportation vehicles with valid PUC certificates are being used for transportation on public roads.
2.7	PP should Install Wind breaker/shield arrangement along the railway siding for reducing the dust propagation in upwind direction.	Being complied.
2.8	The raw coal shall be stacked properly at earmarked site (s) within stockyards fitted with wind breakers/shields. Adequate measures shall be taken to ensure that the stored mineral does not catch fire.	Being complied. Coal is being stacked at designated place within mine area.
2.9	PP shall submit an action plan for using and developing Renewable Energy for its consumption in its utilities/machinery/equipment instead of using electricity from Grid/generated from Thermal Power Plants. PP shall Install additional solar power generation units.	A rooftop solar plant of 88kwp capacity has been installed. Identification of site for installation of additional solar plant is under process. (Photographs of installed rooftop solar plant is enclosed herewith).
2.10	PP shall install the weather monitoring system along with new CAAQMS shall be installed in which all the parameters like PM10, PM2.5, SO2, NOX should be there.	Being complied. Purchase order has been placed for procurement and installation of 4 nos. CAAQMS. (copy of GeM Purchase order is enclosed herewith).

Six Monthly EC Compliance Report for Cluster-III Coal Mine BCCL, File no: J-11015/213/2010-IA.II(M)
Proposal No. IA/JH/CMIN/513800/2024, Date of EC grant: 03.03.2025

	3. Water Quality Monitoring And Mitigation Measures	
3.1	The effluent discharge (mine waste water, workshop effluent) shall be monitored in terms of the parameters notified under the Water Act, 1974 Coal Industry Standards vide GSR 742 (E) dated 25th September, 2000 and as amended from time to time by the Central Pollution Control Board.	Regular monitoring is being done by CMPDIL (A NABL Accredited Lab). Monitoring reports are enclosed herewith as Annexure-VII.
3.2	The monitoring data shall be uploaded on the company's website and displayed at the project site at a suitable location. The circular No.J-20012/1/2006-IA.11 (M) dated 27th May, 2009 issued by Ministry of Environment, Forest and Climate Change shall also be referred in this regard for its compliance.	Being complied. separate section of "MONITORING" has been created on the website for monitoring data and can be accessed through link https://www.bcclweb.in/?page_id=15361&lang=en
3.3	The project proponent shall not alter major water channels around the site. Appropriate embankment shall be provided along the side of the river/nallah flowing near or adjacent to the mine. The embankment constructed along the river/nallah boundary shall be of suitable dimensions and critical patches shall be strengthened by stone pitching on the river front side, stabilized with plantation so as to withstand the peak water pressure preventing any chance of mine inundation.	Agreed to comply. Embankments have been provided along the water bodies, photographs are attached herewith as **Annexure-VIII.**
3.4	Garland drains (of suitable size, gradient and length) around the critical areas i.e. mine shaft and low lying areas, shall be designed keeping at least 50% safety margin over and above the peak sudden rainfall and maximum discharge in the area adjoining the mine sites. The sump capacity shall also provide adequate retention period to allow proper settling of silt material of the surface runoff	Being complied. Garland drain have been constructed around OB dumps at available spaces.
3.5	The water pumped out from the mine, after siltation, shall be utilized for industrial purpose viz. watering the mine area, roads, green belt development etc. The drains shall be regularly desilted particularly after monsoon and maintained properly	Being complied.
3.6	Industrial waste water from coal handling plant and mine water shall be properly collected and treated so as to conform to the standards prescribed under the Environment (Protection) Act, 1986 and the Rules made thereunder, and as amended from time to time. Oil and grease trap shall be installed before discharge of workshop effluent. Sewage treatment plant of adequate capacity shall be installed for treatment of domestic waste water.	Regular monitoring is being done by CMPDIL (A NABL Accredited Lab). Oil & grease trap has been provided at workshop.
3.7	An integrated surface drainage plan including surface water conservation plan for the area of influence affected by the said mining operations shall be prepared, considering the presence of any river/rivulet/pond/lake etc., with impact of mining activities on it, and implemented by the project proponent. The surface drainage plan and/or any diversion of natural water courses shall be as per the provisions of the approved Mining Plan/ EIA-EMP submitted to this Ministry and the same should be done with due approval of the concerned State/GoI Authority. The construction of embankment	Shall be complied. Embankments have been constructed along water bodies. (Photographs of embankments are enclosed herewith). Watershed Management plan has been prepared by IIT ISM, Dhanbad.

	to prevent any danger against inrush of surface water into the mine should be as per the approved mining plan and as per the permission of DGMS.	
3.8	The project proponent shall take all precautionary measures to ensure reverian/ riparian ecosystem in and around the coal mine upto a distance of 5 km. A revarian /riparian ecosystem conservation and management plan should be prepared and implemented in consultation with the irrigation/water resource department in the state government	Agreed to comply. Watershed Management plan has been prepared by IIT ISM, Dhanbad (copy is enclosed herewith as Annexure-III).
3.9	Industrial effluent and domestic wastewater shall be treated in the Effluent treatment Plant (ETP) and Sewage Treatment Plant (STP). After treatment, treated water shall be reused for plantation.	Oil & grease trap has been provided at HEMM workshop.
	4. Noise And Vibration Monitoring And Prevention	
4.1	Adequate measures shall be taken for control of noise levels as per Noise Pollution Rules, 2016 in the work environment. Workers engaged in blasting and drilling operations, operation of HEMM, etc shall be provided with personal protective equipments (PPE) like ear plugs/muffs in conformity with the prescribed norms and guidelines in this regard. Adequate awareness programme for users to be conducted. Progress in usage of such accessories to be monitored.	Regular monitoring of Noise levels is being done by CMPDIL (A NABL Accredited Lab). Regular maintenance of HEMM is being done. ear plugs/muffs are being distributed regularly.
4.2	The noise level survey shall be carried out as per the prescribed guidelines to assess noise exposure of the workmen at vulnerable points in the mine premises, and report in this regard shall be submitted to the Ministry/RO on six-monthly basis.	Regular monitoring of noise levels is being done by CMPDIL (A NABL Accredited Lab). Monitoring reports are enclosed herewith as Annexure-VII.
	5. Mining Plan	
5.1	Project proponent shall obtain star rating as per the guidelines of Ministry of Coal.	Being Complied.
5.2	Mining shall be carried out under strict adherence to provisions of the Mines Act 1952 and subordinate legislations made there-under as applicable.	Being Complied.
5.3	No change in mining method i.e. UG to OC, calendar programme and scope of work shall be made without obtaining prior approval of the Ministry of Environment, Forests and Climate Change (MoEFCC).	Agreed to comply.
5.4	Mining shall be carried out as per the approved mining plan (including Mine Closure Plan) abiding by mining laws related to coal mining and the relevant circulars issued by Directorate General Mines Safety (DGMS)	Being Complied.
5.5	Environmental conditions of mining place shall be rendered ergonomic and air breathable with adequate illumination in conformance with DGMS standards	Being Complied.
5.6	No mining shall be carried out in forest land without obtaining Forestry Clearance as per Forest (Conservation) Act, 1980 and also adhering to The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 read with provisions of Indian Forest Act, 1927.	Agreed to comply.

	6. Land Recalmation	
6.1	Digital Survey of entire lease hold area/core zone using Satellite Remote Sensing survey shall be carried out at least once in three years for monitoring land use pattern and report in 1:50,000 scale or as notified by Ministry of Environment, Forest and Climate Change (MOEFCC) from time to time shall be submitted to MOEFCC/Regional Office (RO)	CMPDI is conducting "Time series of land use maps based on satellite imagery of the core zone and buffer zone in the scale 1:5000 on cluster basis every 03 year and enclosed herewith as **Annexure-IX.**
6.2	Post-mining land be rendered usable for agricultural/forestry purposes and shall be handed over to the respective State Government, as specified in the Guidelines for Preparation of Mine Closure Plan, issued by the Ministry of Coal dated 27th August, 2009 and subsequent amendments.	Includes post mining condition. Shall be complied.
6.3	Regular monitoring of subsidence movement on the surface over and around the working areas and its impact on natural drainage pattern, water bodies, vegetation, structure, roads and surroundings shall be continued till movement ceases completely. In case of observation of any high rate of subsidence beyond the limit prescribed, appropriate effective mitigation measures shall be taken to avoid loss of life and materials. Cracks should be effectively plugged in with ballast and clay soil/suitable material.	Being complied. Regular monitoring is being done.
6.4	A separate team for subsidence monitoring and surface mitigation measures shall be constituted and continuous monitoring & implementation of mitigation measures be carried out.	Being Complied. Separate team has been constituted, copy of office order is enclosed herewith as **Annexure-X.**
6.5	Thorough inspection of the mine lease area for any cracks developed at the surface due to mining activities below ground shall be carried out to prevent inrush of water in the mine.	Being Complied.
6.6	Quick action/mitigation plan shall be established and implemented in the area affected by subsidence caused due to mining activity.	Being Complied.
6.7	The project proponent shall make necessary alternative arrangements, if grazing land is involved in core zone, in consultation with the State government to provide alternate areas for livestock grazing, if any. In this context, the project proponent shall implement the directions of Hon'ble Supreme Court with regard to acquiring grazing land.	Agreed to comply.
	7. Public Hearing And Human Health Issues	
7.1	Adequate illumination shall be ensured in all mine locations (as per DGMS standards) and monitored.	Being Complied.
7.2	The project proponent shall undertake occupational health survey for initial and periodical medical examination of the personnel engaged in the project and maintain records accordingly as per the provisions of the Mines Rules, 1955 and DGMS circulars. Besides regular periodic health check-up, 20% of the personnel identified	Initial Medical Examination (IME) and Periodical Medical Examination (PME) of all the personnel are carried out as per the Statutes and Director General of Mines Safety (DGMS) guideline. Details are provided in table mentioned below:

.	from workforce engaged in active mining operations shall be subjected to health check-up for occupational diseases and hearing impairment, if any, as amended time to time	<table><tr><th>Sl No</th><th>FY</th><th>IME</th><th>PME</th></tr><tr><td>1</td><td>2024-25</td><td>17</td><td>651</td></tr><tr><td>2</td><td>2023-24</td><td>15</td><td>775</td></tr><tr><td>3</td><td>2022-23</td><td>145</td><td>1075</td></tr></table>
7.3	Personnel (including outsourced employees) working in core zone shall wear protective respiratory devices and shall also be provided with adequate training and information on safety and health aspects	A separate full-fledged Human Resource Development Department Is conducting regular training programme on these issues. Apart from this Vocational Training Centres are existing in Cluster-III which provides periodical training on the safety and occupational health issue to each of the workers working in the mines
7.4	Skill training as per safety norms specified by DGMS shall be provided to all workmen including the outsourcing employees to ensure high safety standards in mines	Vocational Training Centres are existing in Cluster-III which provides periodical training on the safety and occupational health issue to each of the workers working in the mines
7.5	Effective arrangement shall be made to provide and maintain at suitable points conveniently situated, a sufficient supply of drinking water for all the persons employed	Drinking water arrangements have been made at suitable places.
7.6	The project proponent shall follow the mitigation measures provided in this Ministry's OM No.Z 11013/5712014-IA.I1 (M) dated 29th October, 2014, titled 'Impact of mining activities on habitations-issues related to the mining projects wherein habitations and villages are the part of mine lease areas or habitations and villages are surrounded by the mine lease area'.	Agreed to comply.
7.7	PP should conduct epidemiology study to (analysis of the distribution, patterns and determinants of health and disease conditions in defined populations).	Being Complied.
8. Corporate Environment Responsibility		
8.1	The company shall have a well laid down environmental policy duly approve by the Board of Directors. The environmental policy should prescribe for standard operating procedures to have proper checks and balances and to bring into focus any infringements/deviation/violation of the environmental/forest/wildlife norms/conditions. The company shall have defined system of reporting infringements/deviation/violation of the environmental/forest/wildlife norms/conditions and/or shareholders/stake holders	A well-defined Corporate Environment Policy has already been laid down and approved by the Board of Directors. This is also posted on BCCL website. https://www.bcclweb.in/environment/CEP_280220.pdf A hierarchical system of the company to deal with environmental issues from corporate level to mine level already exists. Environment Management cell has been constituted at Area level with GM as Chairman. Internal Monitoring Mechanism is in place.
8.2	A separate Environmental Cell both at the project and company head quarter level, with qualified personnel shall be set up under the control of senior Executive, who will directly to the head of the organization.	Environment Management cell has been constituted at Area level with GM as Chairman. A full-fledged Environment Department, headed by a HOD (Environment) along with a suitable qualified multidisciplinary team of executives has been established in Headquarters.
8.3	Action plan for implementing EMP and environmental conditions along with responsibility matrix of the company shall be prepared and shall be duly approved by	Being complied. Details of expenditure made as per EIA/EMP is enclosed herewith.

	competent authority. The year wise funds earmarked for environmental protection measures shall be kept in separate account and not to be diverted for any other purpose. Year wise progress of implementation of action plan shall be reported to the Ministry/Regional Office along with the Six Monthly Compliance Report	
8.4	Self-environmental audit shall be conducted annually. Every three years third party environmental audit shall be carried out	Agreed to comply.
9. Miscellaneous		
9.1	The project proponent shall make public the environmental clearance granted for their project along with the environmental conditions and safeguards at their cost by prominently advertising it at least in two local newspapers of the District or State, of which one shall be in the vernacular language within seven days and in addition this shall also be displayed in the project proponent's website permanently.	Advertisement has been made in Times of India dated 11.03.2025 and Hindustan Newspaper on 11.03.2025 (copy is enclosed herewith as **annexure-XI)**. Copy of EC is also available on BCCL website and can be accessed through link https://www.bcclweb.in/Environment%20Clearance/Cluster-III_ec_mining_amendment05032025.pdf
9.2	The copies of the environmental clearance shall be submitted by the project proponents to the Heads of local bodies, Panchayats and Municipal Bodies in addition to the relevant offices of the Government who in turn has to display the same for 30 days from the date of receipt	Copy has been submitted to Deputy Commissioner, Dhanbad, Dhanbad Municipal Corporation, RO, JSPCB. Copy of mail sent is enclosed herewith as **Annexure-XII.**
9.3	The project proponent shall upload the status of compliance of the stipulated environment clearance conditions, including results of monitored data on their website and update the same on half-yearly basis.	Being complied.
9.4	The project proponent shall submit six-monthly reports on the status of the compliance of the stipulated environmental conditions on the website of the ministry of Environment, Forest and Climate Change at environment clearance portal.	Being complied.
9.5	The project proponent shall submit the environmental statement for each financial year in Form-V to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently and put on the website of the company	Being complied. Copy of environment statement for FY 24-25 is enclosed herewith as **Annexure-XIII.**
9.6	The project authorities shall inform to the Regional Office of the MOEFCC regarding commencement of mining operations	complied.
9.7	The project authorities must strictly adhere to the stipulations made by the State Pollution Control Board and the State Government	Shall be complied.
9.8	The project proponent shall abide by all the commitments and recommendations made in the EIA/EMP report, commitment made during Public Hearing and also that during their presentation to the Expert Appraisal Committee	Shall be complied.
9.9	No further expansion or modifications in the plant shall be carried out without prior approval of the Ministry of Environment, Forests and Climate Change (MoEF&CC).	Agreed to comply.

9.10	Concealing factual data or submission of false/fabricated data may result in revocation of this environmental clearance and attract action under the provisions of Environment (Protection) Act, 1986.	Agreed.
9.11	The Ministry may revoke or suspend the clearance, if implementation of any of the above conditions is not satisfactory.	Agreed.
9.12	The Ministry reserves the right to stipulate additional conditions if found necessary. The Company in a time bound manner shall implement these conditions	Agreed.
9.13	The Regional Office of this Ministry shall monitor compliance of the stipulated conditions. The project authorities should extend full cooperation to the officer (s) of the Regional Office by furnishing the requisite data / information/monitoring reports.	Agreed.
9.14	The above conditions shall be enforced, inter-alia under the provisions of the Water (Prevention & Control of Pollution) Act, 1974, the Air (Prevention & Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986, Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 and the Public Liability Insurance Act, 1991 along with their amendments and Rules and any other orders passed by the Hon'ble Supreme Court of India / High Courts and any other Court of Law relating to the subject matter	Agreed.

Annexure-I

Sl No	Activity to address issues under Public Hearing	Total awarded value of work (Crores)	Expenditure done till November 2025 (Crores)
1	800 m. PQC road from NH-32 to SLG railway siding	1.21	0.8176
2	Construction of PQC road within mine	5.29	1.96
3	Renovation of pressure filter plant at Mahthadih,	0.0846390	0.0184232
4	Planation	0.1906	0.2248 (Payment to DFO, Dhanbad and plantation work at south Govindpur colliery).
Total Expenditure till November 2025			**3.0208232 Crores**

Annexure-II

Revenue Expenditure on Environment Management (Cluster-III)

Sl. No.	Element	Annually Recurring Cost (Rs. in Lakhs) as per EIA/EMP	Actual cost incurred (Lakhs) FY 2024-25	Remarks
1.	Pollution control	20.00	30	Water Sprinkling on haul roads, railway siding and public roads.
2.	Pollution monitoring	5.00	45.608	As per information provided by Env department, HQ; Being done by CMPDIL RI-II, Dhanbad
3.	Occupational health	5.00	20.66	Expenditure incurred on purchase of florescent jackets, rubber and leather gloves ear plugs, Safety helmets, goggles, medical kits, brattice cloth, cement capsule etc. for persons engaged in mining activities.
4.	Green belt & biological reclamation	10.00	11.95	Expenditure on bamboo gabion plantation by DFO, Dhanbad.
5.	Corporate Social Responsibility	138.45	CSR: 2443.55*	Being dealt at HQ level. Cluster-III is contributor for the same.
6.	Corpus fund for mine-closure	130.00	351.06	Deposited in Escrow account.
7.	Water cess and consent to operate	6.00	11	Paid for CTO application of Cluster-III
8.	Others (Lump sum)	5.00	1.4085	Plantation work at area GM office.
9.	Mine Reclamation	25.00	2531.05*	Includes cost of technical reclamation. Reimbursement is subjected to Third party audit of the claim as per approved Mine Closure Plan.
Total *		**344.45**	**471.68**	

*** Cost of CSR expenditure done at corporate level and mine reclamation is not included in total expenditure.**

Capital cost of Environment Management for Cluster-III

Sl. No.	Activity head as per EMP	Item	Unit Name	Year	Cost (Lakhs)	Remarks
1.	Pollution abatement cost including providing 02 additional water sprinklers.	Procurement of two Mobile water Sprinkler (28 KL Capacity)	New Akashkinaree Colliery	2013-14	126.67	As per information provided by Colliery.
			Block-IV Colliery	2020-21	162.84	
		Procurement of 1 truck mounted fog cannon system	New Akashkinaree Colliery	2023-24	41.95	
2.	Development of green belt (100 Ha and the left out area will be taken up during mine closure period) (Rs. 1 lakh per Ha)	Advance work for bamboo gabion plantation	Maintenance work-I for bamboo gabion plantation in Maheshpur, Jogidih, Govindpur Colliery	2023-24	9.70	By DFO, Dhanbad
		Completion work for bamboo gabion plantation	Completion works for bamboo gabion plantation in SLG siding (150 Nos.)	2023-24	0.90	
3.	Dust suppression & extraction in coal handling plant & feeder breaker	Procurement of 3 nos. trolley mounted fog cannon	SLG Railway Siding	2021-22	20.85	
4.	EMP Report	Preparation of EIA and EMP report	Cluster-III	2012-13	89.34851	As per information provided Env Dept, BCCL HQ
5.	Industrial sewage treatment in workshop	Construction of Oil & Grease trap	New Akashkinaree Colliery and Block-IV Colliery	2020-21	22.40	As per details provided by Area Civil Deptt.
6.	Cost of Anti-pollution measures in mine & Industrial area	Construction of Coal transportation Road	Block-IV Colliery	2020-21	5.78	WBM Road for coal transportation. As per details provided by Area Civil Deptt.
			SLG Siding	2020-21	17.72	
			Maheshpur Colliery	2019-20	21.08	
			New Akashkinaree Colliery	2019-20	19.74	
7.	Other provisions	Development of eco-park	New Akashkinaree Colliery	2023-24	2.61	As per details provided by Area Civil Deptt.
		Purchase of 05 nos. PM10 Online analyzer	Cluster-III	2021-22	62.00	PO by HQ MM deptt.
		Construction of wheel washing ditch	Cluster-III	2024-25	24	Civil department
		Installation and commissioning of rooftop solar power plant (88Kwp)	CISF campus, NAKC	2022-23	42.08	HQ E&M.

CSR Expenditure FY 2024-25

Sl. No.	CSR Project/Programme	CSR Expenditure in FY 2024-25(in ₹)
1	Skill Development Program by National Skill Development Council (NSDC) (Loader Operator (Mining), Mine Electrician, Multi Skill Technician (Electrical), Customer Service Associate (Financial Services), Food & Beverage Service – Associate, Solar & LED Technician (Electronics) & door to door survey for need assessment (next phase of work of FY 2023-24) (HQ)	1,46,01,221.60
2	Skill Development Program for 75 candidates through MSME Toolroom, Kolkata (Ministry of MSME) on the trades Asst. Operator (CNC Turning), Jr. Technician (Welding), Technician CNC Machining (HQ)	85,81,004.99
3	Skill Development Program through CIPET, Ranchi for 200 candidates (HQ)	1,74,71,120.00
4	Skill Development training program on Medical Equipment Technician for 150 candidates (Skill training on health) (HQ)	30,77,020.00
5	Development of Strategic Interventions through Innovative Techniques to Promote STEM Education among underprivileged students with special emphasis on PAP (Project Affected Person) students in Dhanbad (HQ)	7,99,920.00
6	Construction of Auditorium at Law College, Dhanbad (work of FY 2023- 24) (HQ)	13,04,724.00

7	Providing 200 wireless sets and 1000 barricades through depository mode to Dhanbad District Administration (HQ)	2,27,00,000.00
8	Installation of Smart Classrooms and Information and Communication Technology (ICT) Labs in Government schools of Dhanbad district (HQ)	9,09,05,584.45
9	Installation of smart classes in Schools of Giridih district (HQ)	1,53,17,422.35
10	Procurement of statue of Bhagwan Birsa Munda (HQ)	5,84,336.00
11	Construction of drain at kharnagadha (Sanitation) (Washery div.)	14,38,457.54
12	Construction of ghat in Khodo river at Gram Panchayat Tundu (Jhajlitand and Sagriyadih) (Barora Area)	15,34,754.19
13	Infrastructure upgradation work in Chungari Free Primary School, Barakar (CV Area)	20,49,586.63
14	Financial assistance to Dhanbad district administration for depository mode procurement of wheelchairs (tricycles) (485 nos.) (HQ)	44,48,040.00

15	Financial assistance to Dhanbad District Administration for depository mode procurement for providing food and other necessary items to Polling teams/sector magistrate etc. during Lok Sabha Elections 2024. (HQ)	12,00,000.00
16	Making available food, water & other necessary items for general populace during visit of Dhanbad by Hon'ble Chief Minister, under CSR head of BCCL (HQ) visit	14,87,381.00
17	Depository mode transfer to D.C. Dhanbad towards providing woollen lowers to children in Dhanbad between ages 03-06 under CSR initiatives of BCCL	2,74,19,510.00
18	Financial assistance to Dhanbad District Administration for depository mode procurement for providing food and other necessary items to Polling teams/sector magistrate etc. during Vidhan Sabha Elections 2024.	15,00,000.00
19	Organizing inter village football tournament (Project Affected Persons) at Sijua Stadium	2,10,280.00
20	Thalassemia screening test organised at BCCL under CIL Thalassemia Bal Sewa Yojana	8,40,380.60
21	Livelihood opportunity to women of handloom project	37,980.00

22	Procurement & distribution of blankets amongst needy under CSR works of BCCL for FY 2024-25	9,95,349.34
23	Additional Civil Works in RBB High School Rajganj for Mini Science Labs under CRY	3,44,560.00
24	Desilting/deepening of Lal Bandh Pond and rehabilitation of adjoining embankment around it at Baliapur under Bastacolla area.	23,15,716.71
25	Construction of Community Hall under Harina Panchayat under Block II Area (Revised Estimate)	16,914.26
26	Infrastructural development works of Vinod Bihari Mahto Inter Mahila Mahavidyalay Topchanchi, Dhanbad(Revised Estimate)	3,33,805.22
	Total	**22,15,15,068.88**

CSR Expenditure for Ongoing projects of FY 2023-24		
27	Construction of a library at Shahid Shakti Nath Mahto Smarak Ucch Vidyalay	53,489.83
28	Skill Development Training program on GDA for 120 candidates	8,89,200.00
29	Skill Development Training program on BFSI for 150 candidates	12,52,500.00
30	Installation of Mini Science Labs in 5 Govt Schools	11,47,904.20
31	Setting Up of MSDI Centre through NSDC at Belgharia Rehabilitation Centre	34,61,572.80
32	Skill Development training on Plastic Processing Trade at CIPET Ranchi for 80 candidates	11,20,000.00
33	Construction of Hostel at Premiya Rishikesh Amlabad Mahavidyalay by BCCL under CSR FY 2023-24	11,61,424.99
34	Development of Public Toilets, Drainage, pathway & other infrastructure works at Bauan Kalan (Uttar Panchayat) Barki Bauan, GKKC (Kusunda)	3,06,747.63
35	Construction of library at Rajendra Balika Uchh Vidyalay at Katras	10,11,463.51
36	Providing & fixing of community shed at Saraidhela Panchayat Bhawan Campus (CCWO)	1,16,496.66

37	Providing and fixing solar lights in nearby villages of PB Area	17,13,600.00
38	Providing and fixing ceiling fans in Government schools in Putki Madhya Vidyalaya and Kustore Madhya Vidyalaya	90,304.80
39	Proposal for supply, fitting and installation of LED based solar street lighting system in AMPC, Barora Area under CSR head (Barora)	16,91,820.00
	Total	**1,40,16,524.42**
CSR Expenditure for Ongoing projects of FY 2022-23		
40	Infrastructural Development Works at Vinod Bihari Mahto Inter Mahila Vidyalay, Topchanchi	4,97,714.51
41	Distribution of Assistive devices to Divyangjans in Dhanbad	50,45,444.60
42	Distribution of TB nutritional Baskets	9,31,755.24
43	CSR funding for the educational performance of tribal children of Jharkhand state through 'Healthy Aging India'	6,00,000.00
44	Block II Area-Construction of community hall under Harina Panchayat	17,48,856.68
	Total	**88,23,771.03**
	Total CSR Expenditure in FY 2024-25	**24,43,55,364.33**

PROJECT REPORT

ON

PREPARATION OF WATERSHED MANAGEMENT PLAN IN CLUSTER-III, GOVINDPUR AREA, BCCL, DHANBAD

SUBMITTED

BY

Prof. Sukha Ranjan Samadder
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SUBMITTED

TO

Cluster-III, Govindpur Area, BCCL, Dhanbad

CENTRE FOR WATER RESOURCE MANAGEMENT (CWRM)
DEPARTMENT OF ENVIRONMENTAL SCIENCE AND ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY (INDIAN SCHOOL OF MINES), DHANBAD, JHARKHAND-826004

SEPTEMBER,2025

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Executive Summary

The BCCL Cluster-III coal mining region, situated in the Govindpur area of Dhanbad, Jharkhand, is part of the larger Jharia Coalfield and plays a vital role in supplying high-grade coking coal essential for steel production in India. This cluster, comprising five operational and two closed mines over a leasehold area of 1420.61 hectares, has witnessed decades of intense underground and opencast mining. While this has significantly contributed to India's industrial development, it has also led to certain environmental concerns, such as localized land degradation, partial vegetation loss, moderate soil erosion, and occasional impacts on water quality. Recognizing these challenges, this study aims to develop a technically sound watershed and environmental management framework and a possible solution for Cluster-III, aligned with the Ministry of Environment, Forest and Climate Change (MoEF&CC) guidelines and other internationally established methodologies from existing literature.

The primary objective of this investigation was to undertake a spatially explicit analysis of hydrological and environmental dynamics using modern geospatial techniques, statistical, and modelling tools. This included morphometric analysis of the watershed, rainfall-runoff modelling & estimation, climate variability assessment, soil erosion estimation, and suitability analysis for both conservation structures and ecological plantations. In addition, water quality monitoring was carried out to understand the impact of mining on local water bodies. The study utilized Digital Elevation Models (DEMs), Remote Sensing imagery, thematic Geographic Information System (GIS) layers, field survey data, and Coupled Model Inter-comparison Project Phase 6 (CMIP6) climate projection datasets to generate actionable insights for environmental management for the period of 2025 to 2039.

Morphometric analysis constituted a fundamental step in delineating 15 micro-watersheds (WS1 to WS15) within the basin areas associated with the two principal drainage systems, namely Bagdighi and Khudia Nala. The terrain of the study area

is predominantly sloping, with slope gradients ranging from 0° to 33°. Elevation within the region varies from a minimum of 122.97 m to a maximum of 274.74 m above mean sea level, resulting in an elevation differential of approximately 151.77 m. This variation in topographic and geomorphological characteristics significantly influences hydrological responses. Smaller watersheds with steeper slopes were found to be more prone to surface runoff and soil erosion, whereas larger watersheds with moderate slopes demonstrated greater infiltration potential. These morphometric parameters served as critical inputs for runoff modelling, erosion risk assessment, and land-use prioritization. Furthermore, stream ordering based on Strahler's method revealed a dominance of first and second-order streams, indicating an early stage of geomorphic development, which is characteristic of mining-impacted catchments. The estimation of surface runoff was carried out using the Soil Conservation Service-Curve Number (SCS-CN) method, which incorporated land-use, soil hydrologic group (HSG), and antecedent moisture conditions (AMC). The results indicated significant spatial and temporal variability in runoff generation between 2015 and 2024. Watersheds contributing to Khudia Nala generated higher cumulative runoff (~17,973 mm) compared to those feeding Bagdighi Nala (~5,193 mm), due to larger contributing areas and less vegetative cover. Runoff peaked in the year 2024 across most watersheds, which aligns with observed extreme rainfall events. These findings underscore the hydrological sensitivity of the region and the need for watershed-specific soil erosion control and conservation infrastructure.

To understand the broader implications of climate variability, spatio-temporal analyses of rainfall and temperature trends were conducted using different climate models. The historical climate data (2008–2024) revealed a gradual increase in both rainfall intensity and temperature, while future projections using CMIP6 data under SSP2-4.5 and SSP5-8.5 scenarios forecast about near future climate impact. A significant rise in daily rainfall extremes is expected to exacerbate surface runoff, soil erosion, and water quality degradation. These projections were integrated with hydrological modelling to estimate future runoff and flood risks. The results

indicate a potential rise in peak flow volumes and the frequency of runoff events, which may gradually influence mining infrastructure and could have localized impacts on nearby human settlements.

Soil erosion was assessed using the Revised Universal Soil Loss Equation (RUSLE), integrating parameters such as rainfall erosivity, soil erodibility, slope, land-use, proximity to drainage, and vegetation type. The erosion potential index (EPI) revealed that more than 31.91% of the study area is under high and very high erosion risk, primarily in steep, unvegetated overburden dumps and degraded mining areas. The estimated annual soil loss was found to be spatially uneven, with the highest losses occurring in areas characterized by steeper slopes and sparse vegetation cover. These findings are essential for prioritizing locations for erosion control interventions such as vegetative barriers, check dams, and contour trenches.

To facilitate the implementation of site-specific restoration measures, suitability mapping was carried out for both conservation structures and plantation interventions using GIS-based Multi-Criteria Decision Analysis (MCDA) integrated with the Analytical Hierarchy Process (AHP). For soil and water conservation structures, thematic layers such as slope, LULC, proximity to drainage, soil type, and erosion potential were evaluated. The results indicated that most of the area falls under the moderate suitability category, covering 44.15% (626.67 ha), followed by low suitability at 40.38% (573.12 ha), and high suitability accounting for 3.96% (56.16 ha). Areas deemed not suitable (11.26%; 159.84 ha), primarily due to the presence of built-up land and water bodies, were excluded from conservation planning, while very low suitability zones made up only 0.26% (3.69 ha). These findings support the feasibility of implementing water conservation structures such as check dams and contour bunding across a substantial portion of the landscape, especially in moderately and highly suitable zones.

In parallel, plantation suitability analysis revealed that 37.69% (535.41 ha) of the area is moderately suitable, followed by low suitability at 31.69% (450.18 ha), and high suitability covering 25.08% (356.31 ha). An additional 2.47% (35.1 ha) was found to

be very highly suitable, offering priority zones for eco-restorative planting. Only 0.87% (13.42 ha) and 2.20% (31.24 ha) of the area were categorized as very low and unsuitable, respectively, due to limiting factors such as slope, soil conditions, or existing land use. These results suggest strong potential for landscape restoration through afforestation and re-vegetation. In identified suitable areas, native species such as *Azadirachta indica* (neem), *Pongamia pinnata* (karanj), and *Dalbergia sissoo* (shisham) are recommended to promote slope stabilization, improve soil health, and enhance overall ecological resilience in the mining-affected terrain.

Water quality monitoring, conducted through field sampling and laboratory analysis, focused on parameters such as pH, TDS, EC, salinity, nitrate, fluoride, sulphate, and phenolic compounds. The results revealed elevated levels of dissolved solids and conductivity in mining-impacted drainage zones, especially during monsoon seasons. Although the majority of samples were within permissible limits, localized contamination near overburden dumps and effluent discharges suggests the need for regular monitoring, and better mine-water management protocols. These insights also indicate a direct correlation between surface runoff pathways and water quality deterioration, further validating the integrated approach adapted in this study.

The key findings of this comprehensive assessment offer valuable insights for policymakers, environmental planners, and mining authorities. One of the major implications is the ability to prioritize specific watersheds based on their vulnerability to runoff and soil erosion. This prioritization enables more effective allocation of restoration resources and targeted implementation of engineering interventions, thereby enhancing the efficiency and impact of land and water management efforts. Second, identification of the high-suitability zones for conservation infrastructure and afforestation can directly feed into the implementation of the Jharia Master Plan and similar policy instruments. Third, integration of the climate projection data ensures that all recommendations are forward-looking and resilient to future climate uncertainties. Finally, the use of

advanced geospatial and hydrological tools offers a replicable framework that can be extended to other mining-affected regions across the Country.

In conclusion, the study successfully demonstrates the efficacy of a multi-pronged, GIS-enabled watershed management strategy personalized to the unique challenges of a mining-dominated terrain. It emphasizes that sustainable land and water management in such regions requires a blend of scientific analysis, stakeholder engagement, and climate-resilient planning. The findings not only contribute to academic understanding but also serve as a strategic guide for on-ground interventions in the BCCL Cluster-III region. The integrated methodology adapted here holds potential for scalability and can inform future environmental impact assessments, mine closure planning, and regional restoration policies.



Chapter 1: Introduction of the study area, Cluster III Coal Mining Region, Govindpur Area, BCCL, Dhanbad

1.1 Introduction

Coal mining has played a pivotal role in India's industrial growth, with the Jharia Coalfield in Jharkhand serving as a major contributor. Within this region, Cluster-III is comprised of an integrated set of mines and is operated by Bharat Coking Coal Limited (BCCL) for coking coal extraction. The Cluster-III region, located in the north-western part comprises both underground and opencast mines, covering an extensive leasehold area of 1420.61 hectares. Though, the coal mining has extremely high economic benefits but, poses significant environmental challenges. Extensive coal extraction results adverse impacts such as land degradation, vegetation loss, soil erosion, underground fires, groundwater depletion, altered drainage patterns, and surface subsidence. The area is intersected by seasonal streams and natural water bodies that are vulnerable to pollution and siltation due to overburden dumps and unregulated runoff. This complex landscape requires an integrated and scientific approach to evaluate and manage its hydrological and environmental dynamics.

To address these challenges, this report outlines a comprehensive plan for watershed delineation and environmental management plan of the Cluster-III region. The primary focus of the study includes morphometric analysis, rainfall-runoff modelling, climate-driven spatiotemporal variability of hydrometeorological parameters, soil erosion estimation, site suitability analysis for suitable water conservation structures, and measurement of water quality. In this study, a watershed management plan has been developed according to the guidelines of Ministry of Environment, Forest and Climate Change (MoEFCC) by integrating the proposed seven objectives of the project. Together, these efforts aim to generate a spatially explicit understanding of watershed behaviours that can support sustainable land and water resource management, mine reclamation planning, and resilience building in the face of climate change.

The study used advanced geospatial technologies, remote sensing data, hydrological modelling, and statistical tools to provide detailed insights on the present environmental condition and recommended suitable conservation plan for the mining-affected terrain. This will aid policymakers, mine managers, and environmental planners in making informed, data-driven decisions to ensure both economic benefits and ecological sustainability in the BCCL Cluster-III coal mining region.

1.2 Study Area

The study area incorporates Cluster-III of BCCL, located in the north-western part of the Jharia Coalfield in Dhanbad district, Jharkhand as shown in Fig.1.1. This region is geographically bounded between latitudes 23°46'46.67" N to 23°48'32.34" N and longitudes 86°14'16.96" E to 86°17'36.91" E and falls within Survey of India topographical sheets 73 I/1, I/2, I/5, and I/6. The leasehold area of Cluster-III spreads across 1420.61 hectares and has five operational and two closed mines. The operational mines include, New Akashkinaree and Block-IV/Koraidih (mixed opencast and underground), Jogidih, Maheshpur, and Govindpur (underground). South Govindpur and Teturiya Collieries are closed currently.

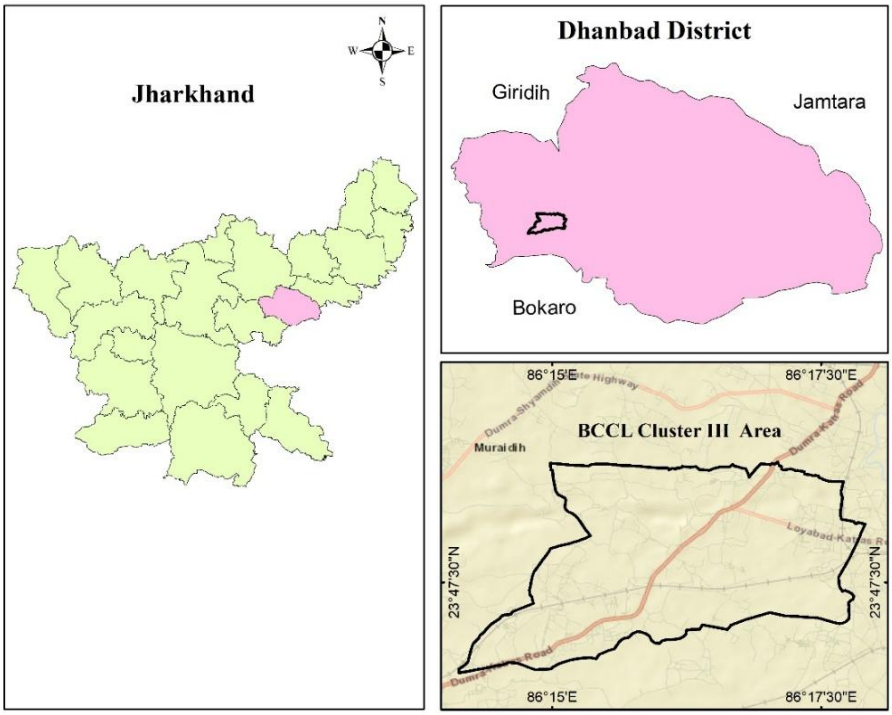


Fig. 1.1: Location of the BCCL Cluster-III Area

1.3 Background

The Jharia Coalfield, one of the India's most significant coal-producing regions, has a long history of mining activity, dating back to the late 19th century. It is the backbone of the nation's metallurgical coal supply, providing high-grade coking coal essential for steel production. Within this coalfield, Cluster-III is pivotal due to its strategic location, extensive coal reserves, and concentration of operational mines under BCCL. The establishment of Cluster-III was intended to facilitate more effective resource management and streamline environmental compliance by consolidating several individual mines into a unified operational framework.

Despite its economic contributions, Cluster-III faces several challenges that arise from decades of intensive mining. These include persistent underground fires, land subsidence, extensive overburden dumps, alteration of surface water quality, and air pollution. Existing overburden dumping practices, deforestation, and a lack of integrated watershed management plan may further aggravate the area's environmental condition. Ground and surface water resources are under increasing

stress due to reduced infiltration capacity and pollution from mining activities. In addition, the risk of soil erosion and sedimentation in nearby watercourses has escalated.

Several environmental monitoring and management strategies have been implemented to address these growing concerns. These include the Jharia Master Plan and the Environmental Action Plan, which emphasize fire control, land reclamation, water treatment, and increased afforestation. However, the success of these initiatives depends on high-resolution spatial analysis and accurate hydrological assessments. The current study is therefore designed to support these broader policy efforts by providing a scientific foundation for watershed planning, erosion control, and climate adaptation at the micro-watershed scale within Cluster-III.

This background forms the rationale for integrating remote sensing, GIS, and hydrological modelling tools in the present investigation. By analyzing morphometric parameters, runoff dynamics, and land suitability for conservation strategies, the study seeks to contribute actionable insights for sustainable land and water resources management in the mining-impacted landscapes of the Cluster-III area.

1.3.1 Topography and Drainage

The region's terrain is gently undulating with an overall slope towards the east-southeast and the drainage system is dominated by dendritic patterns. Two seasonal streams, Khudia and Bagdighi Nala, flow from north to south across the Cluster-III area, and play a significant role in its surface hydrology. These watercourses are the tributary of the Katri River, which consequently merges with the Damodar River.

1.3.2 Railway and Transport

The area is well connected through various modes of transportation, ensuring efficient movement of people and goods. The Dhanbad-Chandrapura railway line passes

directly through the cluster, providing crucial rail connectivity for both passengers and goods, especially coal transport. Major routes include D. B. Road, which connects Katras to Phularitand, and a network of village roads and colliery roads that support internal transport within the mining areas. Additionally, the region is accessible via National Highway 32 (Rajganj–Mohuda section), which links it to broader regional and national road networks. Public Works Department (PWD) roads further enhance local connectivity. The nearest urban city is Dhanbad, located about 8 kilometres from the Cluster-III, offering access to administrative, commercial, and transport facilities. Although, the area does not have its own airport, but air connectivity is available through nearby airports located at Ranchi or Durgapur, which are accessible by road from the region.

1.3.3 Vegetation

Prolonged and intensive mining activities might have significantly influenced the vegetation profile of the Cluster-III region. Historically, the area was covered with natural vegetation dominated by tropical dry deciduous species along with flora and fauna. However, widespread deforestation and land degradation from surface mining have degraded the green cover. However, the ground surveys indicate that most active mining zones lack natural vegetation, with only sparse vegetation observed along roadsides, village boundaries, and non-mineralized patches also supported by the satellite imagery.

The initiative taken by the BCCL for reclamation and afforestation on the degraded land or over burden (OB) as a part of implementation of the Environmental Management Plan (EMP) and the Jharia Action Plan is successfully implemented in the entire study area. These include the creation of green belts along the transport corridors, mine boundaries and alongside of the OB area. High-root-density native species such as neem (Azadirachta indica), karanj (Pongamia pinnata), arjun

(Terminalia arjuna), and shisham (Dalbergia sissoo) are commonly used in plantation efforts to stabilize loose substrates and enhance ecosystem services.

Year-wise satellite imageries confirmed the gradual progress in re-vegetation in the overburden areas being stabilized and reshaped. Apart from ecological functions, vegetation also serves social objectives, including improving aesthetics, reducing dust pollution, and providing shade and microclimatic benefits to nearby settlements. Despite these efforts, challenges such as poor soil quality, low water retention in OB materials, and recurring fires limit the pace of natural and manmade regeneration outcomes. Consequently, the vegetation cover in Cluster-III remains fragmented, and continuous monitoring and adaptive management strategies are necessary to ensure the long-term success of restoration programs.

1.3.4 Temperature

The Cluster-III region of the Jharia Coalfield experiences a tropical climate marked by distinct seasonal variations in temperature. Govindpur experiences a distinctly warm to hot climate throughout the year. Temperature typically ranges between about 53 °F (12 °C) and 100 °F (38 °C), with extremes rarely dipping below 47 °F (8 °C) or rising above 108 °F (42 °C) (weatherspark.com). The hottest period is observed from late March to mid-June, when daytime highs exceed 97 to 95 °F, peaking in May with average highs around 100 to 101 °F (38 °C) and lows near 79 °F (26 °C) (weatherspark.com) (Fig. 1.2). Conversely, the coolest stretch spans from December through February, with daytime temperatures staying below 79 to 82 °F (26 to 28 °C), and January being the coldest month with average lows of 53 to 55 °F (12 to 13 °C) with highs around 74 to 79 °F (23 to 26 °C). Transition seasons bring moderation: in April, highs reach roughly 102 °F with lows near 78 °F, while fall months (September to November) see highs gradually lowering from 88 °F to about 79 °F, and lows from 78 °F to around 57 °F. Overall, Govindpur endures long hot summers and short mild winters with significant temperature variability between day and night.

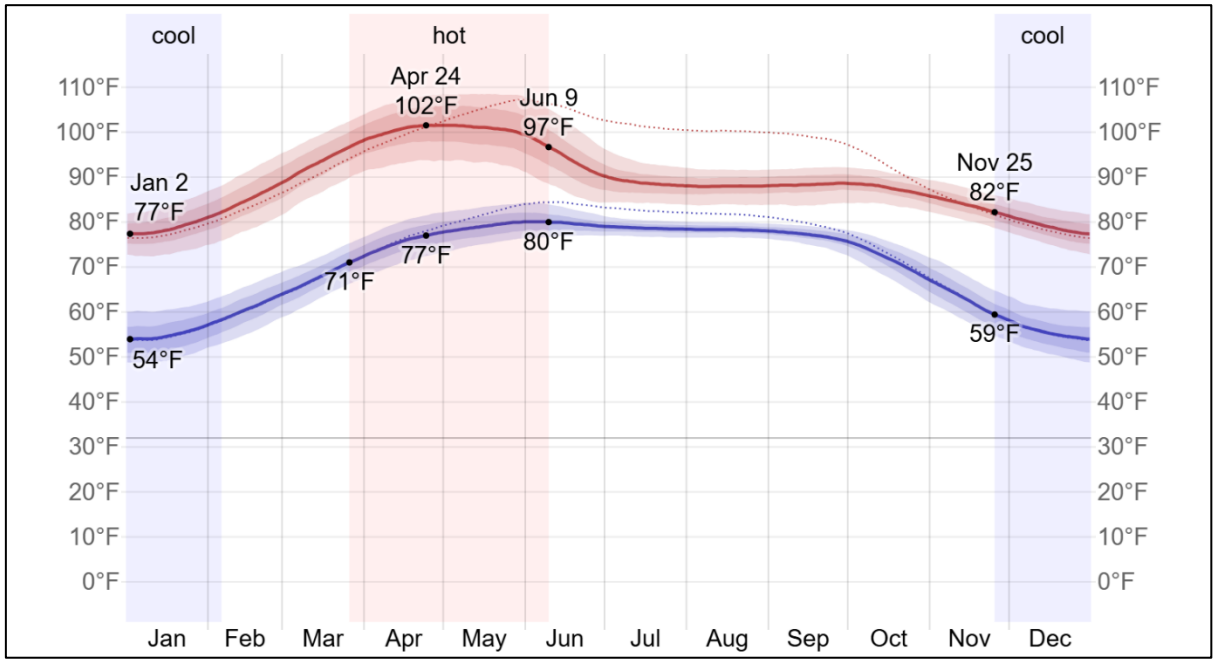


Fig. 1.2: Average Monthly High and Low Temperatures of Cluster III Region, BCCL, Jharia Coalfield (°F)

1.3.5 Relative Humidity

Relative humidity in the Cluster-III region varies seasonally, generally it is high during the monsoon season and low during the summer months. Annual humidity levels typically range between 25% and 90%. During the peak monsoon months (July to September), the humidity frequently exceeds 80%, creating conducive conditions for surface runoff and enhancing the risk of soil erosion. Conversely, relative humidity may drop below 30% during the dry summer months, intensifying the dryness of soils and increasing the chance of dust generation in active mining zones.

1.3.6 Rainfall Data

Cluster-III falls under the influence of the south-west monsoon, which accounts for approximately 75% to 85% of the region's total annual precipitation. The average yearly total rainfall in the area ranges from 1300 mm (51.18 in) to 1400 mm (55.12 in), as the heavy rainfall occurs in the months of July to September and recorded as the wettest months (weatherspark.com). The rainfall pattern is highly seasonal and shows considerable inter-annual variability. The concentration of rainfall within a few months

leads to high surface runoff and occasional localized flooding, particularly in low-lying mining pits, making accurate rainfall-runoff modelling essential for watershed planning and disaster mitigation.

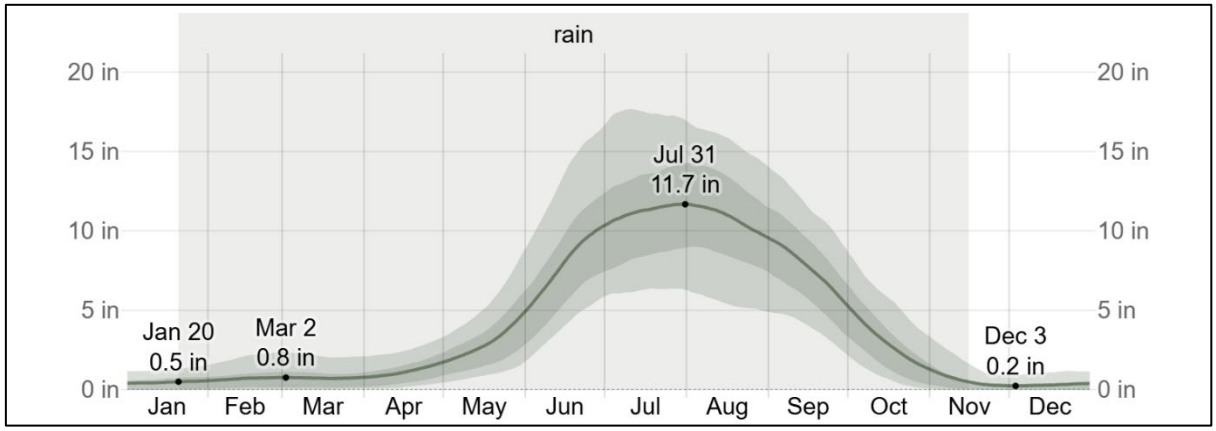


Fig. 1.3: Average Monthly Rainfall in Cluster-III Region, Jharia Coalfield (in inch)

1.3.7 Wind

Wind patterns in Cluster-III are governed by seasonal climatic shifts. Winds predominantly blow from the north-west and west during the pre-monsoon and post-monsoon seasons. In contrast, during the monsoon season, winds shift to a south-east and south-westerly direction. Wind speeds are generally moderate, averaging 5 to 15 km/h. However, occasional high-velocity winds during thunderstorms are also observed in the study area. Understanding wind behaviours is crucial for planning green belt development.

1.3.8 Regional Geology

The Cluster-III mining area lies within the geologically significant Jharia Coalfield which is a part of the Damodar Valley Basin. This region primarily comprises formations from the Lower Gondwana sequence, with the Barakar formation serving as the main coal-bearing unit. The Barakar strata consists of alternating layers of sandstone, shale, and coal seams, with occasional volcanic intrusions. These coal seams are predominantly bituminous and vary in both thickness and quality, making them

well-suited for metallurgical applications. Beneath the Barakar formation, the Talchir Formation lies which is characterized by glacial deposits, while the overlying Barren Measures represents non-coal-bearing formations that cap the sequence.

Geologically, the area is complex and tectonically active, influenced by historical faulting, folding, and crustal movements linked to the Indian Plate's evolution. These structural features result in seam dips that range widely from 10° in relatively undisturbed areas to over 70° near fault zones. Such variability impacts mining layout, safety, and hydrogeological behaviour.

Within Cluster-III, coal seams exhibit varying degrees of thermal instability, with spontaneous combustion being a concern in several zones. Approximately, 72.88 hectares are currently classified as fire affected region. In addition, land-use in the cluster consists of active and abandoned mines, service infrastructure, reclaimed overburden dumps, agricultural fields, and settlements.

Table 1.1: Generalised stratigraphy of the Jharia Coalfields

Formation	Lithology	Maximum Thickness (m)
Supra Panchet	Red and grey sandstones and shales	300
Panchet	Micaceous yellow and grey sandstones, red and greenish shales	600
Raniganj	Grey and greenish soft feldspathic sandstones, shales and coal seams	1050
Ironstone Shales	Dark carbonaceous shales with ironstone bands	360
Barakar	Coarse and medium grey and white sandstones; shales and coal seams	630
Talchir	Coarse sandstones above; greenish shales below (Boulder Bed)	300

1.3.9 Local Geology of the Lease Area

Within Cluster-III, the lease-hold area predominantly comprises of the Barakar Formation of the Lower Gondwana group. This formation hosts multiple coal seams, including Seams I to X, many of which are being exploited through both underground and opencast coal mining methods. The stratigraphy is composed of alternating bands of fine to medium-grained sandstones, carbonaceous shale, and coal seams. The thickness of the coal seams varies across the area, and some zones exhibit multiple seam splits, affecting mining layout and recovery. Fire-affected seams, particularly in the central and northern parts of the leasehold area, are of critical concern and require continuous thermal monitoring and fire-control interventions. The overburden is often composed of weathered sandstone and loose lateritic soils, which contributes to erosion and sedimentation issues for the natural drainage system.

1.3.10 Strike and Dip

The strike and dip of coal seams in Cluster-III exhibit a significant range due to tectonic disturbances. The general strike direction in the area is WNW–ESE to ENE–WSW. The dip of the strata typically varies from 10° to 15° towards the southeast, but in fault-affected zones, the dip can increase drastically, reaching as much as 60° to 70° locally. Faults and folds have disrupted the continuity of coal seams, necessitating detailed structural mapping for effective mine planning. The orientation and inclination of the beds directly influence groundwater flow, mine drainage patterns, and the design of pit slopes in opencast mining operations. Understanding these geological features is essential for ensuring mining safety, optimizing resource recovery, soil loss estimation, finding erosion potential zones and minimizing environmental risks.

1.3.11 Socio-Environmental Profile and Resource Management

Socio-environmentally, the region houses around 3756 project-affected families, with rehabilitation efforts guided by the Jharia Action Plan. The water requirement for the

cluster is estimated at 5745 m^3/day, including 1120 m^3/day for industrial use and 4625 m^3/day for domestic purposes. Environmental and CSR funds are allocated for dust suppression, afforestation, water filtration, and health and safety training. Given its active mining status and associated environmental challenges, Cluster-III presents a complex but crucial landscape for hydrological modelling and watershed-level sustainability planning.

1.4 Current Challenges

Cluster-III faces several interconnected challenges related to land, water, and climate. The absence of proper morphometric analysis makes it difficult to understand landforms and drainage patterns, which affects runoff management and water conservation planning. Rainfall patterns may change due to climate variability, but suitable rainfall-runoff models are lacking, making it hard to predict water flow and flood risks. Hydrometeorological parameters such as rainfall and temperature vary across time and space, adding uncertainty to water resource management planning. Soil erosion is a major issue caused by alteration of land-use due to mining, but without proper estimation, it may continue to damage land and may pollute the nearby water bodies. The lack of site suitability analysis results in poor implementation of water conservation structures. Water quality may also be affected due to seasonal runoff, yet regular monitoring is essential. Moreover, there is requirement of integrated watershed management plan in the study area as per the MoEFCC regulatory framework.

1.5 Scope of the Work

To address the multifaceted issues described above, the present study outlines a comprehensive framework for hydrological and environmental analysis of the Cluster-III mining region. The scope of the work is aligned with seven key objectives:

1. Development of Watershed Management Plan: An integrated and sustainable watershed management plan in line with the MoEFCC guidelines has been developed,

including strategies for land-use planning, water conservation, erosion control, and rehabilitation of degraded areas.

2. Morphometric Analysis: To understand the hydrological response and to identify areas susceptible to erosion, a comprehensive morphometric analysis of the watershed within the coal mining area has been conducted. This involves using Digital Elevation Models (DEMs) to quantitatively assess key parameters like drainage density, stream order, bifurcation ratio, and slope. The findings provide crucial insights into surface runoff patterns and soil erosion potential zones. The expected outcomes provide information on sustainable land management and reclamation strategies in the mining landscape. This analysis is vital for predicting and mitigating the impacts of mining activities on the watershed's hydrological health.

3. Rainfall-Runoff Modeling: The estimation of surface runoff and its spatial distribution across different micro-watersheds could be achieved using hydrological models such as SCS-CN or SWAT. The models have been calibrated with observed rainfall and discharge data to support water resource planning and flood risk assessment.

4. Spatio-Temporal Variability of Hydro-Meteorological Parameters: The statistical methods like Mann-Kendall test and Sen's slope estimator have been used for the computation of seasonal and long-term trends in rainfall and temperature. Climate projections under SSP2-4.5 and SSP5-8.5 from CMIP6 datasets have been done to predict its future variability.

5. Soil Erosion Estimation: The quantification of annual soil loss has been carried out with the help of the Revised Universal Soil Loss Equation (RUSLE) model. The model's key input parameters include rainfall erosivity, soil erodibility, slope length &

steepness, land cover, and conservation practices. The results have been used to identify erosion-prone areas for targeted management.

6. Site Suitability Analysis: The most suitable locations for water and soil conservation structures such as check dams, contour bunds, and afforestation zones have been identified using Multi-Criteria Decision Analysis (MCDA) techniques like AHP and fuzzy logic integrated with GIS tools.

7. Water Quality Parameter Measurement: Assessment of surface and groundwater quality through field sampling and laboratory analysis of key physico-chemical parameters has been carried out in the laboratory at the Department of Environmental Science & Engineering, IIT(ISM), Dhanbad.

8. Final Recommendations: Preparation of the Watershed Management Plan for Cluster-III, Govindpur Area, BCCL, Dhanbad. To address the hydrological and environmental challenges within the Cluster-III mining region of BCCL, Govindpur Area, a comprehensive and multidisciplinary approach has been adapted. The proposed watershed management framework encompasses key thematic domains, aiming to restore and sustainably manage the natural resources impacted by mining operations. The scope of the work is framed around seven interrelated components, which collectively inform the final recommendations for the watershed management plan.

A comprehensive understanding of land degradation within the mining-impacted Cluster-III area is achieved by integrating geospatial technologies, field surveys, and advanced modelling techniques. Degraded zones are primarily identified, and sustainable watershed management practices and effective ecological restoration strategies are then proposed, specifically tailored to this unique terrain. This holistic approach is considered crucial for generating actionable insights to mitigate

environmental degradation. Ultimately, the complex environmental and ecological challenges posed by coal mining will be directly and indirectly addressed by the findings derived from this work, thereby supporting informed decision-making and fostering the long-term environmental well-being of the region.



Chapter 2 : Morphometric analysis to identify various relationships of morphological parameters for the watershed of the study area.

2.1 Introduction

Water is an essential commodity for all human activities all around the world. Water scarcity is one of the major challenges for meeting sustainable development goals in 21st century. The global water scarcity analysis showed that a large share of the world population (up to two-thirds) will be affected by water scarcity over the next few decades in Asia and other regions of the globe. The water available on the earth is estimated to be approximately 1.4 billion cubic kilometers, of which 97 % is salt water and only the remaining 3 % is freshwater. Out of the 3% freshwater, 2 % is locked in glaciers and polar ice caps and leaving only 1 % as surface and groundwater for use. The geographical distribution of this accessible stock of water is highly uneven. Another major problem in the Indian hydrological scenario is the degradation of the water quality.

70% of India's population depends directly or indirectly on agriculture for their livelihood. Agricultural productivity is expected to decline as more areas are becoming unfit for cultivation. The reasons for declining agricultural productivity are the loss and degradation of natural resources, such as soil erosion and degradation of water quality, and the associated problems of declining soil fertility. To address these critical issues, watershed management initiatives have been widely adapted as a sustainable approach to conserve soil and water resources. A watershed, also known as a drainage basin or catchment area, is a physical unit where water converges to a common drainage channel. Though the watershed management approach dates back to the ancient period, it is the only sustainable way to conserve soil and water even today. Watershed management is not a one-time activity but a continuous process.

The term watershed is sometimes referred to as drainage basin, hydrologic basin,

catchment area, catchment, river catchment, and so on. The common terms are watershed, catchment, and basin; morphologically, all these terms convey the same meaning. Within this context, morphometric analysis of watersheds becomes a fundamental component of hydrological investigations. It is a branch of mathematics within geomorphology that quantitatively measures and analyzes the topographic relief and features of the Earth's surface, including parameters like elevation, slope, and other attributes that define landform shape and how they relate to each other. This analysis provides valuable insights into the physical qualities of soil, erosional features, and land processes. By objectively evaluating morphometric parameters such as linear, areal, and relief characteristics of basins, land managers can gain a comprehensive understanding of how drainage morphometry influences landforms and their characteristics, which is essential for informed decision-making in watershed management, land use planning, and environmental conservation.

Hydrologically, a watershed is an area that has only one outlet for draining the surface runoff. For systematic natural resource management in India, the Ministry of Agriculture, Government of India, has developed a watershed atlas of India. The river basins of the country are well organized on a geographical basis, and based on this, six water resource regions have been delineated. The All-India Soil Survey and Land Use division has classified the country into basins, catchments, sub-catchments, and watersheds. Govindpur Cluster-III is in the Khudia and Bagdighi Nala basins and consists of 10 watersheds. The area has more or less slopy terrain with a few hillocks, the highest elevation of the area is 274.74 m and lowest is 122.97 m above mean sea level. This may be the results of erosion by wind and rainwater of the overlying soft lithological formations. The present relief of the locality is being controlled by the hard resistant rocks now exposed to the surface.

2.2 Data Collection and Processing

The present study utilized the Digital Elevation Model (DEM) for hydrological analysis. DEM is a raster dataset capable of giving a 3D representation of elevation

data of the Earth's terrain. Each cell in the raster dataset contains an elevation value of the actual ground terrain. It facilitates drainage network analysis, watershed demarcation, erosion mapping, contour generation, and quantitative analysis like volume-area calculation. CartoSat-1_PAN_CartoDEM-30m is the Digital Elevation Model (DEM) data of the study area that was downloaded from the Indian Space Research Organization's (ISRO) Bhoonidhi portal (http://bhoonidhi.nrsc.gov.in/data/download/index.php, accessed 12 May 2025). The DEM data was collected from Bhoonidhi portal website and details are given in Table 2.1 below.

Table 2.1: Data used for hydrological analysis

Sl. No.	Name	Tile Name	Spatial Resolution	Date of Acquisition	Source
1.	Cartosat-1	P5_PAN_CD_N23_000_E086	30 m	01-05-2024	NRSC, Hyderabad (Bhoonidhi portal)

2.2.1 Preparation of Surface Topography

Surface topography is used to delineate the terrain conditions of any land parcel using satellite imagery. The first derivative of a DEM is used to depict the change in elevation or slope. Slope has been calculated using Spatial Analyst tool available in ArcGIS 10.2.2.

2.2.2 Generation of slope map using DEM

Slope maps are used for analyzing and visualizing landform characteristics and are frequently used to assess watershed units and to estimate slope erosion potential. The Slope tool identifies the steepness at each cell of a surface raster. The lower the slope value, the flatter the terrain; the higher the slope value, the steeper the terrain. In ArcGIS platform, it is processed by using 'Surface' toolset located in 'Spatial Analyst Tools' of ArcToolbox. The input is the raw DEM imagery and output is saved in the desired output folder with image extension such as .tif etc. The output raster can be computed in two-unit types, i.e., degrees or percentage slopes. The

percentage values can be computed by the ratio of Rise to Run with multiplication by 100. The degree values are computed by taking tan of the percentage value. Triangle *B* in Fig. 2.1, when the angle is 45 degrees, the rise is equal to the run, and the percent rise is 100 percent. As the slope angle approaches vertically (90 degree), as in triangle *C* (Fig. 2.1), the percent rise approaches infinity.

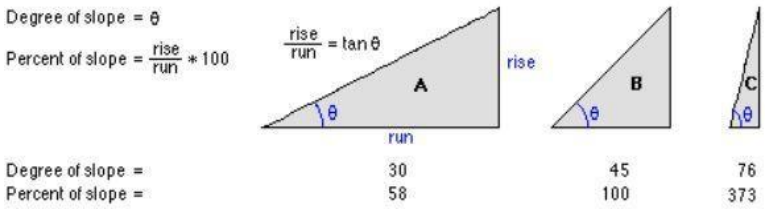


Fig. 2.1: A comparison of the values of slope in degrees & percentage

The red region on the map has a higher steep value and green colored portion shows the lower steep value. The elevation and slope map clearly shows that the northern region of the area has high hills (Fig. 2.2a and 2.2b).

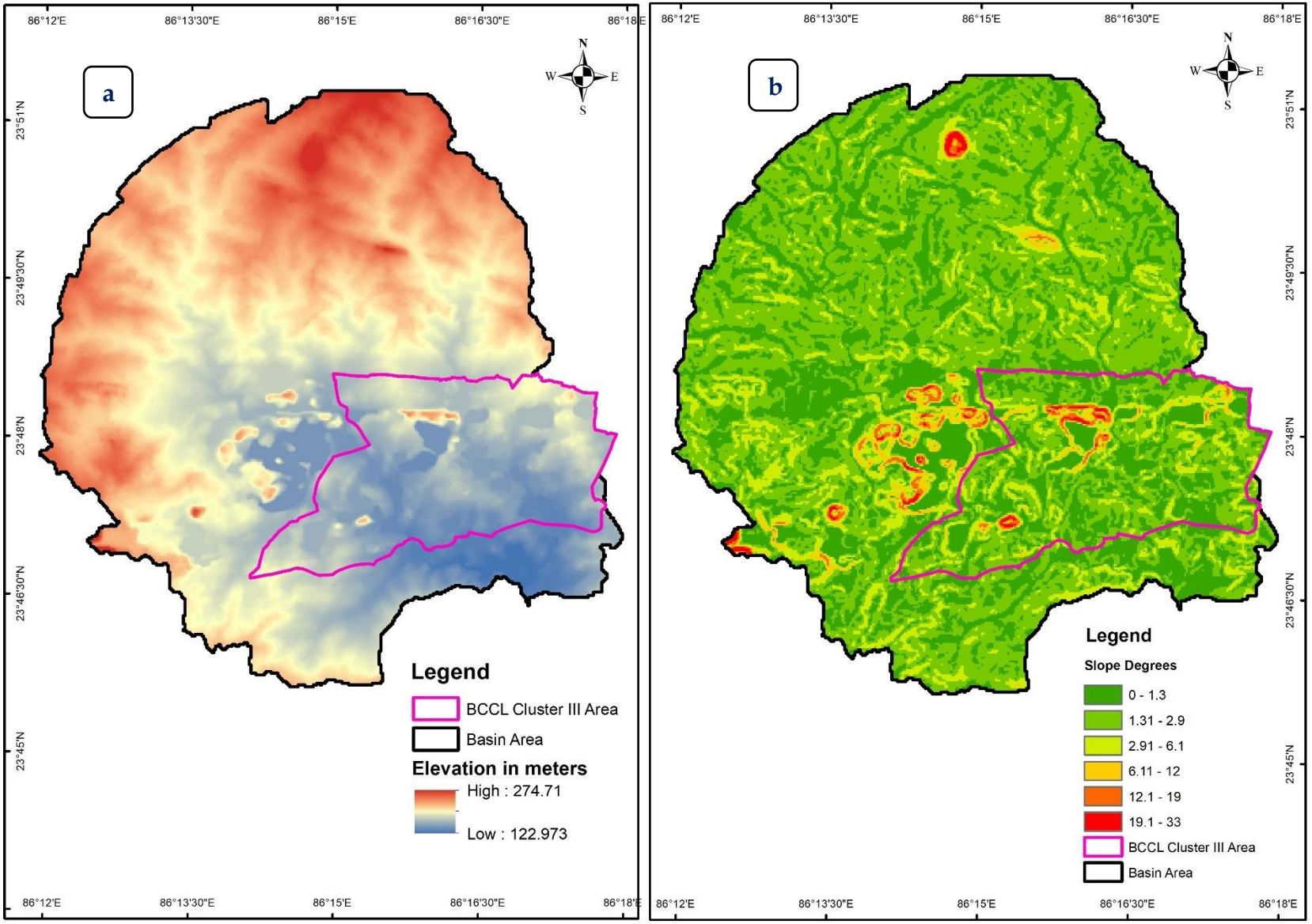


Fig. 2.2: Schematic representation of (a) Elevation and (b) Slope Map of the BCCL Cluster-III Basin Area

2.2.3 Calculation of aspect

An aspect raster identifies the direction that the downhill slope faces. It identifies the downslope direction of the maximum rate of change in value from each cell to its neighbors. In simpler terms, aspect can be thought of as the slope direction; the values of each cell in the output raster indicate the compass direction of the surface faces at that location. It is measured clockwise in degrees from 0 (due north) to 360 (again due north) as shown in Fig. 2.3.

In the ArcGIS platform, it is available in the Surface toolset located in the Spatial Analyst Tools of the ArcToolbox. The input is the raw DEM imagery, and the output is saved in the desired output folder with an image extension such as .tif, etc. The output of the aspect calculation identifies the direction of the downhill slope faces. The values of each cell in the output raster indicate the compass direction of the surface faces at that location, which can be seen in Fig. 2.4.

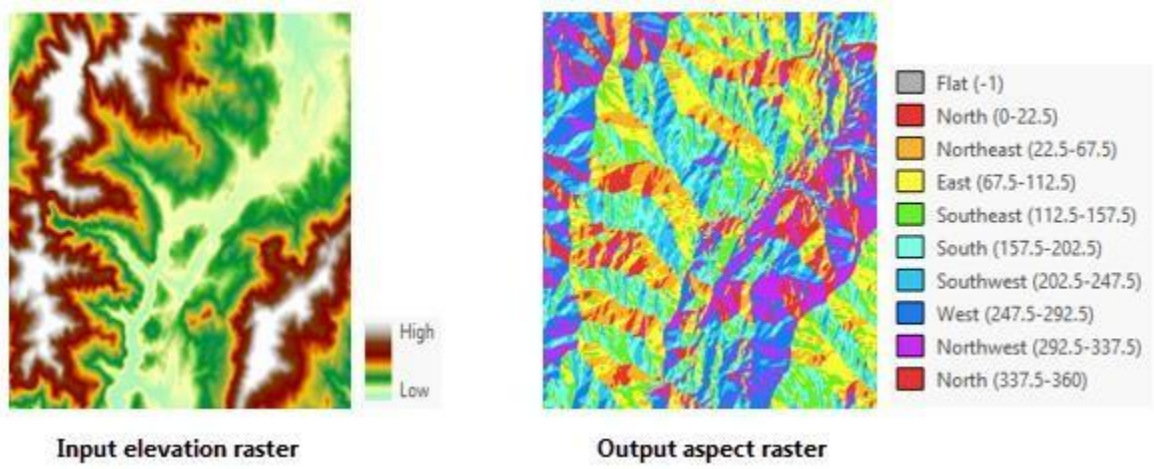


Fig. 2.3: Graphical representation of input elevation grid and output aspect grid

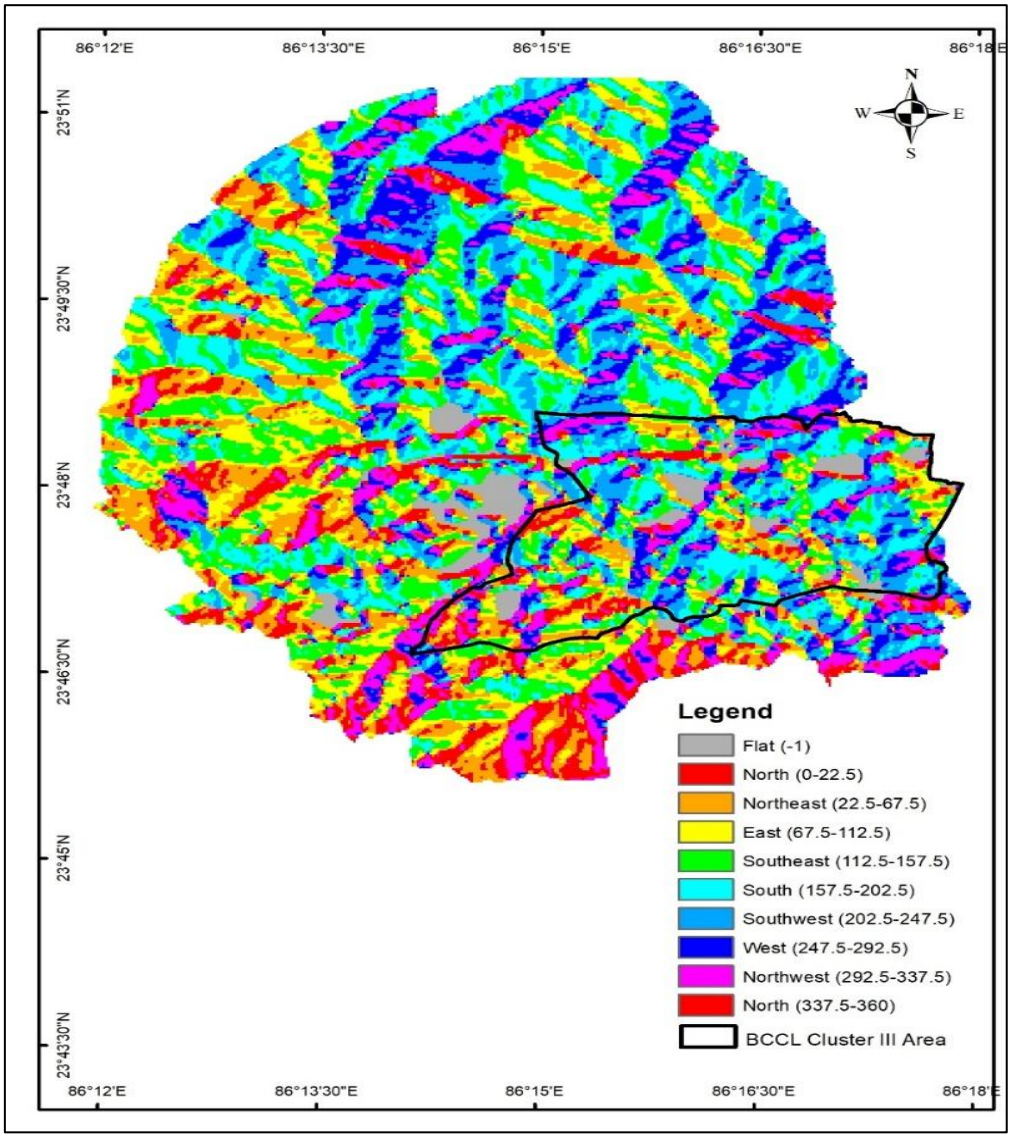


Fig. 2.4: Schematics of the aspect map of the BCCL Cluster-III Basin Area

2.3 Preprocessing of the DEM

Watershed delineation is one of the most commonly performed activities in hydrology and environmental analyses. Digital Elevation Models (DEMs) provide good terrain representation, which can delineate watersheds using GIS Software. The various steps for preprocessing of the DEM for watershed delineation in ArcGIS software are discussed below.

Step 1: Filling of the sinks in raw imagery

After the projection of the raw DEM into a projected coordinate system, the data were processed further for the removal of all sink values in the cells. A sink is a cell with an

undefined drainage direction with no cells surrounding it is at lower elevation than that sink. It is a cell or set of spatially connected cells whose flow direction cannot be assigned in any one of the eight valid values in a flow direction raster. Sinks in elevation data are most commonly due to errors in the data. These errors are often caused by sampling effects and the rounding of elevation values into integer numbers. To remove sinks in the raw data, fill tool is used in the Hydrology toolset located in Spatial Analyst Tool of the ArcToolbox as shown in Fig. 2.5. The next step in the process is the calculation of the flow direction raster.

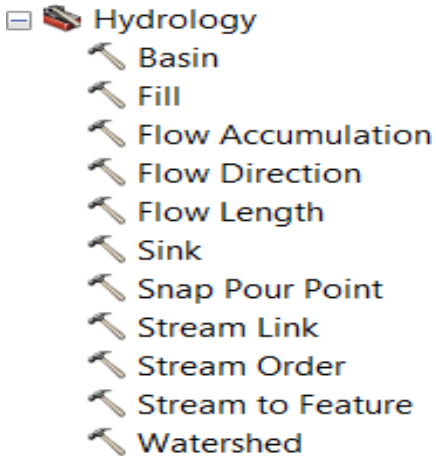
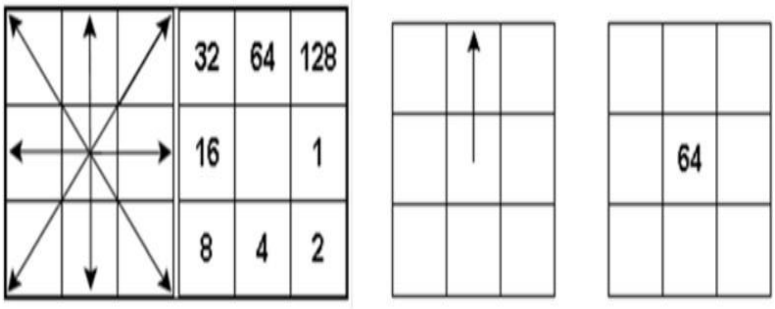


Fig. 2.5: Hydrology Toolset in ArcToolbox of ArcGIS

Step 2: Creation of a flow direction map

The Flow Direction raster function requires a surface DEM as input and creates a raster of flow direction from each pixel to its steepest downslope neighbor. The flow direction is identified by the steepest slope or the direction with the greatest elevation difference. The Flow Direction function supports three flow modeling methods and those are the D8 (eight directions), Multi-Flow Direction (MFD), and D-Infinity (DINF) flow modeling methods. In a given study, D8 algorithm is used to find the flow direction towards steepest descent of 8 neighboring cells. A flow direction grid assigns a value to each cell to indicate the direction of flow that is the direction that water will flow from that particular cell based on the underlying topography of the landscape. The flow direction tool takes a 3×3 cell into consideration and its

neighborhood, then the grid processor finds the lowest neighboring cell from the center. Each number in the matrix below corresponds to a flow direction, i.e. if the center cell flows due north, its value will be 64; if it flows northeast, its value will be 128, etc. as shown in Fig. 2 . 6. In flow direction rasters, the values 1, 2, 4, 8, 16, 32, 64, and 128 represent the eight possible directions a cell's flow can take East, Southeast, South, Southwest, West, Northwest, North, and Northeast directions, respectively. These numbers have no numeric meaning, but they are simply codes that define specific directional values and are determined using the elevation values from the underlying DEM.



Flow direction matrix **Flow direction is north, cell is coded 64**

Fig. 2.6: A schematic diagram of the flow direction matrix

The output of the flow direction gives the direction of the stream flows in each cell as shown in Fig. 2.7 for the entire selected basin area of 73.51 km^2.

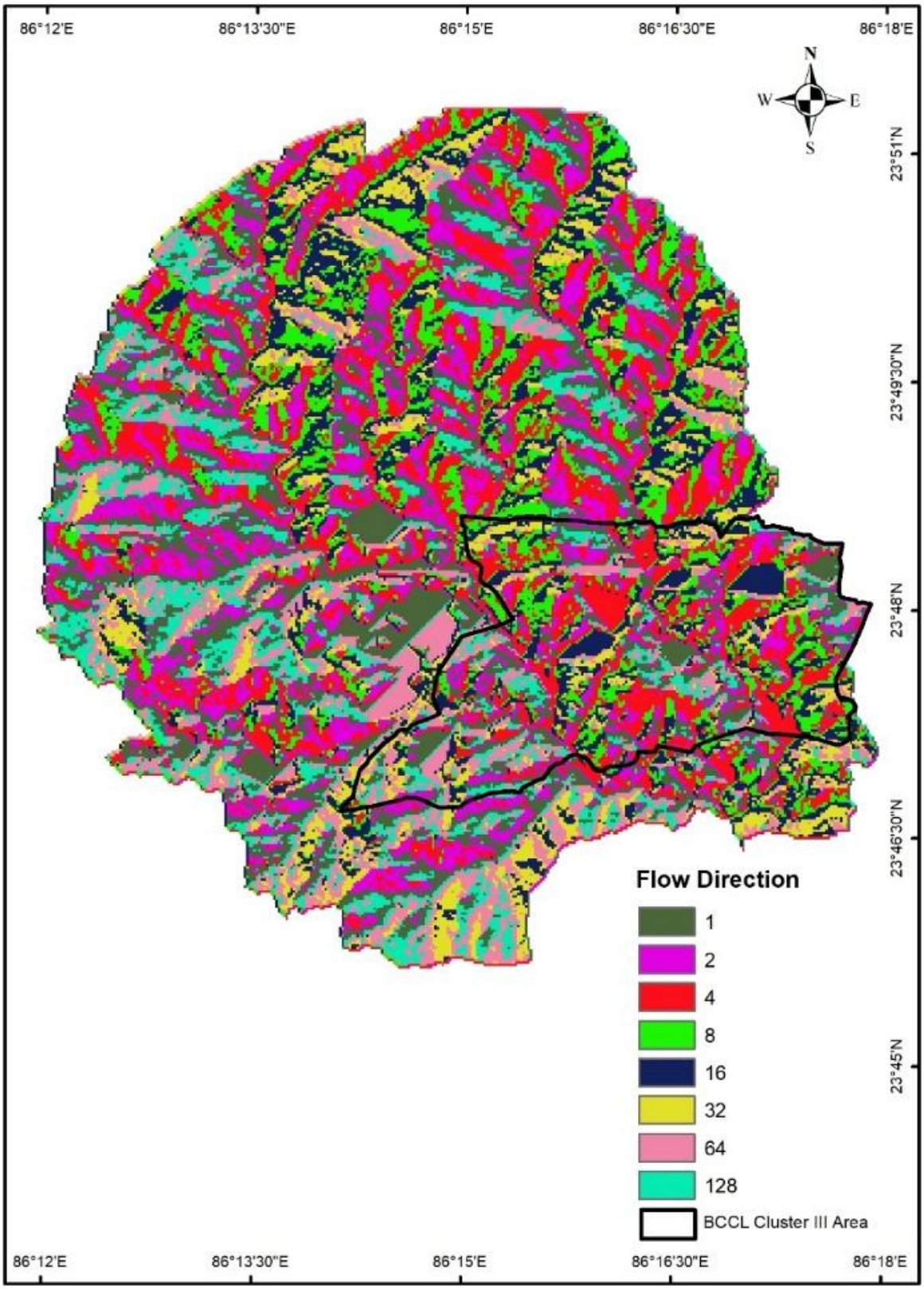


Fig. 2.7: Flow direction map of the BCCL Cluster-III Basin Area

Step 3: Creation of a flow accumulation grid

The flow accumulation tool of ArcGIS calculates accumulated flow as the accumulated weight of all cells flowing into each downslope cell in the output raster. If no weight raster is provided, a weight of 1 is applied to each cell, and the value of cells in the output raster is the number of cells that flow into each cell. The cells with a high value of flow accumulation represent stream channels, while cells with low flow accumulation represent uplands. Cells of undefined flow direction will only receive flow but they do not contribute any downstream flow. The accumulated flow is based on the number of cells flowing into each cell in the output raster. Output cells with a high flow accumulation are areas of concentrated flow and can be used to identify stream channels. Output cells with a flow accumulation of zero are local topographic highs and can be used to identify ridges. Flow accumulations are important because they allow to locate cells with high flow where streams and channels are expected.

The flow accumulation tool is given in the Hydrology toolset located in Spatial Analyst Tool of ArcToolbox as shown in Fig. 2.3. The Flow Accumulation raster, as shown in Figure 2.8, displays the accumulated flow to each cell, which is determined by the sum of the weight of all upslope cells that drain into it. To create a raster representing the stream network, where streams are given a value of 1 and the background is NoData, a threshold would typically be applied to this flow accumulation raster. Cells exceeding a certain flow accumulation threshold are considered part of the stream network, while those below become NoData.

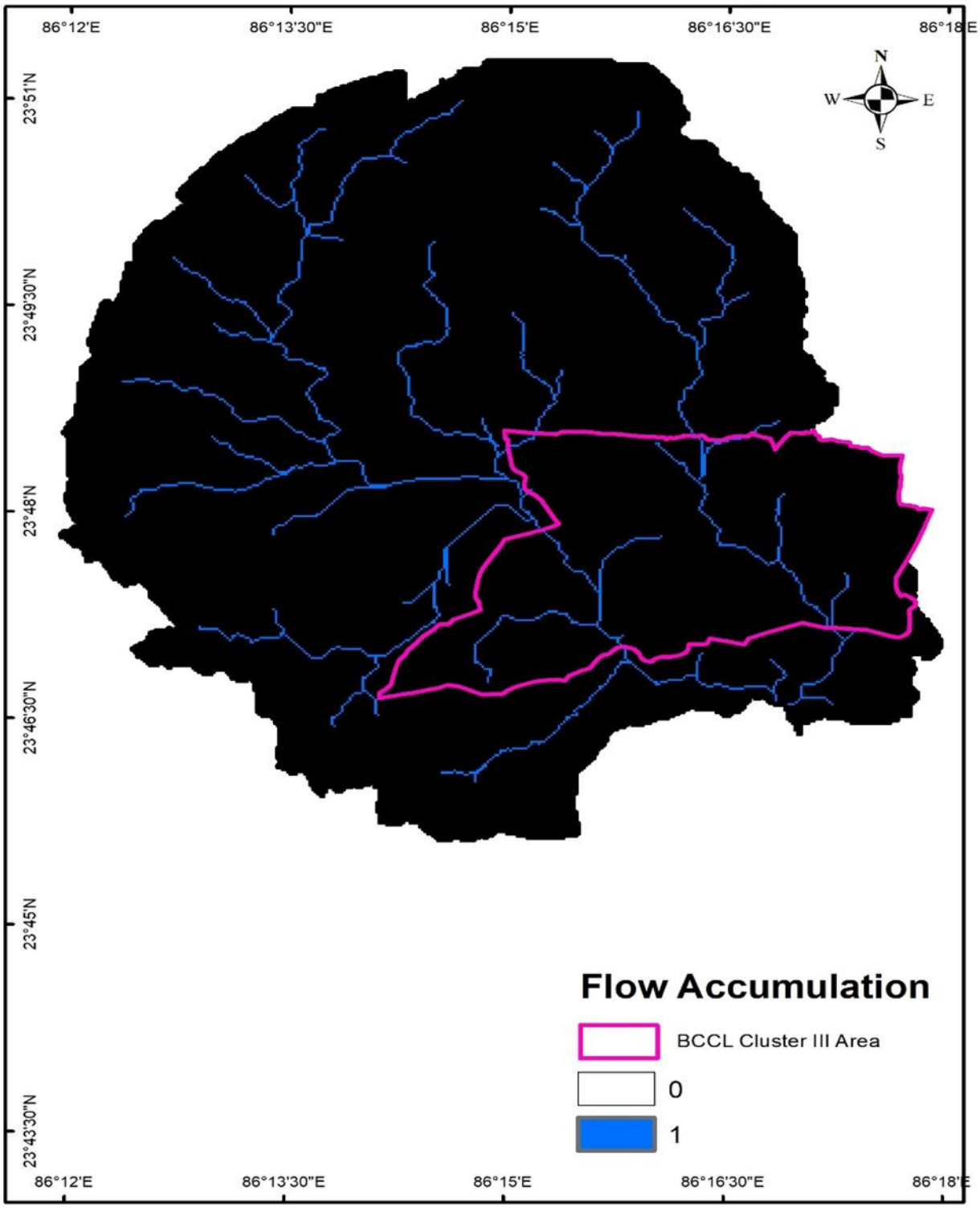


Fig. 2.8: Schematics of flow accumulation map of the BCCL Cluster-III Basin Area

2.4 Stream ordering of the drainage network in and around the mine lease area.

Stream order tool assigns a numeric order and links the stream network based on the

number of tributaries that are joining in a stream. Some characteristics of streams can be inferred by simply knowing their orders. For example, first-order streams are dominated by overland flow of water; they have no upstream concentrated flow. Because of this, they are most susceptible to non-point source pollution and can derive more benefits from wide riparian buffers than other areas of the watershed. The Stream ordering tool has two methods to assign orders. These two methods were proposed by Strahler (1957) and Shreve (1966).

a) Strahler (1957) method of stream ordering

In the Strahler (1957) method, all links without any tributaries are assigned an order of -1 and are referred to as first order. The stream order increases when streams of the same order intersect. Therefore, the intersection of two first-order links will create a second-order link, the intersection of two second-order links will create a third-order link, and so on. The intersection of two links of different orders, however, will not result in an increase in order which can be referred to from the Fig. 2.9. For example, the intersection of a first-order and second-order link will not create a third-order link but will retain the order of the highest ordered link. The Strahler method is the most common and widely used stream ordering method. However, using this method, the order increases only at the intersections of the same order streams, it does not account for all links and can be sensitive to the addition or removal of links (Fig. 2.9).

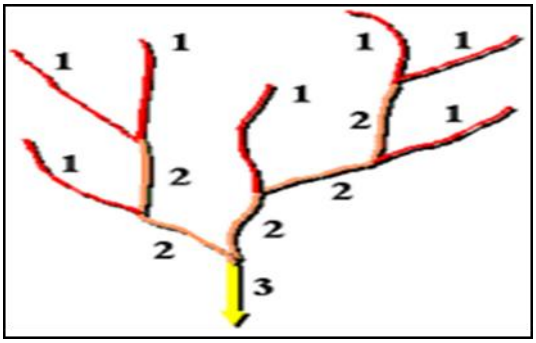


Fig. 2.9: A schematic diagram of Strahler method of Stream ordering

b) Shreve (1966) method of stream ordering

The Shreve (1966) method accounts for all links in the network. As with the Strahler method, all exterior links are assigned an order of 1. For all interior links in the Shreve method, however, the orders are additives which can be seen in the Fig. 2.10 which is given below. For example, the intersection of two first-order links creates a second-order link, the intersection of a first order and second-order link creates a third-order link, and the intersection of a second-order and third-order link creates a fifth-order link and so on. Because the orders are additive, the numbers from the Shreve method are sometimes referred to as magnitudes instead of orders. The magnitude of a link in the Shreve method is the number of upstream links (Fig. 2.9).

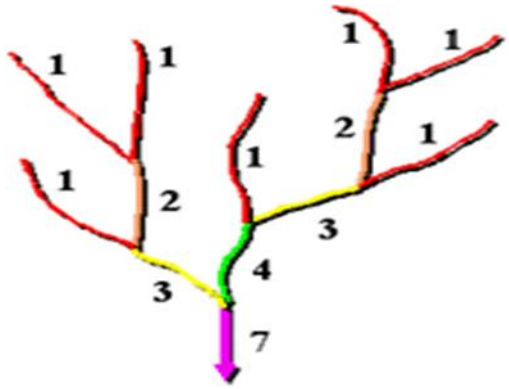


Fig. 2.10: A schematic diagram of Shreve method of stream ordering

Drainage network delineation and stream ordering is a multi-step process. Based on the Strahler method, the stream network and stream ordering of the study area were done. The step wise method for stream order delineation is given below:

Step 1: Determination of stream network

To know the stream order of a particular watershed, first we have to find the stream networks. Stream networks can be delineated from a Digital Elevation Model (DEM) using the output from the Flow Direction and Flow Accumulation tools. Flow accumulation, in its simplest form, is the number of upslope cells that flow into a particular cell. By applying a threshold value to the values of Flow Accumulation, a stream network can be defined that is comprised of catchments that are of the size of

the threshold value. The standard threshold values to identify the stream networks are 5,000 units of flow accumulation and the flow accumulation should be present in at least 30,000 cells. However, depending on the study area the value can change. The threshold flow accumulation value for the present study area was taken as 600 unit, due to its small spatial coverage. The spatial distributions of stream networks in the present study area are presented in Fig. 2. 8.

Step 2: Determination of stream link

Stream links are the linear joints between the junction points of a stream network. A link joins two consecutive junction points, and it is an outlet for the stream flow coming from the upstream region. A schematic diagram of stream link is shown in Fig. 2. 11.

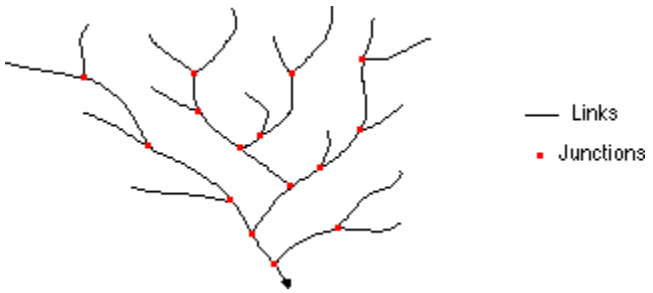


Fig. 2.11: Schematic representation of stream link of a drainage network

The Stream Link function creates a grid of stream links (or segments) that have a unique identification. A link may be a head link or it may be defined as a link between two junctions. All cells in a particular link have the same grid code that is specific to that link. The Stream Link tool only supports a D8 input flow direction raster. The Stream Link tool is given in the Hydrology toolset, located in Spatial Analyst Tool of ArcToolbox as shown in Fig. 2.5. This tool uses the Stream raster and Flow Direction raster as an input and provides a network of streams with junctions and links as the output. The next step is to determine the stream order.

Step 3: Determination of stream order

After determining the stream link, stream order has been determined using either

Strahler (1957) or Shreve (1966) method. Stream order means assigning a numeric order to links in a stream network. This stream ordering is a method for identifying and classifying the types of streams based on their numbers of tributaries. The DEM of Cluster-III area of BCCL was used to determine the Stream Order with Strahler method and it was found that the area has '3' different Stream Orders which can be seen in the given Fig. 2.12 The stream order map was then vectorized to create a stream network dataset. The schematics for the preparation of the stream network are shown in Fig. 2.13.

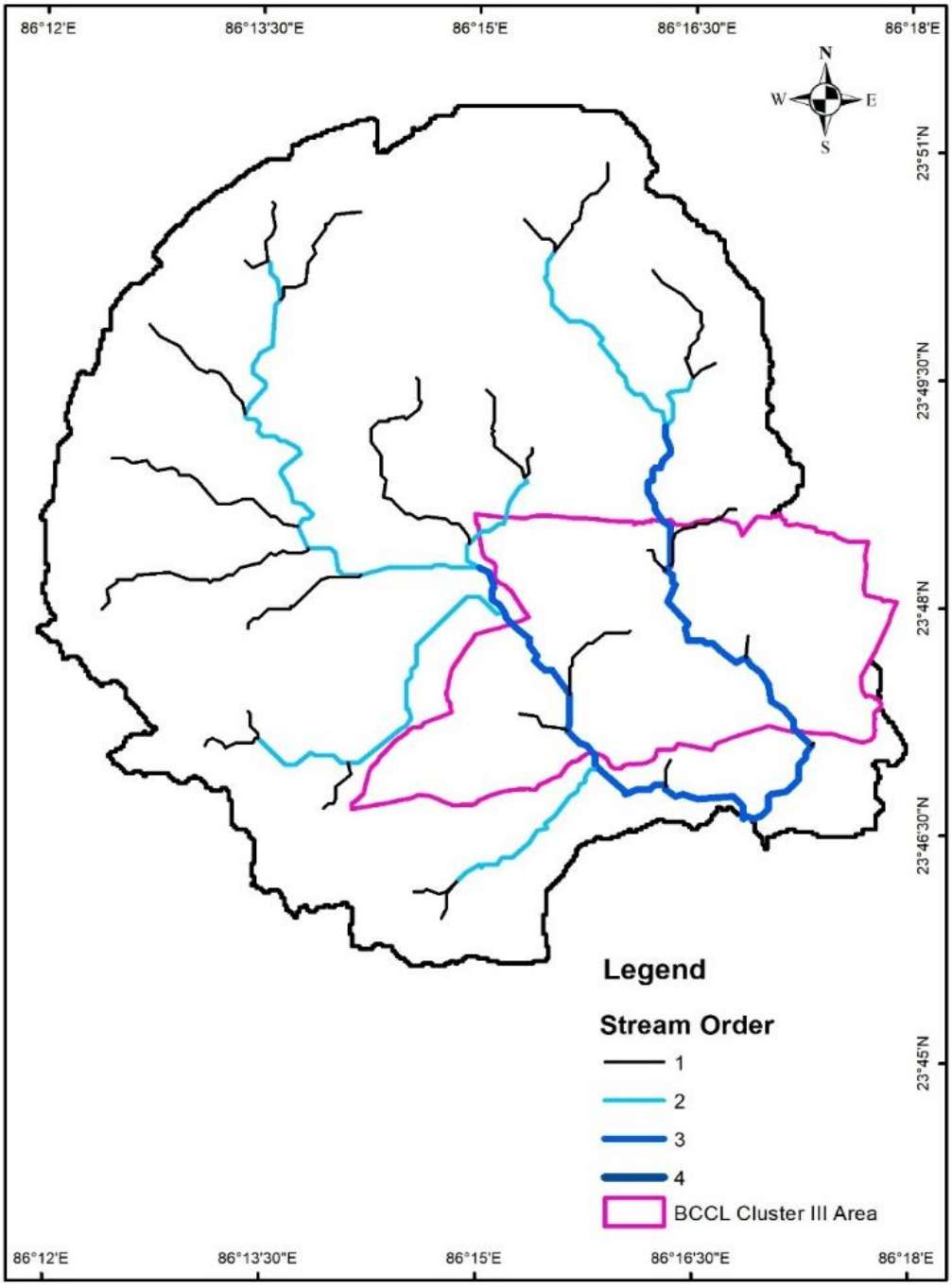


Fig. 2.12: Stream Order map of the BCCL Cluster-III area

2.5 Demarcation of the watershed covering the mine lease area

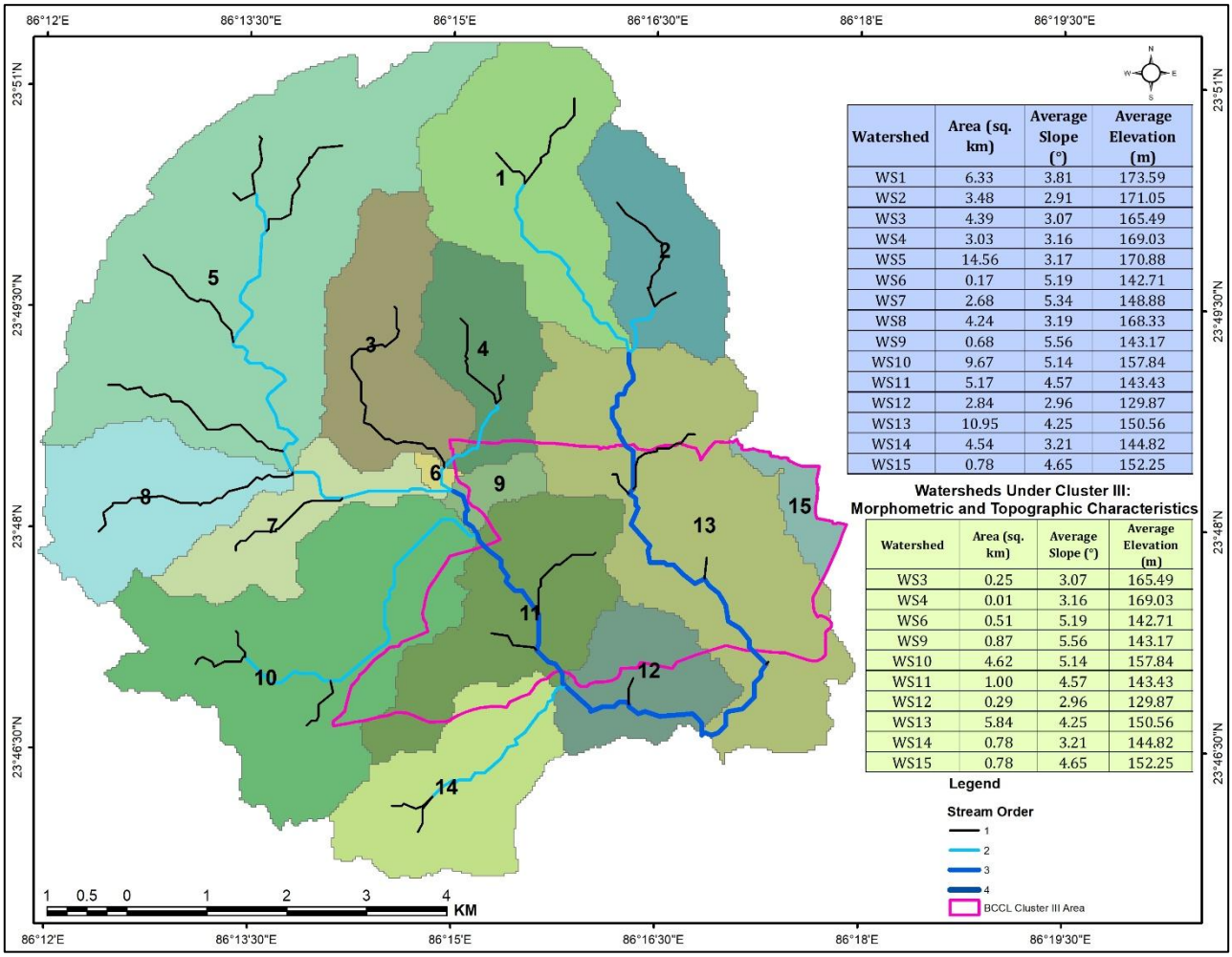
Watershed, also known as basin, is an area of land that drains water into a specific water body. The main purpose of watershed delineation is to divide the watershed into discrete land areas and stream reaches that drain water into a single outlet. The

geographical extent of a watershed is subdivided into smaller categories known as sub-basins.

Methods for watershed delineation

There are two methods for watershed delineation. The first method is based on the topography using GIS algorithm in which the input data required is DEM and the second method is based on uploading the pre-defined watersheds in which input data required is the known sub basin boundaries and streams.

In the present study the watershed has been delineated using the Cartosat-1 DEM data. Watershed delineation is done by using point-based technique. First, DEM is preprocessed and after preprocessing, the stream network and stream links are extracted from the flow accumulation output. In the final step of watershed delineation, flow direction and stream link raster are used as input. The present watershed has been delineated using the point named as pour point. In basin, the pour point has been added over the stream link at the end point of Khudia and Bagdighi Nala just before reaching the Katri River. Finally, the output watershed has been converted into vector features and then has been extracted as polygon features. The final watershed covering the entire basin area has been presented in Fig. 2.13.



Watershed	Area (sq. km)	Average Slope (°)	Average Elevation (m)
WS1	6.33	3.81	173.59
WS2	3.48	2.91	171.05
WS3	4.39	3.07	165.49
WS4	3.03	3.16	169.03
WS5	14.56	3.17	170.88
WS6	0.17	5.19	142.71
WS7	2.68	5.34	148.88
WS8	4.24	3.19	168.33
WS9	0.68	5.56	143.17
WS10	9.67	5.14	157.84
WS11	5.17	4.57	143.43
WS12	2.84	2.96	129.87
WS13	10.95	4.25	150.56
WS14	4.54	3.21	144.82
WS15	0.78	4.65	152.25

Watershed	Area (sq. km)	Average Slope (°)	Average Elevation (m)
WS3	0.25	3.07	165.49
WS4	0.01	3.16	169.03
WS6	0.51	5.19	142.71
WS9	0.87	5.56	143.17
WS10	4.62	5.14	157.84
WS11	1.00	4.57	143.43
WS12	0.29	2.96	129.87
WS13	5.84	4.25	150.56
WS14	0.78	3.21	144.82
WS15	0.78	4.65	152.25

Fig. 2.13: Schematics of morphometric and topographic characteristics along with the demarcation of watershed

2.6. Conclusion

The morphometric analysis of the BCCL Cluster-III area and the broader watershed basin reveals significant spatial heterogeneity in key geomorphological parameters such as area, slope, and elevation that directly may influence the hydrological behavior and surface runoff potential of the region.

In the BCCL Cluster-III area, sub-watersheds range from as small as 0.01 sq. km (WS4) to 5.84 sq. km (WS13), with average slopes between 2.96° and 5.56°, indicating a predominantly undulating to moderately steep terrain. The average elevation in this area ranges from 129.87 m to 165.49 m above mean sea level, which falls within the lower to mid-range of the overall basin elevation.

In contrast, the entire basin exhibits a broader variation in watershed area from 0.17 sq. km (WS6) to 14.56 sq. km (WS5) and covers a wider elevation gradient of 129.87 m to 173.59 m above mean sea level. The slope values span from 2.91° (WS2) to 5.56° (WS9), suggesting varying degrees of potential energy for water movement and erosion susceptibility.

Key insights from morphometric relationships include:

- Watersheds with higher slopes and smaller areas (e.g., WS6, WS9) are likely to exhibit rapid runoff and higher erosion potential.
- Watersheds with larger area and moderate slope (e.g., WS5, WS1) may contribute significantly to base-flow and groundwater recharge, due to greater infiltration potential.
- Low-lying watersheds (e.g., WS12) may serve as accumulation zones or discharge points, potentially vulnerable to flooding or sediment deposition during high rainfall.
- The morphometric variability highlights the complex topographic controls on drainage development, flow dynamics, and sediment transport within the basin. These relationships are vital for:
    - Hydrological modeling and watershed prioritization
    - Designing site-specific soil and water conservation structures
    - Planning sustainable land-use interventions
    - Mitigating risks of erosion and flooding

  This morphometric framework thus provides a crucial scientific basis for integrated watershed management in both mining-affected areas like BCCL Cluster-III and the overall basin landscape.

Chapter 3: Rainfall-runoff modelling to estimate runoff generated in different watersheds of the study area.

3.1 Introduction

Rainfall-runoff modelling is a critical component in the field of hydrology, aimed at understanding and quantifying the transformation of precipitation into surface runoff. Accurate estimation of runoff is essential for the design and operation of hydraulic structures, assessment of water availability, and mitigation of flood risks, particularly in the face of increasing climatic variability and land-use changes. Watersheds exhibit diverse hydrological responses to rainfall due to variations in topography, soil characteristics, land-use, vegetation cover, and climatic conditions. Therefore, modelling runoff generation across different watershed regions requires a robust understanding of these interacting factors and the ability to simulate their complex dynamics. Rainfall-runoff models serve as valuable tools in this regard, enabling the estimation of runoff volumes, flow rates, and spatial distribution under various hydrometeorological scenarios.

This study aims to apply rainfall-runoff modelling techniques to estimate the runoff generated in different watershed regions. By utilizing Rational and Curve Number methods, the runoff flow can be estimated. The most widely used Soil Conservation Service-Curve Number (SCS-CN) method, developed by the USDA, has been selected for the estimation of Runoff in the study area, which is supported by climatic and geospatial data. The study seeks to evaluate the spatial variability in runoff generation and identify key factors influencing the hydrological response of each watershed.

This chapter presents a comprehensive analysis of runoff estimation for the years 2015 to 2024 using the SCS-CN method across 15 delineated watersheds (WS1 to WS15) located in a monsoon-influenced coal mining-dominated catchment. These watersheds drain into two major Nala namely the Khudia and the Bagdighi Nala. The findings of the study are expected to support sustainable watershed management and

adaptation strategies under changing environmental conditions.

3.2 Methodology Adapted

3.2.1 Rational Method

The Rational Method is one of the most widely used empirical techniques for estimating peak surface runoff from small watersheds or urban catchments. It is primarily applied in the design of drainage structures, such as storm water drains, culverts, roadside ditches, detention basins etc. The method assumes that the peak runoff rate occurs when the entire drainage area contributes simultaneously to runoff, typically during short-duration, high-intensity rainfall events. The Rational Method is best suited for small watershed areas (usually less than 200 hectares or 500 acres) where land-use and rainfall intensity are relatively uniform. It provides a quick and straightforward estimate of peak discharge, making it particularly useful in preliminary design and urban storm water planning. The peak rate of runoff can be calculated by using the Eq. 3.1.

$$\boldsymbol{Q = \frac{1}{360} \times CIA} \qquad \textbf{…… (Eq. 3.1)}$$

Where, Q = Peak rate of runoff (m^3/sec), C = runoff coefficient, I = intensity of rainfall (mm/hr), A = area of the catchment (ha), Runoff coefficient C is defined as the ratio of the peak runoff rate to the rainfall intensity. Values of C for different slopes and land-use conditions are determined from field observations (USSCS 1972).

3.2.2 SCS-Curve Number Method

The Soil Conservation Service and Curve Number (SCS-CN) method was developed in 1954 and is documented in Section-4 of the National Engineering Handbook (NEH-4) published by the Soil Conservation Service (now called as Natural Resources Conservation Service) of the United States Department of Agriculture (USDA). The SCS Curve number is an empirical method for estimating direct runoff from rainfall events, especially in ungauged or data-scarce watersheds. It is commonly applied in

agriculture, urban planning, watershed management, and hydrological modeling to assess the impact of land-use, soil type, and antecedent moisture conditions on surface runoff. Unlike the Rational Method, which estimates peak runoff, the SCS-CN method focuses on the depth or volume of runoff and can be extended for event-based, monthly, or annual runoff estimation by aggregating over time. The present study used SCS-CN method to estimate monthly and annual runoff in mm based on precipitation inputs, land-use/land cover, soil type, and hydrologic conditions of the Dhanbad district along with the Govindpur Cluster-III area. The monthly and total annual runoff was computed and aggregated for each watershed connected with the study area. The method uses a dimensionless Curve Number (CN), which reflects the runoff potential of a watershed based on land-use/land cover, hydrologic soil group (HSG), and antecedent moisture condition (AMC) (Bansode et al., 2014). The data for soil properties and hydrologic soil groups were collected from the respective Government Agencies to create thematic layer for runoff potential (https://www.sameti.org/Soil_Inventory/Dhanbad_Soil_Analysis.pdf, accessed on 12th May 2025). The data for soil properties, soil curve number, land-use pattern and other associated parameters were collected and digitized in ArcGIS to create thematic layers for calculating runoff potential. The following equations have been used for calculating the amount of runoff generated using Raster Calculator in ArcMap. Runoff Depth can be calculated by using Eq. 3.2.

$$\boldsymbol{Q = \frac{(P-I_a)^2}{(P-I_a)+S}} \quad \textbf{..... (Eq. 3.2)}$$

Where, Q = Runoff depth in mm, P = Precipitation of the area in mm, S = Potential maximum retention after the start of runoff in mm, Ia = Initial abstraction or losses of the area in mm i.e., losses before runoff in the form of infiltration, interception or evaporation. Here, Ia = 0.3S, this relation was found by analyzing the rainfall in many small agricultural basins for Indian condition (Rao et al., 2010). For Indian condition, the Eq. 3.2 can be simplified as Eq. 3.3.

$$Q = \frac{(P-0.3S)^2}{P+0.7S} \text{ ..... (Eq. 3.3)}$$

Here, S is calculated by Curve Number (CN) values by using Eq. 3.4.

$$S = \frac{25400}{CN} - 254 \text{ ..... (Eq. 3.4)}$$

Here, CN is the curve number which is a dimensionless parameter used to indicate the behavior of runoff of a given area. In this method, it relates to the land-use pattern in the area, the soil moisture conditions, the hydrological conditions and the soil group of the drainage area. The CN value varies from 0 to 100. The number signifies a response of an area to generate runoff with respect to a particular rainfall value. Lower curve number indicates an area with a low potential for runoff generation. Higher CN indicates that a greater portion of the rainfall will flow as runoff (Krois & Schulte, 2014).

Land-use pattern describes the condition of the surface of a drainage basin. Properties of soil also greatly affect the amount of runoff that will be generated. In this method, the soil properties are represented by a parameter called hydrological soil group that can be used to calculate the minimum rate of infiltration that can take place after saturation for a specific soil category. Thus, by this process, the effect of both infiltration rate and horizontal transmission rate are taken into consideration.

The soil is classified into four different hydrological groups that are discussed below:

- **Class A:** This type of soil possesses high water transmission rate. Example: Well drained sand and gravel.
- **Class B:** This type of soil has moderate infiltration rate and a moderate water transmission rate. Example: Moderately drained soil having coarse to fine textures.
- **Class C:** This type of soil has low infiltration rate and low water transmission rate. Example: Clayey loams and sandy loamy soils with moderate to fine textures.

- **Class D:** This type of soil has a very low rate of infiltration and a very low rate of water transmission. Examples: Clayey soils with fine texture.

In the present study area, the soil is found to be inceptisols category which is loamy in structure. It comes under the hydrological group B and C.

The moisture condition of soil in the drainage area before any rainfall is also an important criterion that influences final curve number values. In SCS-CN method, the antecedent moisture condition can be categorized into three classes:

- **AMC I:** Soil present in the drainage area is dry.
- **AMC II:** Soil has average moisture content.
- **AMC III:** Soil is saturated from previous rainfall.

These are classified on the basis of 5-day antecedent rainfall. The AMC condition refers to as the condition of soil moisture just when it starts to rain. The curve number values based on all AMC- I, II, and III conditions taken for each HSG group and corresponding land cover for the entire basin area has been given in Table 3.1.

Table 3.1: Calculated Curve Number (CN) for Various Land-Use Classes (*Source: https://www.hec.usace.army.mil/confluence/hmsdocs/hmstrm/cn-tables*)

Sl. No	LULC Class	HSG Group		Total Area in sq. km		CN Values	
1	Agriculture land	B	C	7.94	0.01	78	85
2	Barren Land	B	C	5.57	3.60	86	91
3	Mining	B	C	3.64	0.79	86	91
4	Nala	B	C	0.33	0.16	100	100
5	National Highway	B	C	0.08	0.07	98	98
6	Railways	B	C	0.38	0.14	85	89
7	Settlements	B	C	7.55	2.16	65	77
8	Sparse Vegetation	B	C	28.20	7.90	69	79
9	Vegetation	B	C	6.80	0.36	61	74
10	Village Road	B	-	0.14	—	89	-
11	Waterbody	B	C	0.55	0.05	100	100

3.3 Watershed Classification and River Systems

Based on detailed investigation, the entire basin area consists of 15 watersheds, which are the tributaries of the two main Nala flowing through the study area (Fig. 3.1). These watersheds are primarily divided into two drainage systems:

i. Khudia Nala: Receives runoff from the watersheds WS3 to WS12 and WS14. The downstream of the Khudia Nala outlet is located at WS12.

ii. Bagdighi Nala: The watersheds WS1, WS2, WS13, and WS15 contribute their runoff into the Bagdighi Nala. The downstream of the Bagdighi Nala outlet falls within the watershed WS15.

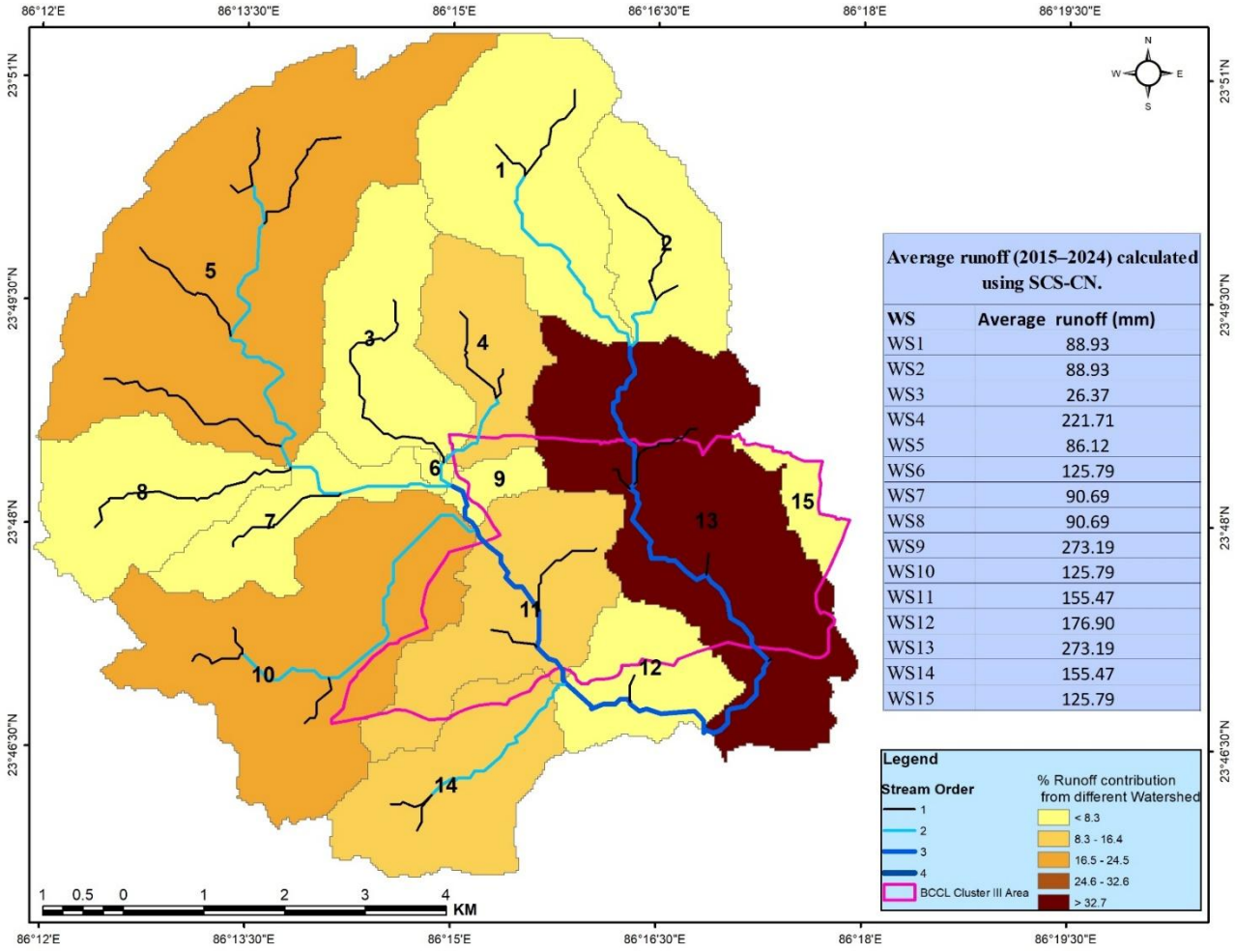


Fig. 3.1: Runoff contribution from different watersheds

3.4. Results and Discussion

3.4.1 Temporal Variability

Runoff generation varied significantly across the study period, with peak runoff occurring consistently in the monsoon months (July to September). The year 2024 recorded the highest runoff, indicating a possible extreme rainfall event.

3.4.2 Spatial Distribution

Watersheds contributing to the Khudia Nala produced substantially more runoff than those feeding the Bagdighi Nala. WS4, WS9, and WS12 were the major contributors, regularly exceeding 300 mm/year. WS13 in the Bagdighi Nala system was the dominant watershed, matching the runoff levels of the top Khudia sub-basins during wet years. The calculated historical annual runoff trend (2015–2024) for Khudia and Bagdighi Nala Systems have been shown in Fig. 3.2.

3.4.3 Total Cumulative Runoff

The cumulative runoff of the watershed of the two different major drainage system has been calculated and shown in the Table 3.2.

Table 3.2: Cumulative Total Runoff (2015–2024) of the existing main drainage system

Rivers	Contributing Watersheds	Total Runoff (2015–2024) in mm
Khudia Nala	WS3–WS12, WS14	17,973.28
Bagdighi Nala	WS1, WS2, WS13, WS15	5,193.38

The Khudia Nala system exhibited a more intense hydrological response, aligning with its larger catchment area and more responsive land cover conditions.

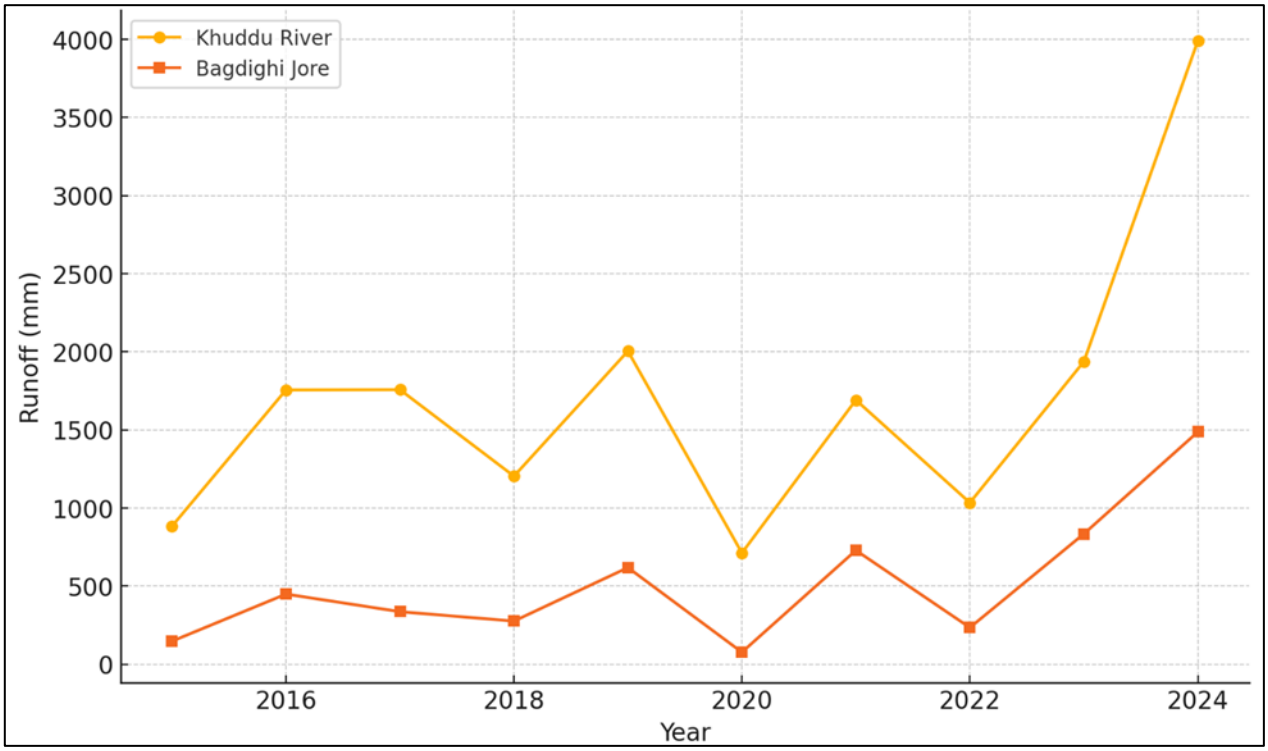


Fig. 3.2: Annual runoff trend (2015–2024) for Khudia and Bagdighi Nala Systems

3.4.4 Peak Runoff Year: 2024

In 2024, runoff values reached record highs across most of the watersheds (Fig. 3.3):

- WS4: 506.76 mm
- WS9: 590.84 mm
- WS12: 438.26 mm
- WS13: 590.84 mm

This highlights the increasing frequency of high-intensity precipitation events and their implications for watershed planning.

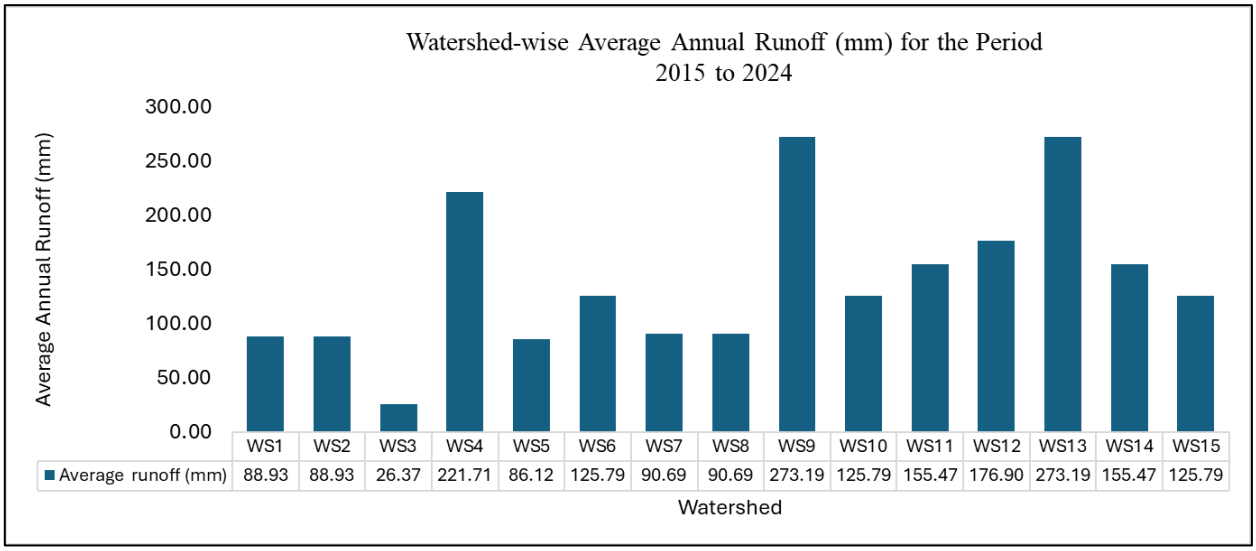


Fig. 3.3: Watershed-wise average annual runoff

3.4.5 Per-Second Runoff Volume (m^3/s)

Monthly runoff flow rates (in cubic meters per second) were also estimated from 2015 to 2024. These values are vital for understanding peak discharge scenarios and designing hydraulic infrastructure. The rainfall runoff depth (mm) of entire basin of different watersheds lying in the study area for the year 2015-2024 is depicted in the Table 3.3 to Table 3.12.

Table 3.3: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2015

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	35.82	0.00	1.17	0.00	0.00	0.00	36.99
WS2	0.00	0.00	0.00	0.00	0.00	0.00	35.82	0.00	1.17	0.00	0.00	0.00	36.99
WS3	0.00	0.00	0.00	0.00	0.00	0.00	8.33	0.00	0.00	0.00	0.00	0.00	8.33
WS4	0.00	0.00	0.00	0.00	0.00	0.19	91.87	4.98	8.27	0.00	0.00	0.00	105.31
WS5	0.00	0.00	0.00	0.00	0.00	0.00	35.82	0.00	1.17	0.00	0.00	0.00	36.99
WS6	0.00	0.00	0.00	0.00	0.00	0.00	54.40	0.00	3.26	0.00	0.00	0.00	57.66
WS7	0.00	0.00	0.00	0.00	0.00	0.00	81.92	2.39	6.98	0.00	0.00	0.00	91.29
WS8	0.00	0.00	0.00	0.00	0.00	0.00	81.92	2.39	6.98	0.00	0.00	0.00	91.29
WS9	0.00	0.00	0.00	0.00	0.00	2.18	116.47	11.24	11.50	0.00	0.00	0.00	141.39
WS10	0.00	0.00	0.00	0.00	0.00	0.00	54.40	0.00	3.26	0.00	0.00	0.00	57.66
WS11	0.00	0.00	0.00	0.00	0.00	0.00	66.52	0.43	4.87	0.00	0.00	0.00	71.82
WS12	0.00	0.00	0.00	0.00	0.00	0.00	73.84	1.38	5.86	0.00	0.00	0.00	81.07
WS13	0.00	0.00	0.00	0.00	0.00	2.18	116.47	11.24	11.50	0.00	0.00	0.00	141.39
WS14	0.00	0.00	0.00	0.00	0.00	0.00	66.52	0.43	4.87	0.00	0.00	0.00	71.82
WS15	0.00	0.00	0.00	0.00	0.00	0.00	54.40	0.00	3.26	0.00	0.00	0.00	57.66

Table 3.4: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2016

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	4.83	11.26	23.94	24.66	0.00	0.00	0.00	**64.68**
WS2	0.00	0.00	0.00	0.00	0.00	4.83	11.26	23.94	24.66	0.00	0.00	0.00	**64.68**
WS3	0.00	0.00	0.00	0.00	0.00	0.07	1.83	2.03	2.55	0.00	0.00	0.00	**6.48**
WS4	0.00	0.00	0.00	0.00	0.00	15.96	35.04	105.05	75.90	0.00	0.00	0.00	**231.95**
WS5	0.00	0.00	0.00	0.00	0.00	4.83	11.26	23.94	24.66	0.00	0.00	0.00	**64.68**
WS6	0.00	0.00	0.00	0.00	0.00	8.64	17.07	46.44	40.13	0.00	0.00	0.00	**112.29**
WS7	0.00	0.00	0.00	0.00	0.00	14.19	29.24	88.24	64.69	0.00	0.00	0.00	**196.37**

WS8	0.00	0.00	0.00	0.00	0.00	14.19	29.24	88.24	64.69	0.00	0.00	0.00	**196.37**
WS9	0.00	0.00	0.00	0.00	0.00	21.78	47.95	143.56	105.98	0.00	0.00	0.00	**319.28**
WS10	0.00	0.00	0.00	0.00	0.00	8.64	17.07	46.44	40.13	0.00	0.00	0.00	**112.29**
WS11	0.00	0.00	0.00	0.00	0.00	11.16	22.11	64.64	50.36	0.00	0.00	0.00	**148.27**
WS12	0.00	0.00	0.00	0.00	0.00	12.61	25.70	76.38	57.11	0.00	0.00	0.00	**171.81**
WS13	0.00	0.00	0.00	0.00	0.00	21.78	47.95	143.56	105.98	0.00	0.00	0.00	**319.28**
WS14	0.00	0.00	0.00	0.00	0.00	11.16	22.11	64.64	50.36	0.00	0.00	0.00	**148.27**
WS15	0.00	0.00	0.00	0.00	0.00	8.64	17.07	46.44	40.13	0.00	0.00	0.00	**112.29**

Table 3.5: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2017

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	67.78	15.19	0.00	1.59	0.00	0.00	84.56
WS2	0.00	0.00	0.00	0.00	0.00	0.00	67.78	15.19	0.00	1.59	0.00	0.00	84.56
WS3	0.00	0.00	0.00	0.00	0.00	0.00	16.81	3.50	0.00	0.00	0.00	0.00	20.31
WS4	0.00	0.00	0.00	0.00	0.00	1.79	178.79	37.67	0.00	21.23	0.00	0.00	239.49
WS5	0.00	0.00	0.00	0.00	0.00	0.00	67.78	15.19	0.00	1.59	0.00	0.00	84.56
WS6	0.00	0.00	0.00	0.00	0.00	0.00	103.12	22.27	0.00	6.00	0.00	0.00	131.40
WS7	0.00	0.00	0.00	0.00	0.00	0.50	158.84	33.57	0.00	16.11	0.00	0.00	209.02
WS8	0.00	0.00	0.00	0.00	0.00	0.50	158.84	33.57	0.00	16.11	0.00	0.00	209.02
WS9	0.00	0.00	0.00	0.00	0.00	0.00	114.53	24.58	0.00	7.73	0.00	0.00	146.84
WS10	0.00	0.00	0.00	0.00	0.00	0.00	103.12	22.27	0.00	6.00	0.00	0.00	131.40
WS11	0.00	0.00	0.00	0.00	0.00	0.00	127.37	27.17	0.00	9.85	0.00	0.00	164.39
WS12	0.00	0.00	0.00	0.00	0.00	0.16	142.16	30.13	0.00	12.72	0.00	0.00	185.17
WS13	0.00	0.00	0.00	0.00	0.00	0.00	114.53	24.58	0.00	7.73	0.00	0.00	146.84
WS14	0.00	0.00	0.00	0.00	0.00	0.00	127.37	27.17	0.00	9.85	0.00	0.00	164.39
WS15	0.00	0.00	0.00	0.00	0.00	0.00	103.12	22.27	0.00	6.00	0.00	0.00	131.40

Table 3.6: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2018

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	53.23	0.39	0.00	0.00	0.00	0.00	53.62
WS2	0.00	0.00	0.00	0.00	0.00	0.00	53.23	0.39	0.00	0.00	0.00	0.00	53.62
WS3	0.00	0.00	0.00	0.00	0.00	0.00	22.73	0.00	0.00	0.00	0.00	0.00	22.73
WS4	0.00	0.00	0.00	0.00	0.00	1.53	102.58	11.74	0.00	0.00	0.00	0.00	115.86
WS5	0.00	0.00	0.00	0.00	0.00	0.00	53.23	0.39	0.00	0.00	0.00	0.00	53.62
WS6	0.00	0.00	0.00	0.00	0.00	0.00	71.21	2.49	0.00	0.00	0.00	0.00	73.71
WS7	0.00	0.00	0.00	0.00	0.00	0.46	95.30	8.81	0.00	0.00	0.00	0.00	104.57
WS8	0.00	0.00	0.00	0.00	0.00	0.46	95.30	8.81	0.00	0.00	0.00	0.00	104.57
WS9	0.00	0.00	0.00	0.00	0.16	7.64	119.23	20.41	1.75	0.00	0.00	0.00	149.19
WS10	0.00	0.00	0.00	0.00	0.00	0.00	71.21	2.49	0.00	0.00	0.00	0.00	73.71
WS11	0.00	0.00	0.00	0.00	0.00	0.07	82.36	4.81	0.00	0.00	0.00	0.00	87.23
WS12	0.00	0.00	0.00	0.00	0.00	0.20	88.58	6.54	0.00	0.00	0.00	0.00	95.32
WS13	0.00	0.00	0.00	0.00	0.16	7.64	119.23	20.41	1.75	0.00	0.00	0.00	149.19
WS14	0.00	0.00	0.00	0.00	0.00	0.07	82.36	4.81	0.00	0.00	0.00	0.00	87.23
WS15	0.00	0.00	0.00	0.00	0.00	0.00	71.21	2.49	0.00	0.00	0.00	0.00	73.71

Table 3.7: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2019

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	12.31	0.46	77.29	0.76	0.00	0.00	90.82
WS2	0.00	0.00	0.00	0.00	0.00	0.00	12.31	0.46	77.29	0.76	0.00	0.00	90.82
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	39.23	0.00	0.00	0.00	39.40
WS4	0.00	0.00	0.00	0.00	4.46	7.35	73.90	11.89	130.68	8.04	0.00	0.00	236.32
WS5	0.00	0.00	0.00	0.00	0.00	0.00	12.31	0.46	77.29	0.76	0.00	0.00	90.82
WS6	0.00	0.00	0.00	0.00	0.00	0.15	27.16	2.68	97.30	2.52	0.00	0.00	129.81
WS7	0.00	0.00	0.00	0.00	2.14	4.21	59.81	8.98	123.06	0.00	0.00	0.00	198.21

WS8	0.00	0.00	0.00	0.00	2.14	4.21	59.81	8.98	123.06	0.00	0.00	0.00	198.21
WS9	0.00	0.00	0.00	0.00	9.61	14.26	108.11	22.05	147.74	15.80	0.00	0.00	317.57
WS10	0.00	0.00	0.00	0.00	0.00	0.15	27.16	2.68	97.30	2.52	0.00	0.00	129.81
WS11	0.00	0.00	0.00	0.00	0.43	1.50	40.84	5.05	109.33	3.95	0.00	0.00	161.11
WS12	0.00	0.00	0.00	0.00	1.30	2.97	50.09	6.78	115.96	4.88	0.00	0.00	181.98
WS13	0.00	0.00	0.00	0.00	9.61	14.26	108.11	22.05	147.74	15.80	0.00	0.00	317.57
WS14	0.00	0.00	0.00	0.00	0.43	1.50	40.84	5.05	109.33	3.95	0.00	0.00	161.11
WS15	0.00	0.00	0.00	0.00	0.00	0.15	27.16	2.68	97.30	2.52	0.00	0.00	129.81

Table 3.8: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2020

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.67	0.00	11.75	0.00	0.00	0.00	0.00	12.42
WS2	0.00	0.00	0.00	0.00	0.00	0.67	0.00	11.75	0.00	0.00	0.00	0.00	12.42
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.20
WS4	0.00	0.00	2.50	1.46	0.00	7.62	5.52	54.27	9.77	0.56	0.00	0.00	81.68
WS5	0.00	0.00	0.00	0.00	0.00	0.67	0.00	11.75	0.00	0.00	0.00	0.00	12.42
WS6	0.00	0.00	0.00	0.00	0.00	2.36	0.34	23.13	0.38	0.00	0.00	0.00	26.20
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	6.53	4.86	0.00	13.61	12.95	76.88	20.52	1.59	0.00	0.00	136.94
WS10	0.00	0.00	0.00	0.00	0.00	2.36	0.34	23.13	0.38	0.00	0.00	0.00	26.20
WS11	0.00	0.00	0.02	0.02	0.00	3.79	1.33	32.41	1.92	0.01	0.00	0.00	39.51
WS12	0.00	0.00	0.39	0.20	0.00	4.79	2.21	38.45	3.59	0.10	0.00	0.00	49.73
WS13	0.00	0.00	6.53	4.86	0.00	13.61	12.95	76.88	20.52	1.59	0.00	0.00	136.94
WS14	0.00	0.00	0.02	0.02	0.00	3.79	1.33	32.41	1.92	0.01	0.00	0.00	39.51
WS15	0.00	0.00	0.00	0.00	0.00	2.36	0.34	23.13	0.38	0.00	0.00	0.00	26.20

Table 3.9: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2021

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	41.14	42.85	0.00	32.11	11.03	0.00	0.00	127.12
WS2	0.00	0.00	0.00	0.00	0.00	41.14	42.85	0.00	32.11	11.03	0.00	0.00	127.12
WS3	0.00	0.00	0.00	0.00	0.00	2.96	0.00	0.00	0.97	1.74	0.00	0.00	5.67
WS4	0.00	0.00	0.00	0.00	0.03	131.29	15.29	0.00	99.67	26.46	0.02	0.00	272.76
WS5	0.00	0.00	0.00	0.00	0.00	41.14	42.85	0.00	32.11	11.03	0.00	0.00	127.12
WS6	0.00	0.00	0.00	0.00	0.00	71.03	2.26	0.00	52.60	0.00	16.49	0.00	142.38
WS7	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.29	0.00	0.00	0.61
WS8	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.29	0.00	0.00	0.61
WS9	0.00	0.00	0.00	0.00	1.19	167.72	25.57	1.17	123.09	33.20	1.10	0.03	353.07
WS10	0.00	0.00	0.00	0.00	0.00	71.03	2.26	0.00	52.60	0.00	16.49	0.00	142.38
WS11	0.00	0.00	0.00	0.00	0.00	91.22	5.64	0.00	68.46	19.82	0.00	0.00	185.15
WS12	0.00	0.00	0.00	0.00	0.00	103.06	8.33	0.00	100.08	21.71	0.00	0.00	233.18
WS13	0.00	0.00	0.00	0.00	1.19	167.72	25.57	1.17	123.09	33.20	1.10	0.03	353.07
WS14	0.00	0.00	0.00	0.00	0.00	91.22	5.64	0.00	68.46	19.82	0.00	0.00	185.15
WS15	0.00	0.00	0.00	0.00	0.00	71.03	2.26	0.00	52.60	0.00	16.49	0.00	142.38

Table 3.10: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2022

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	1.92	25.19	0.00	1.01	0.00	0.00	28.12
WS2	0.00	0.00	0.00	0.00	0.00	0.00	1.92	25.19	0.00	1.01	0.00	0.00	28.12
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.04	0.00	0.00	0.00	0.00	4.04
WS4	0.00	0.00	0.00	0.00	0.00	0.00	21.77	85.40	0.33	13.67	0.00	0.00	121.17
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS6	0.00	0.00	0.00	0.00	0.00	0.00	6.08	43.73	0.00	3.74	0.00	0.00	53.55
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.28	0.00	0.00	0.00	0.00	1.28
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.28	0.00	0.00	0.00	0.00	1.28

WS9	0.00	0.19	0.00	0.00	0.00	0.00	34.99	116.04	3.13	23.44	0.00	0.00	177.79
WS10	0.00	0.00	0.00	0.00	0.00	0.00	6.08	43.73	0.00	3.74	0.00	0.00	53.55
WS11	0.00	0.00	0.00	0.00	0.00	0.00	10.39	56.85	0.00	6.17	0.00	0.00	73.41
WS12	0.00	0.00	0.00	0.00	0.00	0.00	21.33	64.72	0.00	5.42	0.00	0.00	91.47
WS13	0.00	0.19	0.00	0.00	0.00	0.00	34.99	116.04	3.13	23.44	0.00	0.00	177.79
WS14	0.00	0.00	0.00	0.00	0.00	0.00	10.39	56.85	0.00	6.17	0.00	0.00	73.41
WS15	0.00	0.00	0.00	0.00	0.00	0.00	6.08	43.73	0.00	3.74	0.00	0.00	53.55

Table 3.11: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2023

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	49.92	19.82	7.07	43.27	0.00	0.00	120.08
WS2	0.00	0.00	0.00	0.00	0.00	0.00	49.92	19.82	7.07	43.27	0.00	0.00	120.08
WS3	0.00	0.00	0.00	0.00	0.00	0.00	17.30	1.67	0.44	14.09	0.00	0.00	33.51
WS4	0.00	0.00	0.00	2.21	2.86	0.72	96.20	84.27	25.01	94.56	0.00	0.00	305.84
WS5	0.00	0.00	0.00	0.00	0.00	0.00	49.92	19.82	7.07	43.27	0.00	0.00	120.08
WS6	0.00	0.00	0.00	0.00	0.00	0.00	66.90	36.76	12.57	59.66	0.00	0.00	175.89
WS7	0.00	0.00	0.00	0.00	0.00	0.00	9.00	0.25	0.00	8.30	0.00	0.00	17.56
WS8	0.00	0.00	0.00	0.00	0.00	0.00	9.00	0.25	0.00	8.30	0.00	0.00	17.56
WS9	0.00	0.00	0.00	6.06	7.12	3.32	112.13	117.01	37.62	115.76	0.00	0.00	399.02
WS10	0.00	0.00	0.00	0.00	0.00	0.00	66.90	36.76	12.57	59.66	0.00	0.00	175.89
WS11	0.00	0.00	0.00	0.00	0.07	0.02	77.33	50.97	16.44	70.81	0.00	0.00	215.64
WS12	0.00	0.00	0.00	0.29	0.54	0.12	83.14	60.35	18.77	77.76	0.00	0.00	240.96
WS13	0.00	0.00	0.00	6.06	7.12	3.32	112.13	117.01	37.62	115.76	0.00	0.00	399.02
WS14	0.00	0.00	0.00	0.00	0.07	0.02	77.33	50.97	16.44	70.81	0.00	0.00	215.64
WS15	0.00	0.00	0.00	0.00	0.00	0.00	66.90	36.76	12.57	59.66	0.00	0.00	175.89

Table 3.12: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2024

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	20.40	167.39	83.06	0.00	0.00	0.00	270.84
WS2	0.00	0.00	0.00	0.00	0.00	0.00	20.40	167.39	83.06	0.00	0.00	0.00	270.84
WS3	0.00	0.00	0.00	0.00	0.00	0.00	2.72	84.89	35.46	0.00	0.00	0.00	123.07
WS4	0.00	0.00	0.00	0.00	0.00	0.00	63.18	299.49	144.08	0.00	0.00	0.00	506.76
WS5	0.00	0.00	0.00	0.00	0.00	0.00	20.40	167.39	83.06	0.00	0.00	0.00	270.84
WS6	0.00	0.00	0.00	0.00	0.00	0.00	33.83	214.66	106.57	0.00	0.00	0.00	355.06
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.33	64.97	22.71	0.00	0.00	0.00	88.01
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.33	64.97	22.71	0.00	0.00	0.00	88.01
WS9	0.00	0.00	0.00	0.00	0.00	0.00	82.31	345.64	162.89	0.00	0.00	0.00	590.84
WS10	0.00	0.00	0.00	0.00	0.00	0.00	33.83	214.66	106.57	0.00	0.00	0.00	355.06
WS11	0.00	0.00	0.00	0.00	0.00	0.00	43.43	244.47	120.32	0.00	0.00	0.00	408.22
WS12	0.00	0.00	0.00	0.00	0.00	0.00	49.20	261.28	127.78	0.00	0.00	0.00	438.26
WS13	0.00	0.00	0.00	0.00	0.00	0.00	82.31	345.64	162.89	0.00	0.00	0.00	590.84
WS14	0.00	0.00	0.00	0.00	0.00	0.00	43.43	244.47	120.32	0.00	0.00	0.00	408.22
WS15	0.00	0.00	0.00	0.00	0.00	0.00	33.83	214.66	106.57	0.00	0.00	0.00	355.06

The calculation of total runoff of the entire basin as per the SCS-CN method depicted in Table 3.13 to Table 3.22.

Table 3.13: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2015

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.09
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.05
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.01	0.01	0.00	0.00	0.00	0.12
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.01	0.00	0.00	0.00	0.21

WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.01	0.00	0.00	0.00	0.09
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.01	0.00	0.00	0.00	0.15
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.04
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.01	0.00	0.00	0.00	0.22
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.01	0.00	0.00	0.00	0.14
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.01	0.00	0.00	0.00	0.09
WS13	0.00	0.00	0.00	0.00	0.00	0.01	0.49	0.05	0.05	0.00	0.00	0.00	0.60
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.01	0.00	0.00	0.00	0.13
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02

Table 3.14: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2016

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.06	0.06	0.00	0.00	0.00	0.16
WS2	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.03	0.00	0.00	0.00	0.09
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
WS4	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.12	0.09	0.00	0.00	0.00	0.27
WS5	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.13	0.14	0.00	0.00	0.00	0.36
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
WS7	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.09	0.07	0.00	0.00	0.00	0.20
WS8	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.14	0.11	0.00	0.00	0.00	0.32
WS9	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.03	0.00	0.00	0.00	0.08
WS10	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.17	0.15	0.00	0.00	0.00	0.42
WS11	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.13	0.10	0.00	0.00	0.00	0.30
WS12	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.08	0.06	0.00	0.00	0.00	0.19
WS13	0.00	0.00	0.00	0.00	0.00	0.09	0.20	0.61	0.45	0.00	0.00	0.00	1.35
WS14	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.11	0.09	0.00	0.00	0.00	0.26

WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.03

Table 3.15: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2017

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.04	0.00	0.00	0.00	0.00	0.21
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.02	0.00	0.00	0.00	0.00	0.11
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.03
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.04	0.00	0.02	0.00	0.00	0.28
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.09	0.00	0.01	0.00	0.00	0.48
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.03	0.00	0.02	0.00	0.00	0.22
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.05	0.00	0.03	0.00	0.00	0.34
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.04
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.08	0.00	0.02	0.00	0.00	0.49
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.05	0.00	0.02	0.00	0.00	0.33
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.03	0.00	0.01	0.00	0.00	0.20
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.10	0.00	0.03	0.00	0.00	0.62
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.05	0.00	0.02	0.00	0.00	0.29
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.04

Table 3.16: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2018

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.13
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.07
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.04
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.01	0.00	0.00	0.00	0.00	0.14

WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.30
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.01	0.00	0.00	0.00	0.00	0.11
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.01	0.00	0.00	0.00	0.00	0.17
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.04
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.01	0.00	0.00	0.00	0.00	0.27
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.01	0.00	0.00	0.00	0.00	0.17
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.01	0.00	0.00	0.00	0.00	0.10
WS13	0.00	0.00	0.00	0.00	0.00	0.03	0.50	0.09	0.01	0.00	0.00	0.00	0.63
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.01	0.00	0.00	0.00	0.00	0.15
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02

Table 3.17: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2019

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.19	0.00	0.00	0.00	0.22
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.10	0.00	0.00	0.00	0.12
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.07
WS4	0.00	0.00	0.00	0.00	0.01	0.01	0.09	0.01	0.15	0.01	0.00	0.00	0.28
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.43	0.00	0.00	0.00	0.51
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.01	0.13	0.00	0.00	0.00	0.20
ssWS8	0.00	0.00	0.00	0.00	0.00	0.01	0.10	0.01	0.20	0.00	0.00	0.00	0.32
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.04	0.00	0.00	0.00	0.08
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.01	0.36	0.01	0.00	0.00	0.48
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.01	0.22	0.01	0.00	0.00	0.32
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.13	0.01	0.00	0.00	0.20
WS13	0.00	0.00	0.00	0.00	0.04	0.06	0.46	0.09	0.62	0.07	0.00	0.00	1.34
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.01	0.19	0.01	0.00	0.00	0.28

WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.00	0.00	0.04

Table 3.18: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2020

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.03
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.02
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.06	0.01	0.00	0.00	0.00	0.10
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.07
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.04
WS10	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.09	0.00	0.00	0.00	0.00	0.10
WS11	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.06	0.00	0.00	0.00	0.00	0.08
WS12	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.04	0.00	0.00	0.00	0.00	0.05
WS13	0.00	0.00	0.03	0.02	0.00	0.06	0.05	0.32	0.09	0.01	0.00	0.00	0.58
WS14	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.06	0.00	0.00	0.00	0.00	0.07
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01

Table 3.19: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2021

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.00	0.08	0.03	0.00	0.00	0.31
WS2	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.04	0.01	0.00	0.00	0.17
WS3	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01

WS4	0.00	0.00	0.00	0.00	0.00	0.15	0.02	0.00	0.12	0.03	0.00	0.00	0.32
WS5	0.00	0.00	0.00	0.00	0.00	0.23	0.24	0.00	0.18	0.06	0.00	0.00	0.71
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.04	0.01	0.00	0.03	0.01	0.00	0.00	0.09
WS10	0.00	0.00	0.00	0.00	0.00	0.26	0.01	0.00	0.20	0.00	0.06	0.00	0.53
WS11	0.00	0.00	0.00	0.00	0.00	0.18	0.01	0.00	0.14	0.04	0.00	0.00	0.37
WS12	0.00	0.00	0.00	0.00	0.00	0.11	0.01	0.00	0.11	0.02	0.00	0.00	0.26
WS13	0.00	0.00	0.00	0.00	0.01	0.71	0.11	0.00	0.52	0.14	0.00	0.00	1.49
WS14	0.00	0.00	0.00	0.00	0.00	0.16	0.01	0.00	0.12	0.03	0.00	0.00	0.32
WS15	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.04

Table 3.20: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2022

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.07
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.04
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.10	0.00	0.02	0.00	0.00	0.14
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.01	0.00	0.00	0.05
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.16	0.00	0.01	0.00	0.00	0.20
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.11	0.00	0.01	0.00	0.00	0.15
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.00	0.01	0.00	0.00	0.10
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.49	0.01	0.10	0.00	0.00	0.75
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.00	0.01	0.00	0.00	0.13

WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02

Table 3.21: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2023

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.05	0.02	0.11	0.00	0.00	0.29
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.03	0.01	0.06	0.00	0.00	0.16
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.02	0.00	0.00	0.06
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.10	0.03	0.11	0.00	0.00	0.36
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.11	0.04	0.24	0.00	0.00	0.67
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.02
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.03
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.01	0.03	0.00	0.00	0.10
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.14	0.05	0.22	0.00	0.00	0.66
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.10	0.03	0.14	0.00	0.00	0.43
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.07	0.02	0.09	0.00	0.00	0.26
WS13	0.00	0.00	0.00	0.03	0.03	0.01	0.47	0.49	0.16	0.49	0.00	0.00	1.69
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.09	0.03	0.12	0.00	0.00	0.38
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.02	0.00	0.00	0.05

Table 3.22: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2024

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.41	0.20	0.00	0.00	0.00	0.66
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.23	0.11	0.00	0.00	0.00	0.36
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.06	0.00	0.00	0.00	0.21
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.35	0.17	0.00	0.00	0.00	0.59
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.94	0.47	0.00	0.00	0.00	1.52

WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.02
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.02	0.00	0.00	0.00	0.09
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.04	0.00	0.00	0.00	0.14
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09	0.04	0.00	0.00	0.00	0.15
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.80	0.40	0.00	0.00	0.00	1.32
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.49	0.24	0.00	0.00	0.00	0.81
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.29	0.14	0.00	0.00	0.00	0.48
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.35	1.46	0.69	0.00	0.00	0.00	2.50
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.43	0.21	0.00	0.00	0.00	0.72
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.03	0.00	0.00	0.00	0.11

The calculation of total runoff from the Govindpur Cluster-III area as per the SCS-CN method is depicted in Table 3.23 to Table 3.32.

Table 3.23: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2015

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.03
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.01	0.00	0.00	0.00	0.13
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.03
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.03	0.03	0.00	0.00	0.00	0.32
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01

WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02

Table 3.24: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2016

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.02
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.02	0.00	0.00	0.00	0.06
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.00	0.00	0.04
WS11	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.12	0.09	0.00	0.00	0.00	0.26
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.02	0.00	0.00	0.00	0.07
WS13	0.00	0.00	0.00	0.00	0.00	0.05	0.11	0.32	0.24	0.00	0.00	0.00	0.72
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.02
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.03

Table 3.25: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2017

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.03
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.04

WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.05	0.00	0.02	0.00	0.00	0.29
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.01	0.00	0.00	0.00	0.00	0.07
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.06	0.00	0.02	0.00	0.00	0.33
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.02
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.04

Table 3.26: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2018

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.03
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.01	0.00	0.00	0.00	0.00	0.16
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.04
WS13	0.00	0.00	0.00	0.00	0.00	0.02	0.27	0.05	0.00	0.00	0.00	0.00	0.34
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02

Table 3.27: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2019

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.03	0.00	0.00	0.00	0.06

WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.00	0.00	0.04
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.01	0.19	0.01	0.00	0.00	0.29
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.04	0.00	0.00	0.00	0.07
WS13	0.00	0.00	0.00	0.00	0.02	0.03	0.24	0.05	0.33	0.04	0.00	0.00	0.72
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.00	0.00	0.04

Table 3.28: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2020

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.03
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
WS11	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.06	0.00	0.00	0.00	0.00	0.07
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02
WS13	0.00	0.00	0.01	0.01	0.00	0.03	0.03	0.17	0.05	0.00	0.00	0.00	0.31
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01

Table 3.29: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2021

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.03
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.02	0.01	0.00	0.00	0.07

WS10	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.01	0.00	0.05
WS11	0.00	0.00	0.00	0.00	0.00	0.16	0.01	0.00	0.12	0.04	0.00	0.00	0.33
WS12	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.04	0.01	0.00	0.00	0.09
WS13	0.00	0.00	0.00	0.00	0.00	0.38	0.06	0.00	0.28	0.07	0.00	0.00	0.80
WS14	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.02
WS15	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.04

Table 3.30: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2022

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.04
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.00	0.01	0.00	0.00	0.13
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.04
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.26	0.01	0.05	0.00	0.00	0.40
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02

Table 3.31: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2023

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.03
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.02	0.00	0.00	0.08
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.01	0.02	0.00	0.00	0.07
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.11	0.03	0.14	0.00	0.00	0.43
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.01	0.04	0.00	0.00	0.15
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.11	0.04	0.16	0.00	0.00	0.49
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.02

Table 3.32: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2024

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.01	0.00	0.00	0.00	0.05
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.03	0.00	0.00	0.00	0.12
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.04	0.00	0.00	0.00	0.12
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.44	0.21	0.00	0.00	0.00	0.73
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.05	0.00	0.00	0.00	0.17
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.78	0.37	0.00	0.00	0.00	1.33
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.05
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.03	0.00	0.00	0.00	0.11

Summary of the rainfall-runoff calculations

As expected, highest per-second flows into the two major streams of the study area were recorded in the monsoon season, particularly from the month July to September. In 2024 (during which the rainfall was highest since 2015), the calculated peak flows for the different watersheds are shown in the Fig. 3.4. From Fig. 3.4, it is evident that watershed 13 (WS13) contributed the highest flow (2.50 m^3/s) followed by watershed 5 (WS5: 1.52 m^3/s), watershed 10 (WS10: 1.32 m^3/s), and watershed 11 (WS11: 0.81 m^3/s). Watersheds 2 (WS2), 3 (WS3), 6 (WS6), 8 (WS8), 9 (WS9), and 15 (WS15) contributed negligible flows into the streams.

Annual variations in flow highlight the impact of inter-annual rainfall variability and watershed conditions. These values reinforce the spatial dominance of a few specific watersheds and that will help to plan hydrological infrastructure development and flood control strategies in the study area.

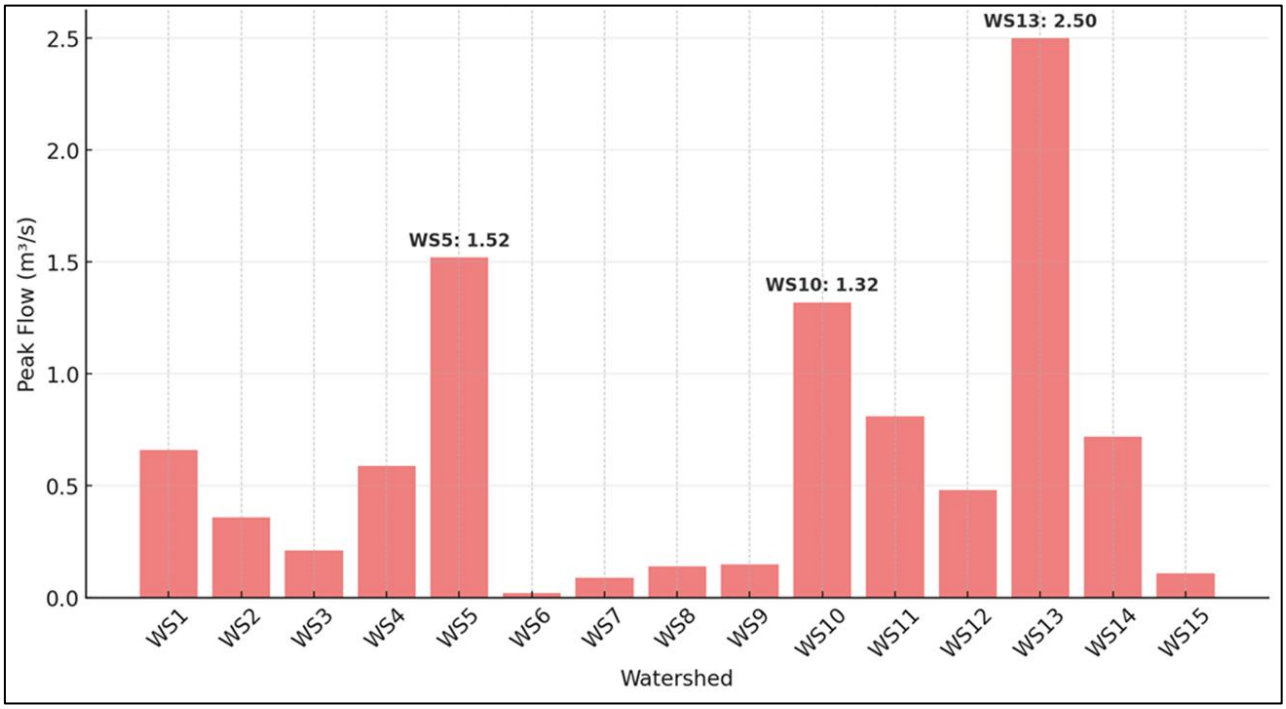


Fig. 3.4: Monthly peak runoff flow (m^3/s) (during 2015 to 2024) per watershed

3.5 Conclusion

The decade-long analysis of runoff using the SCS-CN method reveals a strong monsoon influence on hydrological behaviour. The Khudia Nala basin shows

significantly higher cumulative runoff accumulation (2015 to 2024) of 17,973.28 mm as its watersheds have greater spatial coverage and catchment dynamics.



Chapter 4: Analysis of Spatio-Temporal Variability of Hydro-meteorological Variables and Assessment of Impact of Climate Change on Water Resources in Cluster – III Area of BCCL

4.1 Introduction

The BCCL Cluster-III watershed in Govindpur, Dhanbad lies at the centre of the Damodar River Basin which is one of the India's most intensive coal mining regions. The area is characterized by undulating terrain and a moderate drainage network developed by natural processes and prolonged mining activities. Climatologically, the region is governed by a subtropical monsoon climate, receiving an average annual rainfall of 1300 to 1400 mm, of which approximately 75 to 85 % rainfall occurs between June and September, driven by the southwest monsoon. Historically, meteorological records show that mean summer temperatures in the Cluster-III region range between 32 °C and 45 °C, while winter temperatures can drop to between 7 °C and 10 °C. Notably, over the past two decades, the region has experienced a measurable warming trend, with average annual maximum temperatures increasing at a rate of approximately 0.2 °C per decade. At the same time, rainfall patterns have become increasingly variable, with evidence of short-duration, high-intensity events and a rising number of dry spells within the monsoon season.

Hydrologically, the watershed exhibits seasonal variability in stream discharge, with peak flow from July to August and base flow conditions from November to March. Empirical studies from adjacent sub-basins indicate that the post-monsoon base flow discharge, typically ranging from 0.5 to 2.0 m^3/s, has declined by over 25%, due to reduced infiltration and declining groundwater tables. These trends reflect a broader set of weather and climate anomalies, including delayed monsoon onset, increased frequency of localized storms, and seasonal shifts in evapotranspiration patterns. Such variations have significant implications for runoff generation, aquifer recharge, surface water availability, and mine water drainage systems, particularly in regions under hydrological stress.

Understanding the spatio-temporal variability of hydro-meteorological variables, namely rainfall, temperature, and discharge, is thus essential for assessing both present and future vulnerabilities of water resources in the region. Quantifying this variability helps in delineating the zones of hydrological sensitivity and supports adaptive planning in the face of ongoing climatic shifts.

This chapter adapts a dual approach for hydroclimatic assessment. First, it statistically analyses historical rainfall trends, utilizing the data collected from the India Meteorological Department (IMD) for the years 2008 to 2024, and then forecasts monthly trends for 2025 to 2030 using time-series models like Autoregressive Integrated Moving Average (ARIMA) and Error Trend Seasonal (ETS).

Second, the chapter also evaluates the future climatic stress. This involves analyzing various climate change scenarios and projections from global climate models. Ultimately, these combined findings aim to inform future water management strategies. The major goal is to identify patterns and projections of climatic stress, which could impact the surface and sub-surface hydrological systems in this coal mining-dominated region.

4.2 Materials and Methods

4.2.1 Study Area: BCCL Cluster-III Watershed

The BCCL Cluster-III encompasses seven mines (a mix of operational underground, opencast, and closed mines) within the Jharia Coalfield, Dhanbad district, Jharkhand, India. The watershed's hydrogeological regime is primarily influenced by the Khudia and Bagdighi Nala, which pass through the Cluster–III area and meet the broader Damodar River. Groundwater resources are primarily accessed via shallow aquifers, utilized through dug wells, dug-cum-bore wells, and shallow bore wells. Persistent challenges include land degradation, erosion, and alterations of the surface and sub-surface water flow regimes due to mining activities.

4.2.2 Climate Projection Data

The climate projection data utilized in this analysis are derived from the global climate model compilations of the Coupled Model Inter-comparison Projects (CMIPs), specifically the CMIP6 dataset, providing insights into future climate scenarios. Data are presented at a high resolution of 0.25^{o} x 0.25^{o} (approximately 25 km x 25 km) and include various Shared Socioeconomic Pathways (SSPs). These SSPs are essentially different plausible future that describe how global society, demographics, and economics might change over the coming century, and how these changes could influence greenhouse gas emissions. For instance:

- ***SSP1-2.6 (Sustainability):*** This scenario depicts a future with sustainable development, focusing on environmental protection and low greenhouse gas emissions. It's an optimistic pathway where the world shifts towards a more sustainable path, leading to a radiative forcing of 2.6 W/m² by 2100.
- ***SSP2-4.5 (Middle of the Road):*** This scenario represents a continuation of historical patterns, with moderate challenges to sustainable development and an intermediate level of greenhouse gas emissions, leading to a radiative forcing of 4.5 W/m² by 2100.
- ***SSP3-7.0 (Regional Rivalry):*** This scenario portrays a future characterized by strong regional rivalries, leading to slow development, high population growth, and high greenhouse gas emissions, resulting in a radiative forcing of 7.0 W/m² by 2100.
- ***SSP5-8.5 (Fossil-fueled Development):*** This is a high-emission scenario where the world continues to rely heavily on fossil fuels and experiences rapid economic growth but with little environmental concern, leading to a radiative forcing of 8.5 W/m² by 2100.

For this study, projections for SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5 scenarios were analysed across the period 2020-2039, which serves as the closest available proxy for the 2025 - 2039 range. All projections are relative to a reference period of 1995 - 2014 and are presented as multi-model ensembles. The CMIP6 data were accessed and downloaded from the Earth System Grid Federation (ESGF) nodes

(June 26, 2025.), which serve as the primary distributed archive for CMIP project outputs.

4.2.3 Rainfall Pattern in BCCL Cluster-III Area

4.2.3.1 Historical Rainfall Pattern in BCCL Cluster-III (2008-2024) Area

The historical rainfall data from 2008 to 2024 in the BCCL Cluster - III region show seasonal and yearly variations, mainly influenced by the southwest monsoon. Most rainfall is concentrated between June and September, contributing over 75% of the annual total. July and August are consistently the wettest months, with August 2024 recording the highest monthly rainfall of 529.63 mm, followed by July 2008 (493.36 mm) and July 2017 (485.01 mm). In contrast, the pre-monsoon (January to May) and post-monsoon (October to December) months usually receive very low rainfall, often less than 10 mm, and in many years, certain months, especially December, recorded no rainfall.

The annual rainfall varied significantly over the years. The lowest recorded annual rainfall was 815.91 mm in 2015, marking it a drought-prone year. The highest was 1376.04 mm in 2016, reflecting intense monsoon. In recent years, such as 2023 and 2024, high annual rainfall was also recorded, each exceeding 1300 mm, possibly indicating a trend of increasing rainfall influenced by regional climate change. These fluctuations could be related to large-scale climatic phenomena such as El Niño-Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), and local factors like land-use changes caused by mining, deforestation, and soil compaction, which affect infiltration and local weather patterns.

The dataset presented in Table 4.1 is important for identifying rainfall trends, estimating runoff, and planning for water availability. It also forms the basis for forecasting future rainfall using time-series models like ARIMA. The ARIMA model was used to forecast monthly rainfall from 2025 to 2030 based on 17 years of historical data. Forecasting of rainfall is crucial as rainfall variability increases and extreme events are becoming more frequent due to climate change. Accurate predictions of total and extreme rainfall events are essential for designing adequate

drainage and water management systems. While advanced models like Long Short-Term Memory (LSTM) and Prophet are available, ARIMA remains reliable for this analysis due to its proven accuracy and data suitability for monthly and yearly analysis.

Table 4.1: Monthly historical rainfall (2008 - 2024) received by the BCCL Cluster - III Area (in mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2008	4.58	3.32	11.68	9.55	20.46	159.95	493.36	259.71	217.21	27.94	0.00	0.00	1207.76
2009	2.81	0.00	8.24	0.14	97.55	48.76	207.04	272.47	230.60	41.51	8.40	1.02	918.54
2010	0.00	6.01	1.41	17.42	60.07	157.78	196.81	275.32	236.82	43.87	0.30	3.35	999.17
2011	0.00	1.35	14.69	9.55	84.46	265.45	173.20	405.74	277.73	24.37	1.81	0.00	1258.34
2012	24.03	4.13	2.83	48.90	13.97	91.58	379.52	270.71	189.90	60.34	51.25	8.74	1145.90
2013	0.00	19.16	0.58	8.43	61.65	217.14	179.83	290.05	164.07	250.55	0.00	0.00	1191.46
2014	10.12	46.61	11.47	0.24	86.85	109.99	286.19	227.88	158.92	28.07	0.00	0.00	966.35
2015	15.66	2.14	5.55	51.12	6.68	131.60	339.88	178.06	66.57	16.04	0.00	2.62	815.91
2016	3.69	11.83	3.46	0.00	56.21	185.77	253.99	403.07	436.80	21.21	0.00	0.00	1376.04
2017	7.29	0.00	7.18	25.73	45.15	120.72	485.01	239.61	95.74	204.56	0.12	0.00	1231.10
2018	0.00	0.00	0.00	85.69	53.94	235.44	241.38	188.98	110.97	15.48	0.00	14.56	946.45
2019	0.00	19.92	6.16	44.10	70.55	111.46	325.75	251.83	311.72	165.77	0.00	5.69	1312.95
2020	15.35	6.76	66.50	42.81	69.72	185.50	224.39	230.03	179.08	56.94	0.60	0.00	1077.69
2021	0.00	0.00	9.23	1.14	122.36	331.54	225.70	123.77	293.52	117.12	33.40	23.00	1280.77
2022	11.33	74.57	0.00	0.99	90.59	108.25	152.55	340.67	177.23	88.73	0.00	0.46	1045.36
2023	0.00	0.00	10.98	59.98	64.67	86.55	230.47	316.13	288.12	203.40	0.00	50.23	1310.54
2024	2.87	23.30	30.70	2.18	63.79	39.40	262.96	529.63	291.54	71.32	0.00	0.00	1317.70

4.2.3.2 Forecasting of the Near Future Monthly Rainfall Pattern in BCCL Cluster-III (2025 - 2030) Area

For forecasting the future monthly rainfall pattern in the BCCL Cluster-III region from 2025 to 2030, two of the most commonly used time series forecasting methods, ARIMA and ETS, were employed, and their results were compared using test data series.

The ARIMA model is a generalization of the simpler Auto-Regressive Moving Average model that incorporates the concept of integration. It is characterized by three main components viz. 'p' (lag order, representing the number of lag observations), 'd' (degree of difference, representing the number of times raw observations are differenced for stationarity), and 'q' (order of moving average, indicating the size of the moving average window). Fitting of the ARIMA model involves calculating the Auto-correlation Function (ACF) and Partial Auto-correlation Function (PACF) with lags from 1 to 12 months, where the first significant spike in these plots helps to determine the 'p' and 'q' values.

The ETS model is another approach for univariate time series forecasting, specifically designed to model trend and seasonal components using exponential smoothing. Its flexibility lies in its ability to adapt to different characteristics of these components. The three states of occurrence for ETS components are Additive (A), Additive Damped (Ad), and None (N), which dictate how parameters are applied in the exponential non-parametric regression.

When an ETS model only has "additive components", it means that the different parts of the forecast (like the overall level, the trend, and the seasonal pattern) are simply added together. In such cases, the "ETS point forecasts are equal to the medians of their forecast distributions, which are normal" means that the most likely future value (the "point forecast") is the middle value of all possible future outcomes. These possible outcomes, when plotted, form a bell-shaped curve, which is what "normal distribution" refers to, suggesting that values closer to the median are most probable.

The future monthly rainfall pattern for the BCCL Cluster-III region from 2025 to 2030 has been projected using these ARIMA and ETS time-series models. As illustrated in Fig. 4.1, both the models indicate a pronounced monsoon season, with peak rainfall expected between June and September. The highest rainfall is specifically anticipated in August, with the ARIMA model forecasting values around 301.85 to 301.97 mm, while the ETS estimates slightly lower but comparable values. July also shows consistently high rainfall across all six projected years, with ARIMA predictions ranging from 258.83 to 258.95 mm, and ETS values consistently higher, reaching up to 284.47 mm. In contrast, the non-monsoon months (January to May and October to December) are projected to receive significantly less rainfall, generally below 100 mm, with January, February, November, and December showing minimal rainfall amounts. The ETS model typically estimates slightly higher rainfall than ARIMA in these drier months. These forecasts detailed in Table 4.2, revealed a stable seasonal pattern with minimal year-to-year variability, thereby emphasizing the region's continued reliance on monsoon rainfall. This information is crucial for future water resource planning, flood risk management, and infrastructure development in mining-affected areas that are particularly vulnerable to rainfall extremes.

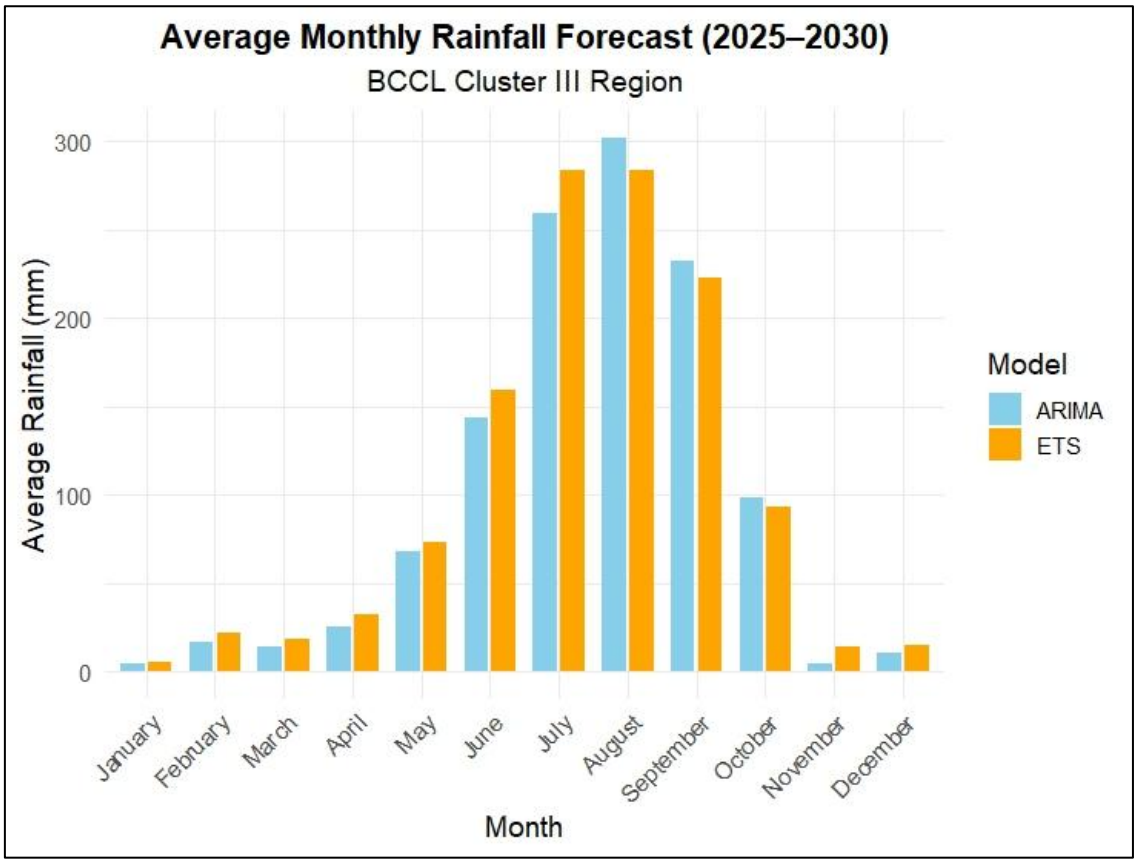


Fig. 4.1: Average Monthly Rainfall Forecast (2025-2030) in BCCL Cluster-III Region

Table 4.2: Monthly Rainfall Forecast (2025-2030) in BCCL Cluster-III Area using ARIMA and ETS Models (in mm)

Year	2025		2026		2027		2028		2029		2030	
	ARIMA	ETS	ARIMA	ETS	ARIMA	ETS	ARIMA	ETS	ARIMA	ETS	ARIMA	ETS
Jan	4.88	2.88	4.85	4.72	4.83	5.92	4.80	6.71	4.78	7.22	4.76	7.56
Feb	16.74	19.05	16.77	20.82	16.80	21.98	16.82	22.74	16.85	23.24	16.87	23.56
Mar	14.13	16.08	14.10	17.80	14.07	18.92	14.05	19.65	14.02	20.13	14.00	20.44
Apr	25.64	29.63	25.67	31.29	25.69	32.37	25.72	33.08	25.74	33.54	25.76	33.84
May	68.20	70.29	68.17	71.89	68.14	72.93	68.12	73.61	68.10	74.06	68.07	74.35
Jun	143.41	156.92	143.43	158.46	143.46	159.47	143.48	160.12	143.51	160.56	143.53	160.84
Jul	258.95	280.69	258.92	282.18	258.89	283.15	258.87	283.79	258.85	284.20	258.83	284.47
Aug	301.85	281.10	301.87	282.54	301.90	283.48	301.92	284.09	301.94	284.49	301.97	284.75
Sep	231.89	220.08	231.86	221.47	231.83	222.37	231.81	222.97	231.79	223.35	231.77	223.61
Oct	98.71	91.17	98.73	92.51	98.76	93.38	98.78	93.95	98.80	94.33	98.82	94.57
Nov	4.52	11.91	4.50	13.20	4.47	14.04	4.45	14.60	4.43	14.96	4.40	15.19
Dec	10.39	13.18	10.42	14.42	10.44	15.24	10.47	15.77	10.49	16.12	10.51	16.35

4.2.3.3 Analysis and Visualization of Daily Extreme Rainfall Events Between 2008 to 2024

Daily extreme rainfall events in the BCCL Cluster - III Area are defined as those exceeding the 95th percentile of historical daily rainfall data, a threshold of approximately 19.26 mm for the present dataset. Between 2008 and 2024, 311 such events were identified, and their frequency was calculated for each year. For visualization and interpretation, several plots were generated. Fig. 4.2, a bar plot, clearly illustrates the annual occurrence of these events, providing a straightforward representation of their frequency over time. Furthermore, Fig. 4.3, a line plot, displays the maximum extreme rainfall amount recorded yearly, offering insight into the intensity of the most extreme events annually. The analysis, supported by these visualizations, highlights the number of days with extreme rainfall in each year based on the defined threshold and the maximum rainfall amount during an extreme event in each year. The plots provide valuable insights into the inter-annual variability in the frequency and intensity of extreme rainfall events.

Regarding extreme rainfall frequency analysis and return periods, the maximum annual rainfall values were successfully extracted for each year from 2008 to 2024 to conduct an extreme value analysis. The Gumbel and Generalized Extreme Value (GEV) distributions were fitted to this annual maximum rainfall data.

For the Gumbel distribution, the estimated parameters are as follows:
Location (μ) ≈ 72.54: In the context of the Gumbel distribution, the location parameter is like the mean in a normal distribution. It indicates the central tendency of the data, essentially where the distribution is centred. A higher location parameter would suggest that larger extreme rainfall events are more common.

Scale (β) ≈ 22.00: The scale parameter describes the spread or variability of the data. A larger scale parameter indicates a wider spread of extreme rainfall values, meaning there's a greater range between the smallest and largest extreme events.

In contrast, the GEV distribution yielded estimated the following parameters:

Shape (c) ≈ -0.33: The shape parameter is unique to the GEV distribution and dictates the tail behaviour of the distribution, which is crucial for extreme value analysis. A negative shape parameter, as seen here, indicates that the distribution has an upper bound, meaning there's a theoretical maximum value that rainfall events are unlikely to exceed.

Location (μ) ≈ 69.01: Like the Gumbel distribution, this parameter indicates the central tendency of the GEV distribution.

Scale (β) ≈18.24: Also like the Gumbel distribution, this parameter describes the spread or variability of the extreme rainfall data for the GEV distribution.

Visual inspection of the Q-Q plots (Fig. 4.4) indicated that both the distributions reasonably fit the observed annual maximum rainfall data, with most points closely aligning with their respective theoretical lines. However, the calculated extreme rainfall values for various return periods exhibited differences between the two distributions. For a 10-year return period (probability 0.9), the Gumbel distribution estimates 122.05 mm, while the GEV distribution estimates 130.02 mm. This divergence becomes more pronounced for extended returns such as, for a 50-year return period (probability 0.98), the Gumbel distribution estimates 158.39 mm, whereas, the GEV distribution predicts a higher value of 214.64 mm. Similarly, for a 100-year return period (probability 0.99), Gumbel estimates 173.75 mm, while GEV estimates a significantly larger amount of 266.92 mm. The observed maximum annual rainfall in the dataset was 169.15 mm. The return period for this observed maximum was calculated to be approximately 81.24 years (with a probability of 0.9877) according to the Gumbel distribution, but only approximately 23.30 years (with a probability of 0.9571) based on the GEV distribution. The relationship between these return periods and the extreme rainfall values was further analysed visually, as presented in Fig. 4.5 Return Period vs. Extreme Rainfall value with Fitted Distributions, showing the extrapolated curves for both the fitted

distributions alongside the empirical plotting positions of the observed annual maximums.

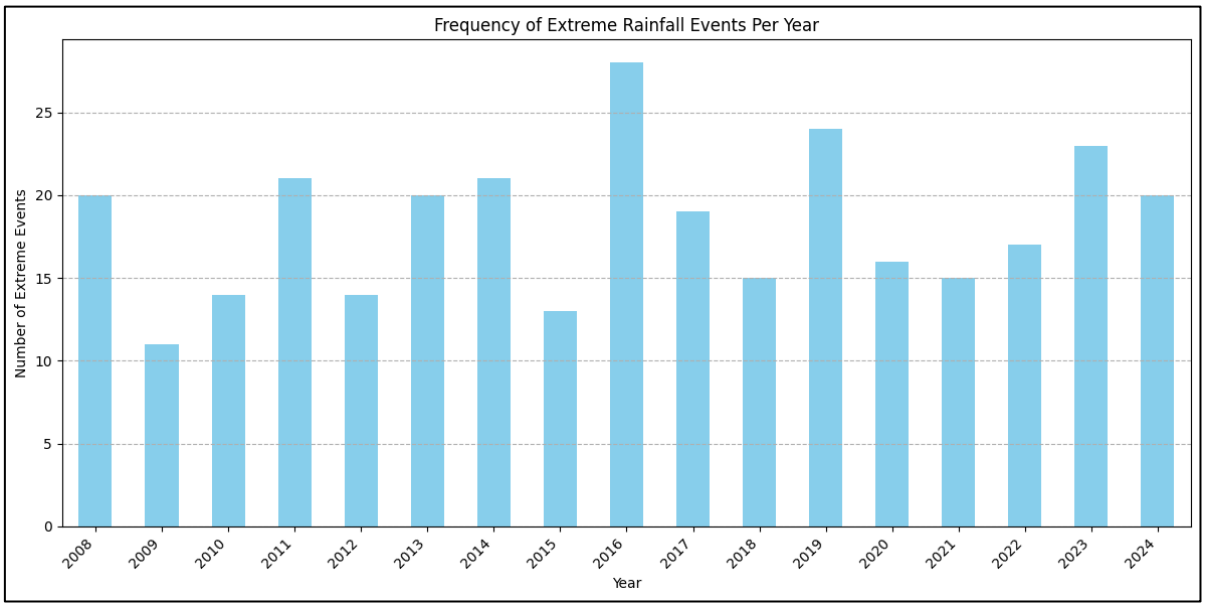


Fig. 4.2: Number of Extreme Rainfall Events for Each Year (2008-2024)

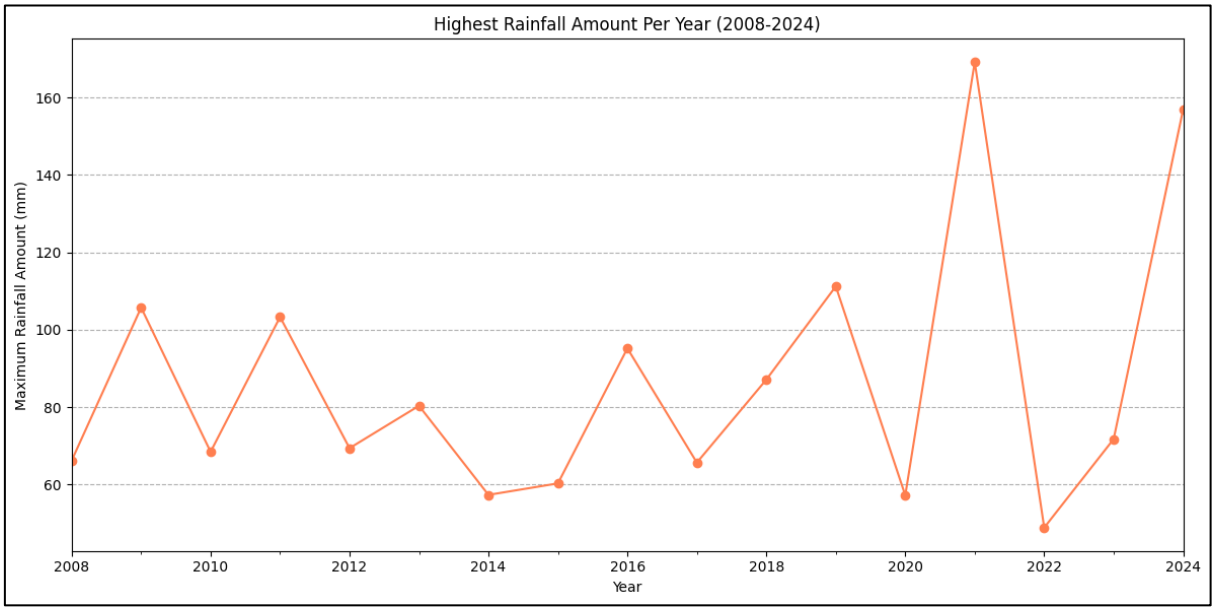


Fig. 4.3: Maximum Annual Extreme Rainfall values (2008-2024)

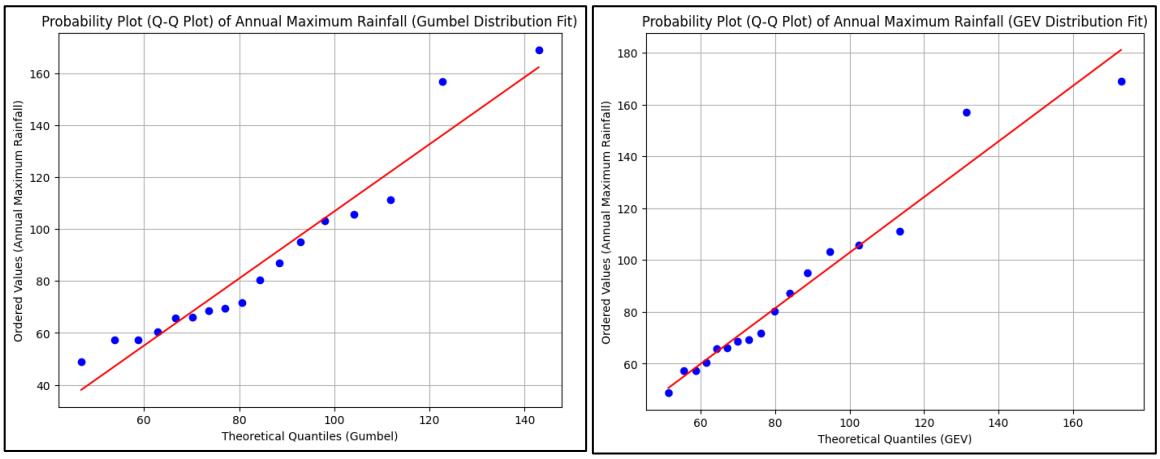


Fig. 4.4: Comparison of the Observed and the Predicted Maximum Daily Rainfall Using Gumbel and GEV Distributions

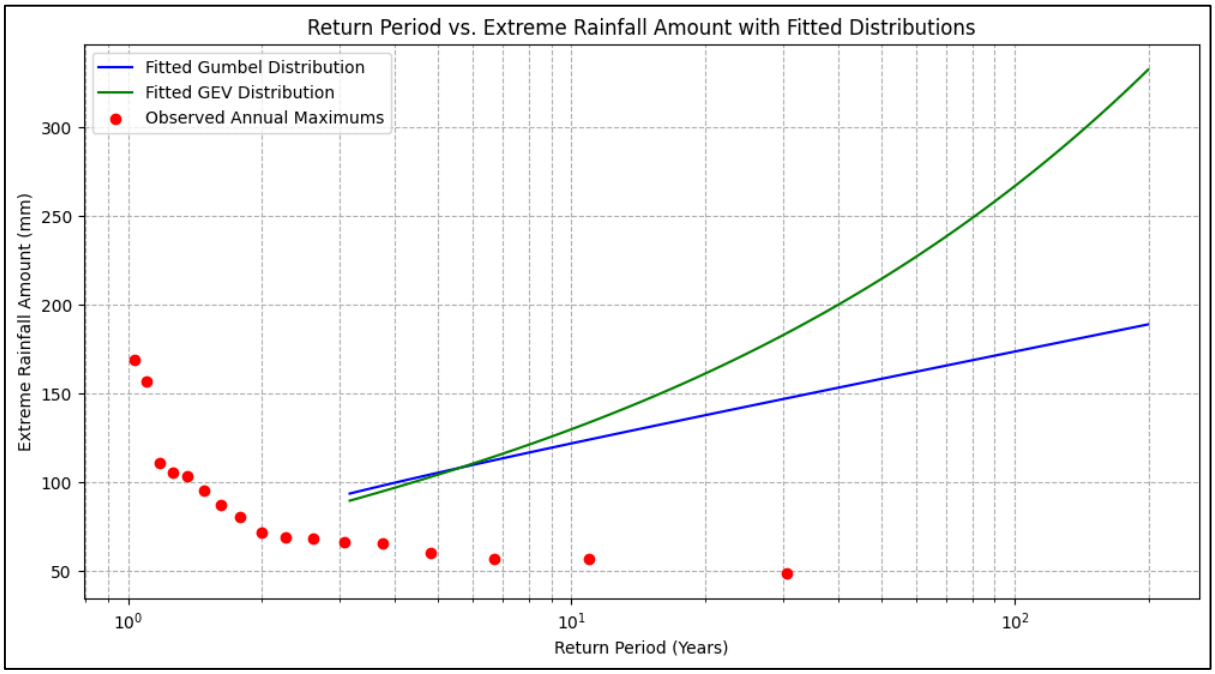


Fig. 4.5: Plot of Return Period vs. Extreme Rainfall Values with the Gumbel and GEV Fitted Distributions

4.2.4 Projected Temperature Trends and Climate Variability under SSP Scenarios in BCCL Cluster - III (2020-2039)

Future climate projections for the BCCL Cluster-III area have been analysed using multi-model ensemble outputs from CMIP6 datasets under four representative Shared Socioeconomic Pathways (SSPs), viz. SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5. These scenarios represent varying degrees of global climate mitigation efforts and socioeconomic development, ranging from sustainable pathways to fossil-fuel intensive growth. The temperature changes are assessed for the near-future period

2020-2039. This 19-year period serves as the closest available proxy for the 2025-2039 range, which is the specific timeframe of interest for the present study. All the four scenarios, when assessed against a historical reference baseline of 1995-2014, consistently show a clear warming trend in the Cluster-III region. Among these, SSP1-2.6 projects the least warming, while SSP5-8.5 indicates the highest. Fig. 4.6 (Monthly Average, Minimum, and Maximum Temperatures in BCCL Cluster-III) illustrates the expected seasonal temperature variation up to the year 2039, highlighting significant warming during the pre-monsoon (March-May) and summer months. During these periods, maximum temperatures are projected to exceed 40 °C, especially under high-emission pathways. This anticipated increase poses a possible impact on the mining area.

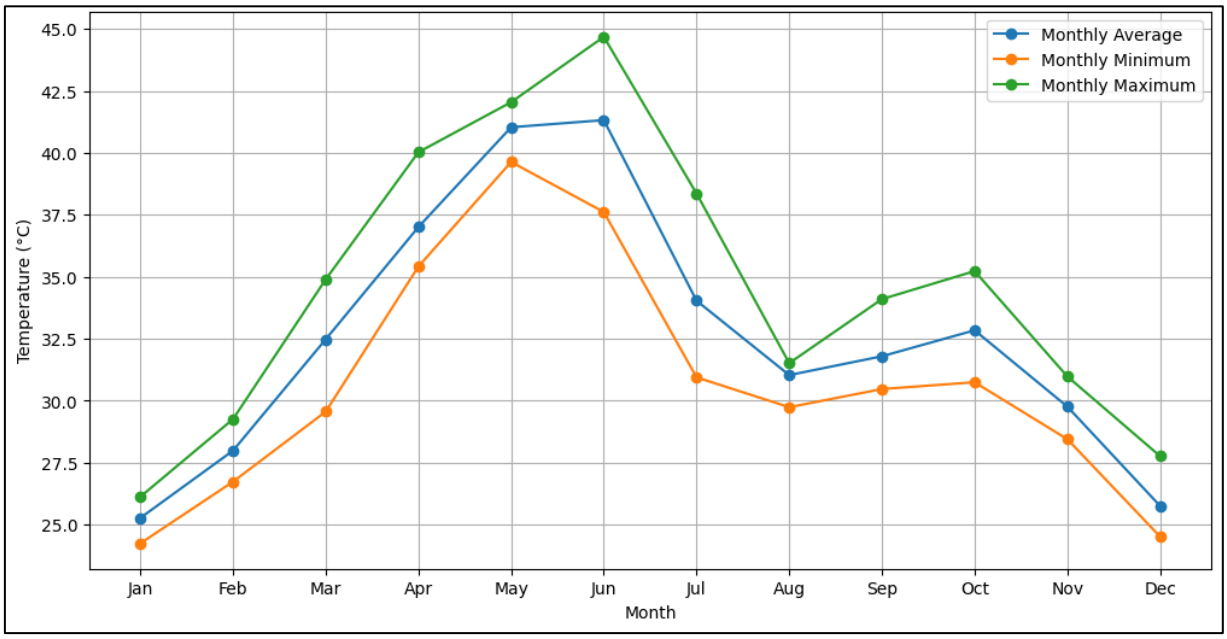


Fig. 4.6: ***Monthly Average, Minimum, and Maximum Temperatures in BCCL Cluster-III Area (2020-2039)***

Fig. 4.7 (Annual Surface Temperature Trend under Multiple SSPs) illustrates the national-scale temperature projections up to 2100, showing a sharp divergence between scenarios after 2040. For the near term (2020-2039), a steady temperature rise is observed across all the pathways, with SSP3-7.0 and SSP5-8.5, showing accelerated warming compared to the more stabilized trends of SSP1-2.6 and SSP2-4.5.

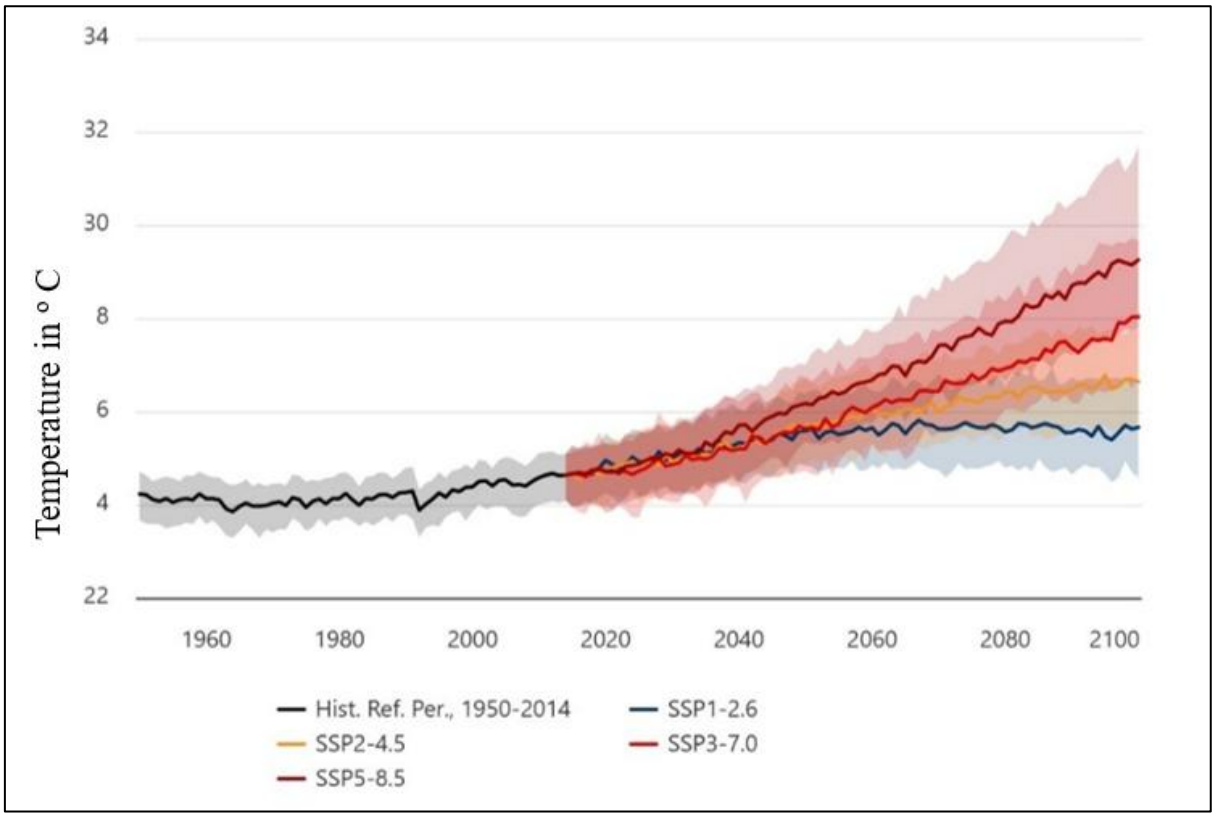


Fig. 4.7: Projected Annual Mean Surface Air Temperature under Multiple SSP Scenarios (1950-2100) (Compares SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5 with historical reference)

Model-wise projections for Dhanbad under SSP5-8.5 as presented in Fig. 4.8 indicate a 0.5-1.2 °C temperature rise by 2039, with the taiesm1 model showing the highest increase. This figure illustrates inter-model variation and projected warming. While analysis of all SSP scenarios for BCCL Cluster-III (Dhanbad) shows a moderate warming trend, particularly in pre-monsoon and summer, the projected 0.5-1.2 °C increase is gradual and unlikely to severely disrupt mining operations, infrastructure, or water availability in the short term. Though slight influences on evapotranspiration and surface water are possible, the overall hydrological impact remains limited, and extreme heat stress is not expected to critically affect productivity. Therefore, current projections suggest no immediate adverse threat to mining activities, but integrating climate-resilient planning and water conservation measures is still recommended for long-term sustainability.

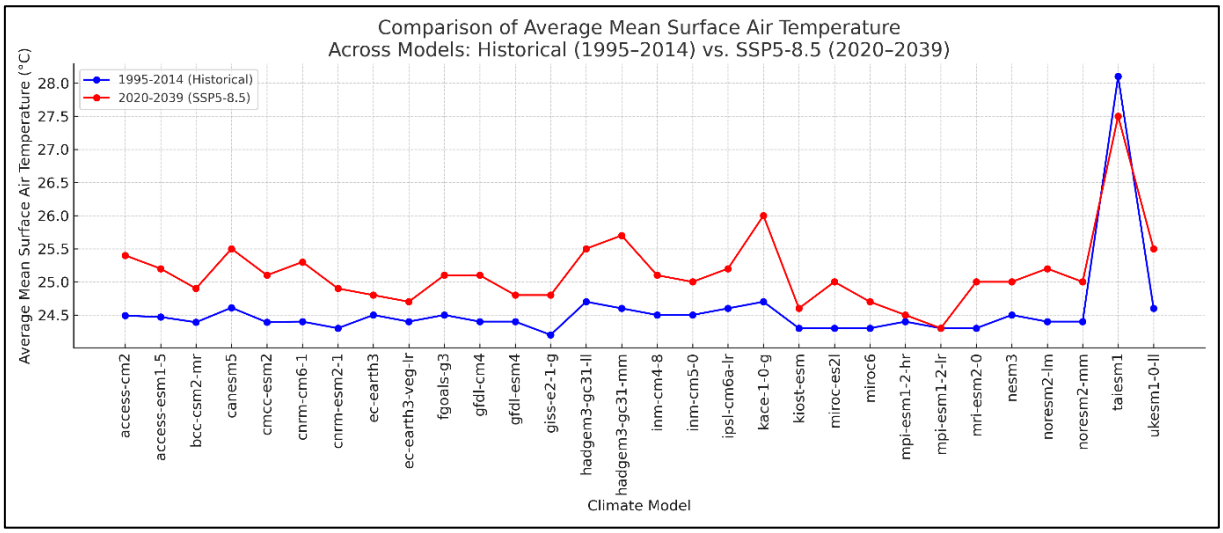


Fig. 4.8: Comparison of Average Mean Surface Air Temperature across Models: Historical (1995-2014) vs SSP5-8.5 (2020-2039) (Illustrates inter-model variation and projected warming under high-emission scenario)

4.2.5 Spatio-Temporal Variability of Rainfall (Forecasting for 2020-2039)

While, Section 4.3 presents the historical rainfall patterns in the BCCL Cluster-III region, this section focuses on projected changes in precipitation for the near-term period 2020-2039 based on CMIP6 multi-model outputs under SSP5-8.5 scenario. These projections highlight the expected increase in total rainfall and a greater likelihood of extreme precipitation events. This aligns with observed recent increases in rainfall in 2023 and 2024. The analysis integrates monthly variability, distribution shifts, and model-based seasonal precipitation trends to evaluate potential impacts on water resources and mining operations.

Fig. 4.9 (Monthly average, minimum, mean, and maximum surface air temperature and precipitation for Dhanbad District) shows the historical seasonal rainfall peak during the monsoon months (June-September), aligned with rising temperatures. The historical data from 2008 to 2024 confirms a consistent monsoon pattern with maximum rainfall in July and August, contributing significantly to the annual water budget.

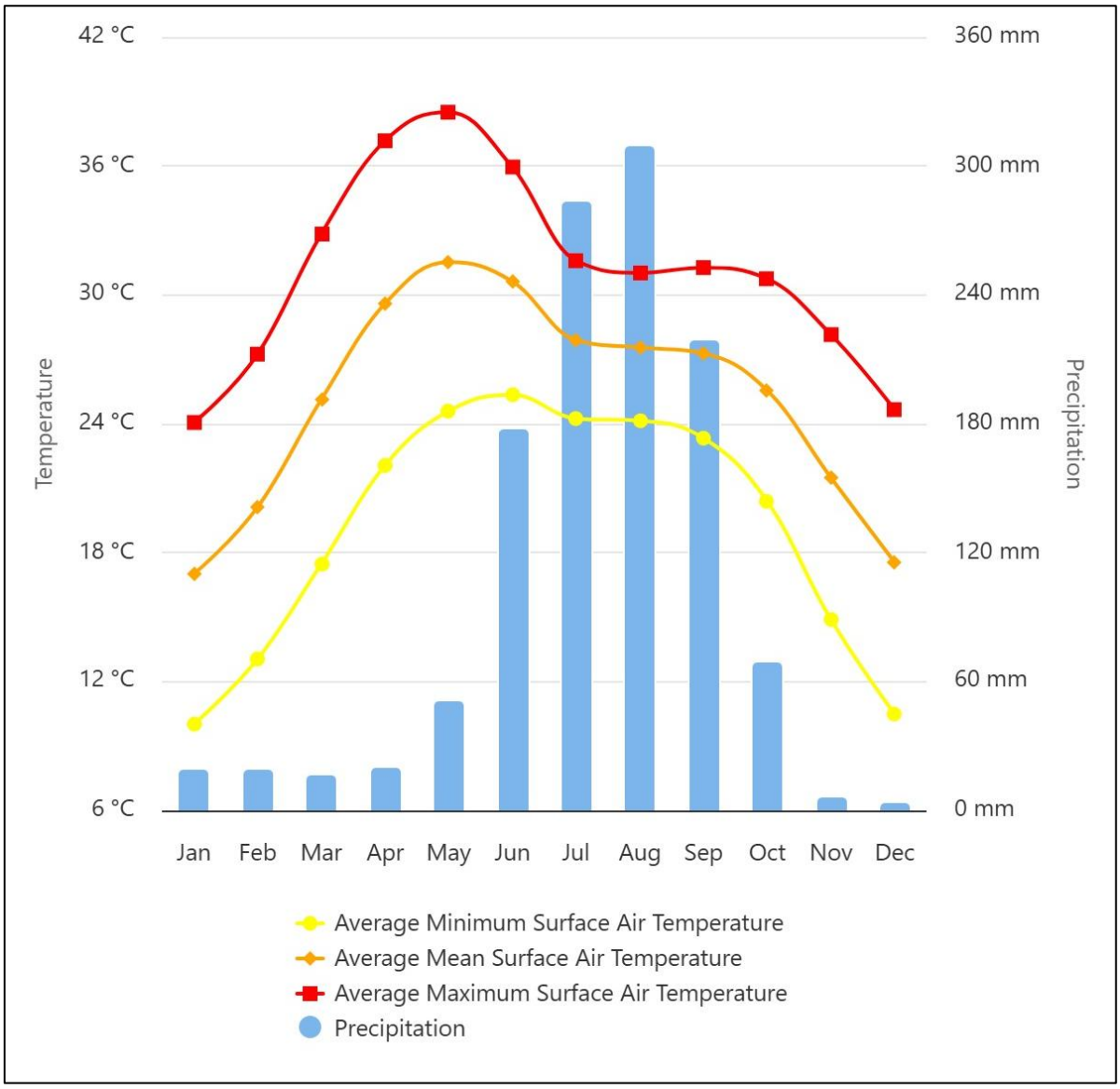


Fig. 4.9: Monthly Average, Minimum, Mean, and Maximum Surface Air Temperature and Precipitation in Dhanbad, India (1991-2020)

According to Fig. 4.10 (Projected Distribution Shift in Precipitation; SSP5-8.5), the distribution of annual precipitation in Jharkhand is projected to shift towards higher values in the 2020-2039 period compared to the 1995-2014 baseline. The peak of the distribution curve moves from approximately 1250 mm to 1350 mm, indicating a modest but notable increase in average annual rainfall. In this context, the Y-axis of the distribution plot represents the probability density of observing a particular annual precipitation value, showing how often different rainfall amounts are expected. This shift, however, is not extreme and remains within a manageable range for the current mining and hydrological infrastructure.

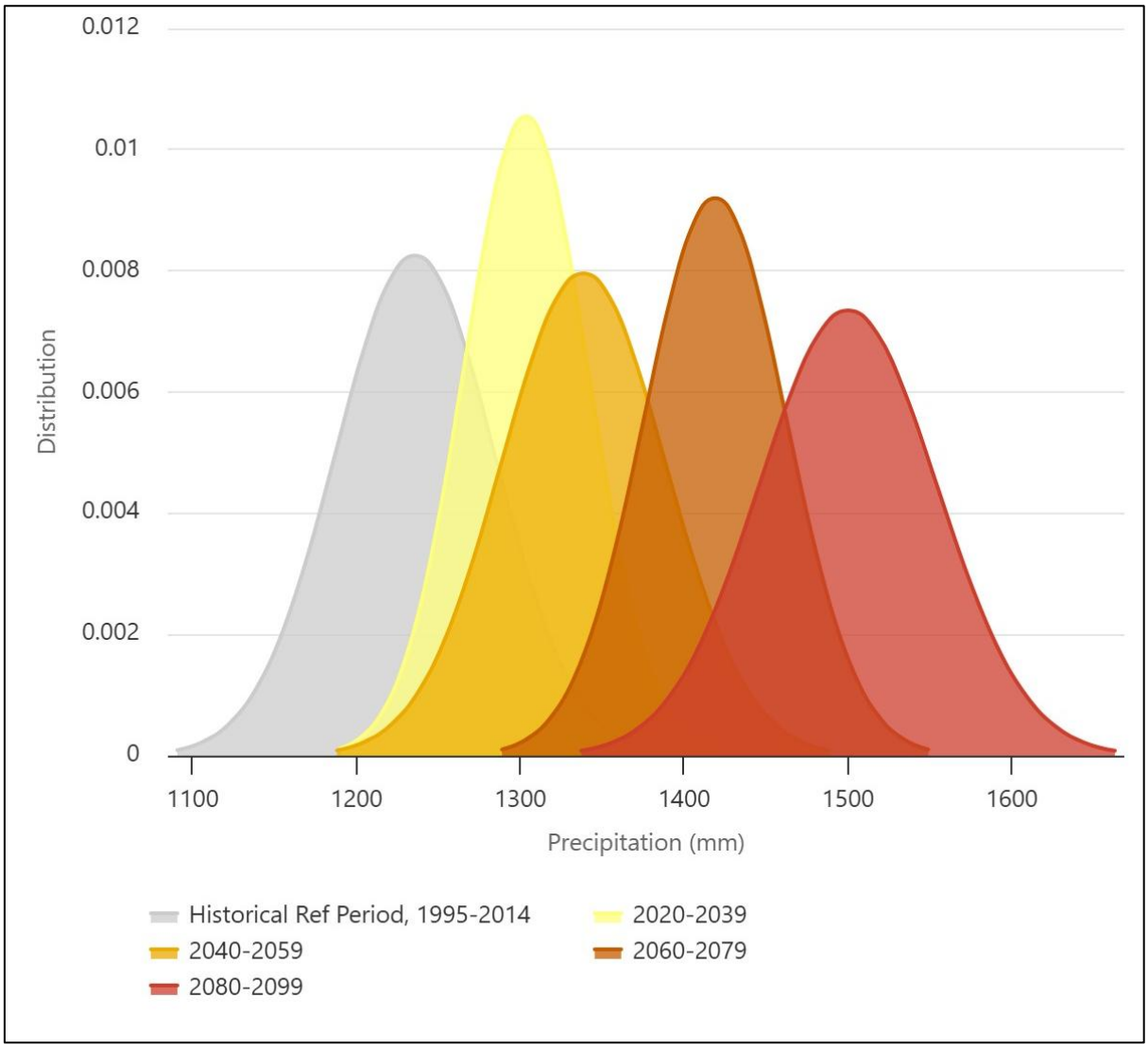


Fig. 4.10: Projected Change in Distribution of Annual Precipitation under SSP5-8.5 for (2020-2099)

Additionally, Fig. 4.10 (Projected Monthly Precipitation Trends across Seasonal Cycle; SSP5-8.5) displays future monthly rainfall variability for 2020-2099, showing that July and August continue to dominate in terms of peak rainfall. For the 2020-2039 period, model points cluster around historically observed rainfall magnitudes, with no significant deviation in peak intensity or timing of monsoon onset and retreat. This suggests stable seasonal patterns are likely to persist till 2039, albeit with slightly higher interannual variability.

Cross-referencing with historical data in Table 4.1 and the forecast values (2025-2030) confirms this stability. ARIMA and ETS models indicate sustained rainfall

trends with peak values in July and August, projecting monthly rainfall between 280 - 300 mm, consistent with historical observations from 2008-2024.

In summary, while the region is expected to experience a slight increase in total precipitation and intensity of rainfall events, the seasonal distribution remains unchanged. These changes are not severe and are unlikely to adversely impact mining operations in BCCL Cluster-III area in the short term period up to 2039. However, the increase in 1-day extreme rainfall events, as seen in broader CMIP6 analysis, may warrant future infrastructure updates for drainage and water management systems.

4.2.6 Future Runoff Estimation and Hydrological Implications

The estimation of future runoff for the BCCL Cluster-III area is critical for proactive water management and risk mitigation. This section presents an estimation of future runoff for the return periods of 10 and 50 years, integrating projected extreme rainfall events from Gumbel and Generalized Extreme Value (GEV) distributions with land-use/land cover (LULC) characteristics and hydrologic soil groups (HSG) using the Soil Conservation Service Curve Number (SCS-CN) method.

4.2.6.1 Future Rainfall Projections

Analysis of extreme rainfall events reveals a significant divergence in future projections. For a 10-year return period (indicating a 0.9 probability of being exceeded once in 10 years), the Gumbel distribution estimates an annual extreme rainfall event of 122.05 mm, while the GEV distribution predicts a higher 130.02 mm for an annual event. This disparity becomes more pronounced with longer return periods; for a 50-year return period (with a 0.98 probability of being exceeded once in 50 years), Gumbel projects an annual extreme rainfall of 158.39 mm, whereas GEV indicates a substantially higher 214.64 mm for an annual event. This trend suggests that the GEV distribution, by consistently predicting higher rainfall magnitudes for longer return periods, points towards a potentially more intense future extreme annual rainfall regime.

The observed maximum annual rainfall in the dataset, which is 169.15 mm, further highlights this uncertainty. Its return period is estimated at approximately 81.24 years by the Gumbel distribution but only 23.30 years by the GEV distribution. This significant difference underscores how sensitive the calculation of return periods for extreme events is to the specific statistical distribution chosen for the analysis.

4.2.6.2 Runoff Estimation Methodology

Runoff was estimated for each LULC class, considering both Hydrologic Soil Group B (HSG B) and Hydrologic Soil Group C (HSG C), for the projected 10-year and 50-year future rainfall scenarios. The SCS-CN method was employed, which calculates direct runoff based on rainfall amount (P) and a Curve Number (CN) that reflects the land cover, soil type, and antecedent moisture conditions. The study uses the SCS-CN method formula (Eq. 4.1).

$$\boldsymbol{Q = \frac{(P-I_a)^2}{(P-I_a)+S}} \quad \textbf{…….. (Eq. 4.1)}$$

Where, Q = Runoff depth in mm, P = Precipitation of the area in mm, S = Potential maximum retention after the start of runoff in mm, I_a = initial abstraction or losses of the area in m, i.e., losses before runoff in the form of infiltration, interception, or evaporation. Here, I_a = 0.3S; this relation was found by analysing the rainfall in many small agricultural basins for Indian conditions (Rao et al., 2010). The HSG group and the corresponding land cover for the entire basin area have been given in Table 4.3.

4.2.6.3 Estimated Future Runoff

The calculated runoff values for each LULC class demonstrate a clear response to the projected increase in rainfall for the 10-year and 50-year return periods. Generally, higher rainfall amounts, particularly those from the GEV distribution, lead to significantly higher runoff. The influence of Hydrologic Soil Group is also evident, with HSG C (representing soils with lower infiltration rates and higher runoff potential) consistently generating greater runoff compared to HSG B for the

same LULC class and rainfall event. These patterns highlight the combined influence of land-use and soil characteristics on surface hydrological response (Table 4.4 Estimated Runoff (mm)) for Different LULC Classes under Various Rainfall Scenarios and Hydrologic Soil Groups HSG B and HSG C).

Key observations from the runoff calculations include:

- **High Runoff Contributors:** LULC classes such as 'Nala Stram' and 'Waterbody', having Curve Numbers (CN) of 100, are projected to convert nearly all rainfall into runoff across all 10-year and 50-year scenarios. For instance, under a 50-year GEV rainfall of 214.64 mm, these areas would generate 214.64 mm of runoff. Similarly, 'National Highway' (CN 98) shows very high runoff, converting a 50-year GEV rainfall into approximately 208.54 mm of runoff.
- **Varying LULC Response:** Even for the same rainfall, runoff varies significantly by LULC. 'Vegetation' (HSG B, CN 61) under a 10-year Gumbel rainfall (122.05 mm) generates approximately 31.84 mm of runoff, while 'Barren Land' (HSG B, CN 86) for the same rainfall yields about 83.45 mm. This highlights the role of land cover in modulating hydrological response.
- **Impact of Extreme Events:** Comparing the 10-year Gumbel scenario with the the 50-year GEV scenario for 'Settlements' (HSG B, CN 65), runoff increases from approximately 38.74 mm to 108.24 mm. For 'Sparse Vegetation' (HSG C, CN 79), runoff increases from about 66.92 mm (10-year Gumbel) to 150.59 mm (50-year GEV). These substantial increases underscore the amplified hydrological response under more extreme rainfall conditions.

Table 4.3: Land-Use/Land Cover (LULC) and Hydrologic Soil Group (HSG) Characteristics with Corresponding Curve Numbers (CNs) and Rainfall Scenarios for Runoff Estimation

Sl. No	LULC Class	Rainfall Scenario (mm)				HSG Group		Total Basin Area in sq. km		CN Values	
		10-year Gumbel	10-year GEV	50-year Gumbel	50-year GEV						
1	Agriculture land	122.05	130.02	158.39	214.64	B	C	7.94	0.01	78	85
2	Barren Land					B	C	5.57	3.6	86	91
3	Mining					B	C	3.64	0.79	86	91
4	Nalla Stram					B	C	0.33	0.16	100	100
5	National Highway					B	C	0.08	0.07	98	98
6	Railways					B	C	0.38	0.14	85	89
7	Settlements					B	C	7.55	2.16	65	77
8	Sparse Vegetation					B	C	28.2	7.9	69	79
9	Vegetation					B	C	6.8	0.36	61	74
10	Village Road					B	-	0.14	—	89	-
11	Waterbody					B	C	0.55	0.05	100	100

Table 4.4: Estimated Runoff (mm) for Different LULC Classes under Various Rainfall Scenarios and Hydrologic Soil Groups (HSG B and HSG C)

Sl. No	LULC Class	Runoff (mm)							
		HSG Group B				HSG Group C			
		10-year Gumbel	10-year GEV	50-year Gumbel	50-year GEV	10-year Gumbel	10-year GEV	50-year Gumbel	50-year GEV
1	Agriculture land	64.70	71.45	96.21	147.54	80.99	88.34	114.94	168.87
2	Barren Land	83.45	90.88	117.70	171.92	96.34	104.08	131.78	187.18
3	Mining	83.45	90.88	117.70	171.92	96.34	104.08	131.78	187.18
4	Nalla Stram	122.05	130.02	158.39	214.64	122.05	130.02	158.39	214.64
5	National Highway	116.04	124.00	152.33	208.54	116.04	124.00	152.33	208.54
6	Railways	80.99	88.34	114.94	168.87	91.07	98.70	126.09	181.08
7	Settlements	38.74	44.02	64.12	108.24	62.50	69.16	93.62	144.50
8	Sparse Vegetation	46.15	51.92	73.61	120.27	66.92	73.77	98.83	150.59

9	Vegetation	31.84	36.60	54.99	96.31	56.13	62.47	85.96	135.39
10	Village Road	91.07	98.70	126.09	181.08	–	–	–	–
11	Waterbody	122.05	130.02	158.39	214.64	122.05	130.02	158.39	214.64
	Total	880.54	956.85	1234.48	1803.98	910.45	984.64	1252.12	1792.62

4.2.6.4 Hydrological Implications for 10-year and 50-year return periods

Despite the historical period of 2008–2024 showing no major hydrological hazards and limited short-term impacts, projections for 2025–2039 suggest potential long-term challenges due to increased rainfall intensity and runoff, particularly for 10-year and 50-year return periods. Historically, peak flows have remained manageable; for instance, in 2024, observed flows, predominantly from July to September, included 2.50 m^3/s for WS13, 1.52 m^3/s for WS5, 1.32 m^3/s for WS10, and 0.81 m^3/s for WS11 (Detailed delineation and mapping of the mentioned watersheds are provided in Section 3.4.5 and Figure 3.4.)

However, continuation or intensification of these projected trends could render existing drainage systems insufficient. This may pose high risks of waterlogging, soil erosion, and degradation of water quality. Over time, such conditions may place significant stress on water infrastructure and adversely affect both surface and groundwater systems. Consequently, there is a need for proactive planning and adaptive management strategies. These must encompass upgrading and expanding drainage infrastructure, implementing green infrastructure solutions (e.g., permeable pavements, rain gardens, detention ponds) to enhance infiltration, enforcing strict land-use zoning to minimize development in flood-prone areas, and adapting robust soil conservation practices in agricultural and barren lands in the future. Furthermore, the development and deployment of early warning systems for extreme rainfall and flood events will be increasingly critical to bolster community preparedness and disaster risk reduction in the near future.

4.3 Conclusion

This chapter on hydro-meteorological variability in the BCCL Cluster-III watershed highlights important trends in rainfall, temperature, and runoff in the future. Historical data from 2008 to 2024 show that most rainfall occurs during the monsoon months (June to September), with July and August receiving the highest rainfall. However, rainfall patterns have become more variable in recent years, with an increase in short, intense rainfall events and irregular monsoon behaviour. At

the same time, average temperatures have been rising steadily, especially during the summer months.

Using time-series models (ARIMA and ETS), rainfall forecasts for 2025 to 2030 indicate that the monsoon will remain the dominant season for rainfall. The forecasts also suggest only minor year-to-year changes, with no major shifts in rainfall patterns. Climate change projections from global models (CMIP6) for the period 2020 to 2039 also show a moderate rise in temperature (0.5°C to 1.2°C) and a slight increase in total rainfall, especially under the high-emission scenario (SSP5-8.5). These changes are not expected to cause significant disruption to current mining operations or water systems in the short term.

However, extreme rainfall events, those that occur rarely but with high intensity, are projected to become more frequent and expected to be severe in log-term period. Analysis using Gumbel and GEV distributions shows that these extreme events may produce significantly more rainfall during 10-year and 50-year return periods. Runoff estimation using the SCS-CN method shows that land-use and soil type strongly influence how much rainfall becomes surface runoff. Areas like highways and barren lands generate the highest runoff, especially during extreme events.

In summary, while climate change is expected to bring moderate increases in rainfall and temperature over the next 10 to 15 years, these changes are not likely to severely affect current hydrological conditions or infrastructure in BCCL Cluster-III area. However, some adjustments are recommended. These include improving drainage systems, encouraging water infiltration through green infrastructure, managing soil erosion, and preparing for extreme rainfall events through early warning systems. Overall, the region is not facing an immediate threat from climate change, but proactive planning is needed to make the water management system more resilient and sustainable in the near future.



Chapter 5: Estimation of soil erosion in the study area and mapping of the vulnerable zones

5.1 Introduction

Soil erosion is a critical environmental concern that significantly affects land productivity, water quality, and ecosystem health, particularly in watershed regions where topographical, climatic, and anthropogenic factors interact intensively. The detachment and transport of soil particles by agents such as water and wind not only lead to the degradation of fertile topsoil but also contribute to sedimentation in rivers, reservoirs, streams, and irrigation systems, thereby impairing their functioning and lifespan. In watershed areas, the risk and intensity of soil erosion vary spatially due to differences in rainfall pattern, surface slope or gradient, land-use/land cover (LULC), soil characteristics, and land management practices. Therefore, accurate estimation of soil erosion and spatial mapping of soil erosion potential zones are essential for prioritizing conservation efforts and implementing sustainable land and watershed management strategies. This chapter of the present study aims to estimate soil erosion rates within the watershed under consideration using scientifically validated models such as the Revised Universal Soil Loss Equation (RUSLE), and to develop erosion vulnerability maps using geospatial techniques. By integrating Remote Sensing (RS) and Geographic Information System (GIS) aided tools with erosion modelling, the study seeks to provide spatially explicit information on high-risk areas, thus supporting targeted soil and water conservation interventions.

5.2 Materials and Methodology

The methodological framework adapted for estimation of the Erosion Potential Index (EPI) is depicted in Fig. 5.1. It comprises several sequential stages viz. data acquisition & processing, preparation of thematic layers corresponding to the selected parameters, assignment of criteria weights using the Analytical Hierarchy Process (AHP), and finally, weighted overlay analysis to generate the final map.

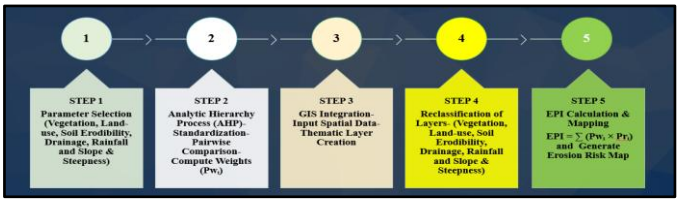


Fig. 5.1: Methodology flowchart for estimation of the EPI

5.2.1 Data Acquisition and Preparation

The study area, encompassing 1420.61 hectares, is located within a larger basin that covers approximately 8000 hectares. Therefore, a single satellite image scene was sufficient to cover the entire study area including the larger basin. Planet satellite data of 12th April 2025 was obtained from the PlanetScope archive of the European Space Agency (https://earth.esa.int/eogateway/missions/planetscope, accessed: 13th May 2025). The captured image with a ground sampling distance (GSD) of 3.9 m, the image exhibits 100 % clear sky conditions with no cloud, haze, or shadow interference, ensuring high-quality visual data. CartoSat-1_PAN_CartoDEM-30m is the Digital Elevation Model (DEM) data of the study area that was downloaded from the Indian Space Research Organization's (ISRO) Bhoonidhi portal (http://bhoonidhi.nrsc.gov.in/data/download/index.php, accessed 12th May 2024). However, daily gridded rainfall data of 10 years (2015 - 2024) of the study area (Cluster-III) was taken from 9395 grid cells of the IMD, with a resolution of 0.25×0.25 degrees. Soil data were obtained from the State Agricultural Management & Extension Training Institute (SAMETI), Jharkhand (https://www.sameti.org/Soil_Inventory/Dhanbad_Soil_Analysis.pdf, accessed on 12th May 2025). All the datasets were projected to a standard coordinate system (UTM Zone 45 WGS 84) and resampled to a uniform spatial resolution to ensure geometric consistency for the overlay analysis.

5.2.2 Erosion Potential Index (EPI) and GIS Analysis

For the present work, an Erosion Potential Index (EPI) model was developed and used as an indicator of potential zones of soil erosion in the study area. The EPI for the study area was developed by aggregating the parameters that are responsible for erosion and sediment transport to the existing high-order drainage system. Parameter selection in this study was based on the input required for the Universal

Soil Loss Equation (USLE) and RUSLE, as these two models are well accepted and widely used for the calculation of erosion potential globally. Development of spatial relations amongst the input parameters using GIS can help to deal with interception, transport, and deposition of sediment through erosion (Karan & Samadder, 2016). In this study, Rainfall-Runoff erosivity, Soil erodibility, Slope length & steepness, Land-use, Vegetation type, and Distance from drainage lines were selected as the main parameters influencing the EPI for the study. Some of the parameters selected for the present study may have physical dimensions, and their aggregation may result in erroneous results. Hence, unit less scores were assigned to the different sub-ranges of every parameter based on their relative importance in causing erosion. Detailed description of the selected parameters and the rationale behind the assignment of these unit-less scores are explained in the following sections.

5.2.2.1 Rainfall runoff erosivity (R)

According to Wischmeier and Smith (1978), the USLE-based erosion index is directly proportional to the erosive force of a specific rainfall event. Keeping other parameters constant, losses from rainfall events are directly related to the product of total kinetic energy *(E)* of the storm multiplied by its maximum 30 min intensity *(I_{30})*. Availability of long-term pluviographic data at fine spatial and temporal scales is operose (Jain & Das, 2010), which is required to realistically estimate EI_{30}. Several studies have attempted to estimate rainfall erosivity using long-term or annual pluviographic data. Babu et al. (2004) developed an equation (Eq. 5.1) to estimate rainfall erosivity based on the linear relationships between annual rainfalls and computed annual average rainfall (Karan et al., 2019; Ganasri & Ramesh, 2016). The equation developed by Babu et al. (2004) has been used for estimating rainfall erosivity in the present study area, as this method was recommended for coal mining areas. As the rainfall in the study area is found to be nearly uniform, the annual average rainfall over a 10-year period (2015 - 2024) was utilized for mean annual rainfall calculations (R_N). The mean annual rainfall for the 10 years of the study area was found to be 1171.45 mm, and the rainfall runoff erosivity (R) was found to be 526.65 MJ mm $ha^{-1}h^{-1}year^{-1}$.

$$\boldsymbol{R = 81.5 + 0.38\,(R_N)} \quad \textbf{…….. (Eq. 5.1)}$$

Where, R_N corresponds to mean annual rainfall in mm, and R corresponds to rainfall runoff erosivity.

5.2.2.2 Soil erodibility (K)

According to the soil dataset provided by SAMETI (State Agricultural Management & Extension Training Institute), Jharkhand, the study area is classified into three soil types based on texture viz. Sandy Clay Loam, Loam, and Sandy Loam. The corresponding soil erodibility (K) factor values for each category have been adapted from Karan et al. (2019). The soil erodibility factor (K) estimates the sensitivity of soil or surface materials to detachment and transportation due to the rainfall and subsequent runoff (Renard et al., 1997). Soil erodibility factor has been defined as the rate of soil loss per erosion index unit for a specified soil as measured on a unit plot (Wischmeier & Smith, 1978). It is reported that silt and very fine sand are most easily eroded, whereas, aggregated soil is less susceptible to erosion (Kim, 2006). The details about the three defined textures, along with the K-factor and erosion risk level (as per Renard et al. 1997), are shown in Table 5.1.

Table 5.1: Properties of soil in the study area as per the SAMETI user-soil dataset

Soil Type	K-factor (t ha h MJ-1 mm-1 ha-1)	Erosion Risk Level	Reference
Loam	0.2449	Very High	Karan et al.,2019
Sandy Clay Loam	0.2592	High	Karan et al.,2019
Sandy Loam	0.2512	Moderate	Karan et al.,2019

5.2.2.3 Slope length and steepness (Ls)

In the RUSLE model (Renard et al., 1997), the effect of topography on soil erosion is accounted for by the slope length and slope steepness factor (Ls). CartoSat-1 DEM data was used for estimating the slope length and slope steepness factor. The DEM data was projected to UTM Zone 45N datum WGS 1984 projection system. Sinks in the DEM data were filled using the fill tool under the hydrology tools available in ArcGIS 10.2.2 for resolving errors from rounding of elevation values to the nearest integer values. Flow direction and accumulation were estimated using the hydrology toolset of the ArcGIS 10.2.2 toolbar. Eq. 5.2 was used to estimate the slope length and slope steepness factor of the study area as per Luvai et al. (2022). In this

study area, the values of Ls range from 0 to 18, representing low to high erosion risk levels, respectively. The selected range is comparable with that reported by Biswas and Pani (2015) as depicted in the Table. 5.2.

$$L_s = \left\{\left(\frac{FlowAcc \times cell\ size}{22.13}\right)^{0.4} \times \left(\frac{Sin(Slope^{\circ}) \times 0.1745}{0.09}\right)^{1.4}\right\} \ldots\ldots\ldots\ldots\ldots \textbf{(Eq. 5.2)}$$

Where, Flow Acc is the accumulated weight of all cells of the DEM flowing into each downslope cell in the output raster.

Table 5.2: Slope Length and Steepness (LS) Factor Values for the Study Area

Parameter	Value	Erosion Risk Level
Slope length and steepness (Ls)	< 3.6	Very Low
	3.6 – 7.2	Low
	7.21 – 10.80	Moderate
	10.81 – 14.40	High
	>14.40	Very High

5.2.2.4 Land-use pattern (C)

Land-use pattern (C) is an important parameter influencing erosion and sediment transport. In RUSLE, the C-factor indicates how the conservation plan will affect the average annual soil loss and how that soil-loss potential will be distributed in time during construction activities, crop rotations or other management schemes. Atmospherically corrected planet data were used for delineation of the land-use pattern of the present study area. Using digitization tool of ArcGIS 10.2.2, the study area was delineated in eleven distinct classes (Waterbody, Railways, Nala/Stream, Village Road, National Highways, Sparse Vegetation, Vegetation, Agricultural Land/Fallow Land, Mining, Settlements, Barren lands, Overburden, and Plantation on Overburden). The distribution of land-use land cover in the study area along with their corresponding C-factor and erosion risk level are shown in Table 5.3.

Table 5.3: Distribution of land-use land cover in the study area along with their corresponding C-factor and erosion risk level

Parameter	Sub Parameter	C-Factor (Unitless)	Erosion Risk Level	Reference
	Waterbody	0.00	Very Low	Karan et al., 2019; Ganasar &

Land Use/Land Cover (C)				Ramesh (2016)
	Railways	0.00	Very Low	
	Nala	0.001	Very Low	
	Village Road	0.01	Low	
	National Highways	0.001	Very Low	
	Vegetation (Vegetation, Sparse Vegetation, and Plantation on OB)	0.006	Moderate	Karan et al., 2019; Biswas & Pani (2015)
	Agricultural Fallow Land	0.05	Moderate	Gelagaya & Minale (2016)
	Mining	1.00	Very High	Karan et al.,2019
	Settlements	1.00	Very High	Karan et al., 2019; Biswas & Pani (2015)
	Barren lands	1.00	Very High	Karan et al., 2019; Chatterjee et al.,2014
	Overburden	1.00	Very High	

5.2.2.5 Distance from drainage lines (D)

Runoff through natural drainage lines during rainfall events promotes sediment transport and erosion. The risk of erosion and sediment transport may be higher in areas closer to the natural drainage pattern due to higher mechanical forces of erosion. The drainage map of the Cluster-III area was extracted from the DEM of the study area using the flow accumulation tool in the hydrology toolset of ArcGIS 10.2.2. All values less than 600 were set to null, and the resultant raster was converted into a stream feature using the stream to feature tool in the hydrology toolset of ArcGIS 10.2.2. To analyse the influence of proximity to drainage on erosion potential, multiple buffer zones were created at distances of 50 m, 100 m, 150 m, and > 150 m from the extracted stream features using the Multiple Ring Buffer tool in ArcGIS 10.2.2 and shown in Table 5.4.

Table 5.4: Buffer Zone Analysis of Erosion Risk Based on Distance from drainage lines.

Parameter	Values (meter)	Erosion Risk Level
Distance from drainage lines (D)	< 50	Very High
	50 - 100	High
	100 - 150	Moderate
	>150	Low

5.2.2.6 Vegetation type (V)

Both the vegetation type and its density are important parameters governing erosion and sediment transport (Lieskovský & Kenderessy, 2014). Atmospherically corrected planet data were used for estimating the spatial distribution of vegetation in the study area. Normalized Difference Vegetation Index (NDVI) was used to estimate the spatial distribution of vegetation types in the study area. NDVI calculation is based on the concept of the normalized ratio of scattering of radiation in the near infrared (NIR) zone of the electromagnetic spectrum to that of radiation absorbed by the chlorophyll present in the canopy in the red wavelength. It is the most popular of all the vegetation indices, and the values of NDVI range from −1 to +1 depending on the types of features available in the area. Vegetation is generally present when the NDVI values are between 0.2 and 1. Lower NDVI value signifies low vegetation density, herb/shrub, and cropland. Higher values of NDVI signify dense vegetation (Carlson & Ripley, 1997). In the present study, NDVI was calculated using Eq. 5.3.

$$NDVI = \frac{NIR-RED}{NIR-RED} \quad \text{..... (Eq. 5.3)}$$

Where NIR is the Near Infra-red spectrum image band, and RED is the red spectrum image band. The NDVI values in the study area ranged from - 0.02 to 0.29. As per the calculated NDVI distribution, the study area was successfully classified into 5 distinct classes (Waterbody, Dense herbs, vegetation grassland, and Barren Land) as shown in the Table. 5.5.

Table 5.5: Vegetation Classification of the Study Area Using NDVI

Parameter	Vegetation Type	Erosion Risk Level

Vegetation type (V)	Waterbody	Very Low
	Dense Herbs and Shrubs	Low
	Vegetation	Moderate
	Grassland	Very High
	Barren Land	Very High

5.2.3 Factor Reclassification and Standardization

The parameters were reclassified and assigned suitability scores based on their influence on erosion risk and is depicted in Table 5.6. For instance, regarding Land-Use/Land Cover (C-Factor), settlements, mining, barren lands, and overburden were assigned a very high suitability score of 5, indicating very high erosion potential. Conversely, water bodies, railways, Nala, and village roads received a very low suitability score of 1. In terms of Soil Erodibility (K Factor), loam soil exhibited a very high suitability score of 5, while sandy loam was classified as moderate with a score of 3.

Furthermore, the distance from drainage lines (D) plays a crucial role, with areas lesser than 50 m from the drainage lines scoring a very high value of 5, and those greater than 150 meters scoring a low value of 2. The Rainfall Runoff Erosivity (R) was uniformly very high at a score of 5 for a Rainfall Runoff Erosivity value of 565.55 MJ mm $ha^{-1}h^{-1}year^{-1}$. Slope length and steepness (Ls) showed increasing suitability scores with increasing slope, with values greater than 14.40 receiving a very high score of 5. Lastly, for Vegetation Type, grassland with low density and barren land area scored a very high value of 5, while dense herbs and shrubs scored a low value of 2, as shown in Fig. 5.2.

Table 5.6: Reclassification Criteria and Suitability Scores for Thematic Layers

Parameter	Sub-Parameter/Value	Suitability Score	Suitability Class
Land Use/Land Cover (C)	Waterbody	1	Very Low
	Railways	1	Very Low
	Nala	1	Very Low
	Village Road	2	Low
	National Highways	1	Very Low

	(Vegetation, Sparse Vegetation, and Plantation on OB)	3	Moderate
	Agricultural Fallow Land	3	Moderate
	Mining	5	Very High
	Settlements	5	Very High
	Barren lands	5	Very High
	Overburden	5	Very High
Soil Erodibility (K) (tons $hMJ^{-1}m^{-1}$)	Loam	5	Very High
	Sandy Clay Loam	5	High
	Sandy Loam	3	Moderate
Distance from drainage lines (D) (meters)	50	5	Very High
	100	4	High
	150	3	Moderate
	>150	2	Low
Rainfall runoff erosivity (R) ($MJmmha^{-1}h^{-1}year^{-1}$)	565.55	5	Very High
Slope length and steepness (Ls)	0.00 – 3.6	1	Very Low
	3.7 – 7.2	2	Low
	7.3 – 10.80	3	Moderate
	10.81 – 14.40	4	High
	>14.40	5	Very High
Vegetation type (V)	Dense Herbs and Shrubs	1	Low
	Vegetation	3	Moderate
	Grassland	5	Very High
	Barren Land	5	Very High

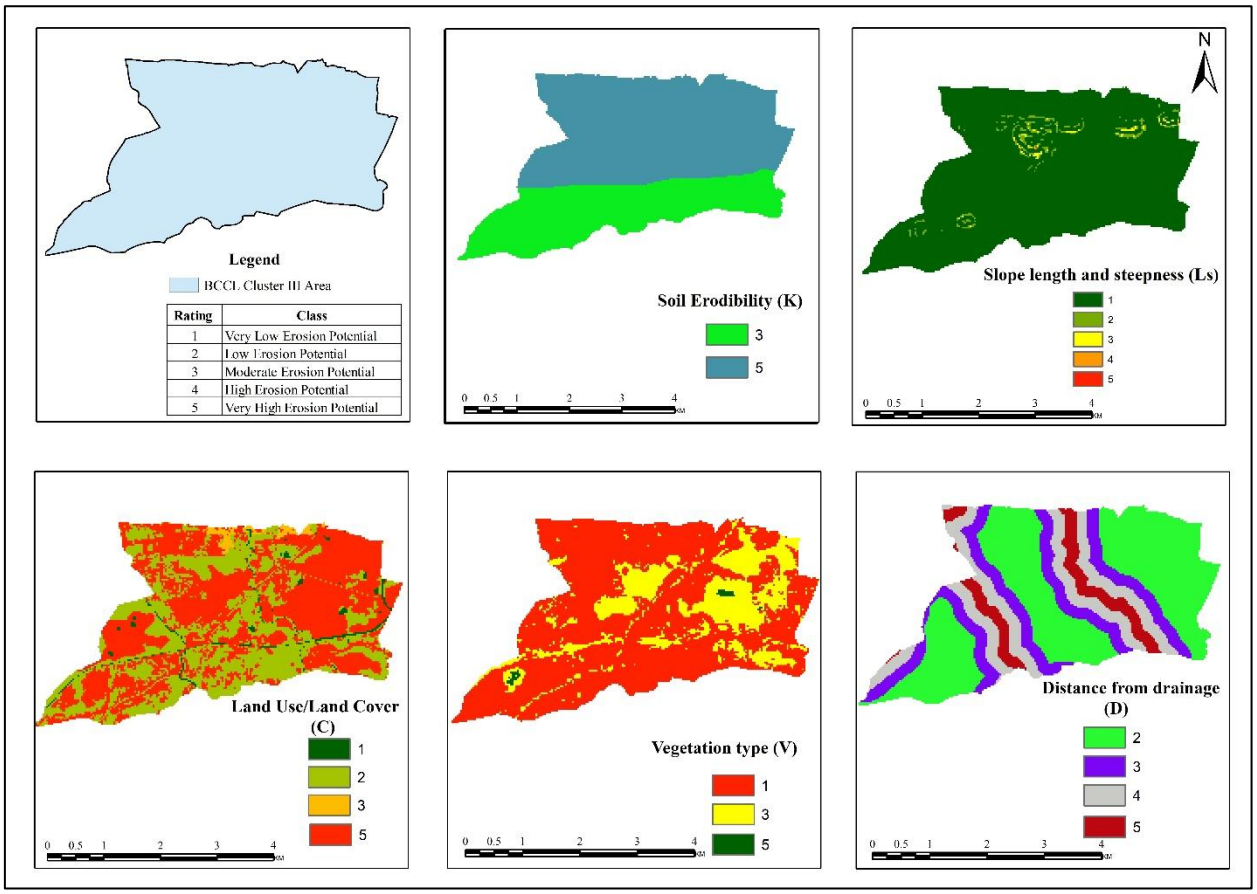


Fig. 5.2: Thematic Layers Used for EPI Analysis in BCCL Cluster-III Area

5.2.4 Analytic Hierarchy Process (AHP)

Building upon the insights from these reclassified parameters, the rationale of the erosion model is based on the rough concept of the USLE and its subsequent modifications, such as the RUSLE. While the primary purpose of the USLE model and its modifications was to assess soil loss at catchment scales, and most of these models involve the direct multiplication of factors responsible for erosion, it is recognized that not all parameters may contribute equally to the erosion process. Therefore, to create a more robust model capable of identifying areas more vulnerable to erosion, a weighted addition of the selected factors is required. Moreover, rainfall-runoff erosivity and soil erodibility factors within the RUSLE model possess physical dimensions. Consequently, directly creating an index by spatially overlaying them may yield erroneous results due to inconsistencies in units. To effectively address this issue, the AHP is employed to assign numerical, unit less weights to these parameters. This approach significantly helps in

maintaining coherency during the overlaying and indexing process, ensuring that each parameter's contribution is appropriately justified.

To further facilitate a comparative analysis, each thematic layer was standardized onto a standard five-point numerical scale, ranging from 1 (Very Low Erosion) to 5 (Very High Erosion). The classification thresholds for these layers were meticulously established based on existing literature, standard hydrological guidelines, and expert judgment for the study region.

In AHP, the off-diagonal relationships among the selected parameters were systematically examined using a 5-point scale in this study, which ranged from 1 (indicating equal importance) to 5 (signifying absolute importance). While, a 9-point scale is the standard and widely accepted practice in AHP, offering a broader range for expressing relative preferences and finer discrimination between criteria, but a 5-point scale (or any other reduced scale) could theoretically be used. The 9-point scale, as proposed by Saaty, is specifically designed to capture the full spectrum of human judgment on relative importance more effectively, thereby allowing for a more precise and consistent elicitation of priorities in complex decision-making scenarios. The AHP matrix, specifically utilized to evaluate the weights of the selected parameters, is presented in Table 5.7. A numerical score of 1 was consistently assigned to the diagonal elements of this matrix. To meticulously assess the consistency of the AHP matrix, a consistency index (CI) was computed using (Eq. 5.4). Sener and Davraz (2013) reported that the CI could be associated with a stochastic matrix (SM), such that the ratio between CI and SM constitutes the consistency ratio (CR). As a widely accepted guideline for AHP, the CR should ideally be less than or equal to 0.1 (i.e., CI/SM ≤ 0.1) (Saaty, 2003).

$$\boldsymbol{CI = \frac{\lambda_{max} - n}{n-1}} \quad \textbf{..... (Eq. 5.4)}$$

Where, λ_{max} is the largest principal eigenvalue of the matrix, and n is the number of parameters. Determination of rates of each parameter was performed by aggregating the computed results of the weights of each sub-parameter multiplied by the rate of each alternative.

Table 5.7: AHP matrix for calculating weight of each parameter of the Erosion Potential Index (Consistency Ratio: 0.031)

Parameters	Rainfall runoff erosivity *(R)*	Soil erodibility *(K)*	Slope length and steepness *(Ls)*	Land-use *(C)*	Distance from drainage lines *(D)*	Vegetation type *(V)*
Rainfall runoff erosivity *(R)*	1	2	3	4	3	5
Soil erodibility *(K)*	0.5	1	2	3	2	4
Slope length and steepness *(Ls)*	0.33	0.5	1	3	0.5	3
Land-use *(C)*	0.25	0.33	0.33	1	0.33	2
Distance from drainage lines *(D)*	0.33	0.5	2	3	1	4
Vegetation type *(V)*	0.2	0.25	0.33	0.5	0.25	1

5.2.5 Estimation of EPI

For estimation of the EPI, the methodological hierarchy shown in Fig. 5.1 was followed. The first step of the hierarchy is the selection of relevant parameters based on the USLE model. The second step includes the estimation of the weights and rates of the parameters using AHP. In the third step, the parameters were converted into the required format compatible with ArcGIS, and subsequently, in the next step, the parameters were reclassified to their respective weighted value (Table 5.8) calculated in the second step. Finally, the parameters were aggregated to estimate the EPI of the Cluster-III area using (Eq. 5.5).

$$\boldsymbol{EPI = \sum_{i=1}^{n} P_{wi} P_{ri}} \quad \textbf{…….. (Eq. 5.5)}$$

Where EPI is the erosion potential index, n is the number of parameters responsible for causing erosion; wi and ri in subscripts represent the respective weights and ratings of the parameter i. The reclassified parameters were scaled to a resolution of 30 m to maintain consistency during the aggregation process. The parameters were aggregated, and the EPI was estimated using (Eq. 5.6) in the raster calculator tool available under the Map Algebra Toolkit of ArcGIS 10.2.2.

$$EPI = R_w R_r + K_w K_r + Ls_w Ls_r + C_w C_r + D_w D_r + V_w V_r \ldots\ldots\ldots\ldots \text{(Eq. 5.6)}$$

Where, R is the rainfall-runoff erosivity, K is soil erodibility, L_s is the slope length and steepness factor, C is land-use, D is the distance from drainage lines, and V is the vegetation type.

Table 5.8: Weights of different parameters calculated using AHP

Parameters	Weight (Unitless)
Rainfall runoff erosivity *(R)*	0.35
Soil erodibility *(K)*	0.22
Slope length and steepness *(Ls)*	0.13
Land-use *(C)*	0.08
Distance from drainage lines *(D)*	0.17
Vegetation type *(V)*	0.05

5.2.6 Estimation of soil loss

Soil loss is measured in terms of tons per hectare per year. For the present study, the RUSLE model was used for estimating the soil loss for the Cluster-III area. The rationale of RUSLE model is based on the spatial multiplication of the factors affecting soil loss and erosion. These factors are (R) rainfall-runoff erosivity factor (MJmm $ha^{-1}h^{-1}year^{-1}$), (K) soil erodibility factor (t ha h $MJ^{-1}mm^{-1}ha^{-1}$), (Ls) slope length and steepness factor, (C) land cover management factor, and (P) the conservation supporting practice factor (unitless). The value of P is assigned using a practice analogy that is not readily available. Therefore, in the absence of conservation practices data (P) of the study area, the P factor was assumed as 1 (consistent with Pradhan et al., 2012). The soil loss equation uses spatial multiplication of the parameters, and the calculation was done using (Eq. 5.7).

$$A = R \times K \times L_s \times C \times P \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(Eq. 5.7)}$$

Where, A is the annual soil loss (in tons ha^{-1} $year^{-1}$). The parameters were reclassified into their respective ranges in ArcGIS environment. Raster calculator tool available in the map algebra toolbar of ArcGIS 10.2.2 was used to evaluate soil

loss using (Eq. 5.7) for the present study. All the parameters were scaled to a uniform spatial scale for error-free analysis.

5.3 Results and Discussion

5.3.1 Erosion Potential Index (EPI) in the Cluster-III Area

The numerical values of the composite EPI ranged from 3.0 (signifying lowest vulnerability to erosion) to > 4.12 (signifying highest vulnerability to erosion) for the entire Cluster-III area. The range of EPI was divided into 4 distinct classes (Low, Moderate, High, and Very High) based on equal interval division of EPI (Table 5.9). The results of the weighted linear combination of the parameters revealed that about 42.66% area of the Cluster-III area lies in the moderate EPI zone, and 25.43 of % area lies in the low EPI zone (Table 5.9). About 28.74% and 3.17 % area of the total study area lie in the high and very high EPI zones, respectively (Fig. 5.3). Critical observation on the model results revealed that the north, north-western, and south-eastern regions of the Cluster-III area had the highest vulnerability to erosion. Additionally, very high EPI values were found for the regions closer to the drainage lines located near overburden dumps, which indicate the presence of loose soil.

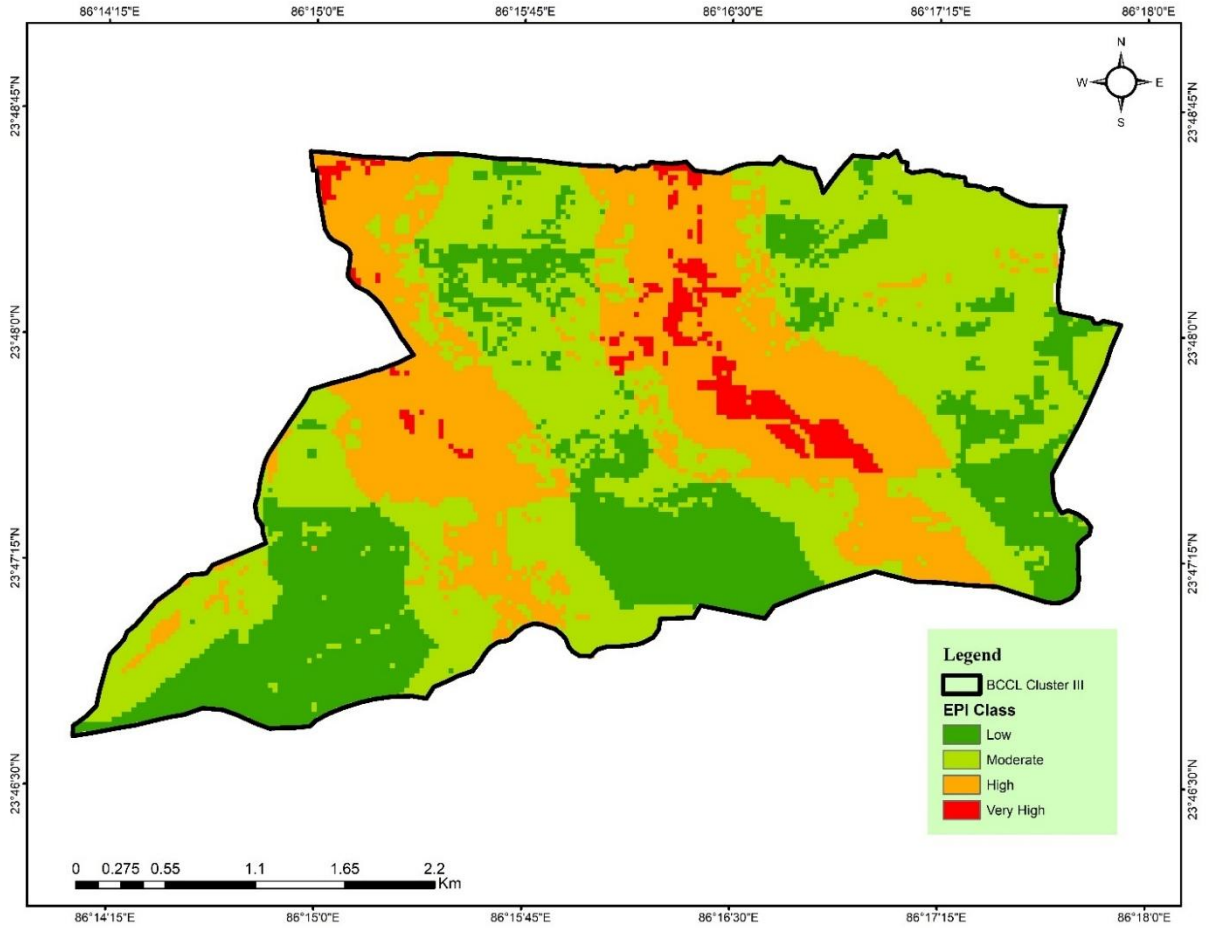


Fig. 5.3: Distribution of EPI zones in the Cluster-III area of BCCL

Table 5.9: Percentage distribution of EPI in the Cluster -III area based on EPI values

EPI Class	EPI class	Area %	Area (Hectare)
Low	3.00 – 3.38	25.43	361.089
Moderate	3.39– 3.75	42.66	605.81
High	3.76 – 4.12	28.74	408.226
Very High	>4.12	3.17	45.0802
Total Area = 1420.20 ha.			

5.3.2 Soil loss in the Cluster-III area

In the Cluster-III study area, the estimated soil loss ranged from 0 to 2023 tons ha^{-1} $year^{-1}$, with the RUSLE model employed to quantify annual soil erosion. The severity of soil erosion was categorized into five distinct classes based on soil loss rates namely Very Low (0 – 5 t ha^{-1} yr^{-1}), Low (6 – 10 t ha^{-1} yr^{-1}), Moderate (11 – 25 t ha^{-1} yr^{-1}), Severe (26 – 50 t ha^{-1} yr^{-1}), and Extreme Severe (>50 t ha^{-1} yr^{-1}). This classification scheme closely aligns with the ranges adapted in previous studies by

Ganasri and Ramesh (2016) and Karan et al. (2019). The detailed classification is presented in Table 5.10. A substantial portion of the study area, about 74.46%, is approximately 1057.51 ha falls under the Very Low erosion class, suggesting minimal soil degradation. This is followed by 1.90% (26.92 ha) in the Low erosion class, and 6.20% (88.10 ha) in the Moderate erosion category. The areas experiencing Severe and Extreme Severe erosion are relatively limited, covering 6.88% (97.67 ha) and 10.56% (149.99 ha), respectively, as shown in Fig.5.4.

Table 5.10: Distribution of soil loss in Cluster-III area in hectares

Soil loss (tons ha^{-1} year^{-1})	Class	Area %	Area (hectare)
0-5	Very Low	74.46	1057.51
6-10	Low	1.90	26.9229
11-25	Moderate	6.20	88.1031
26-50	Severe	6.88	97.6737
>50	Extreme Severe	10.56	149.999
	Total =1420.20 ha		

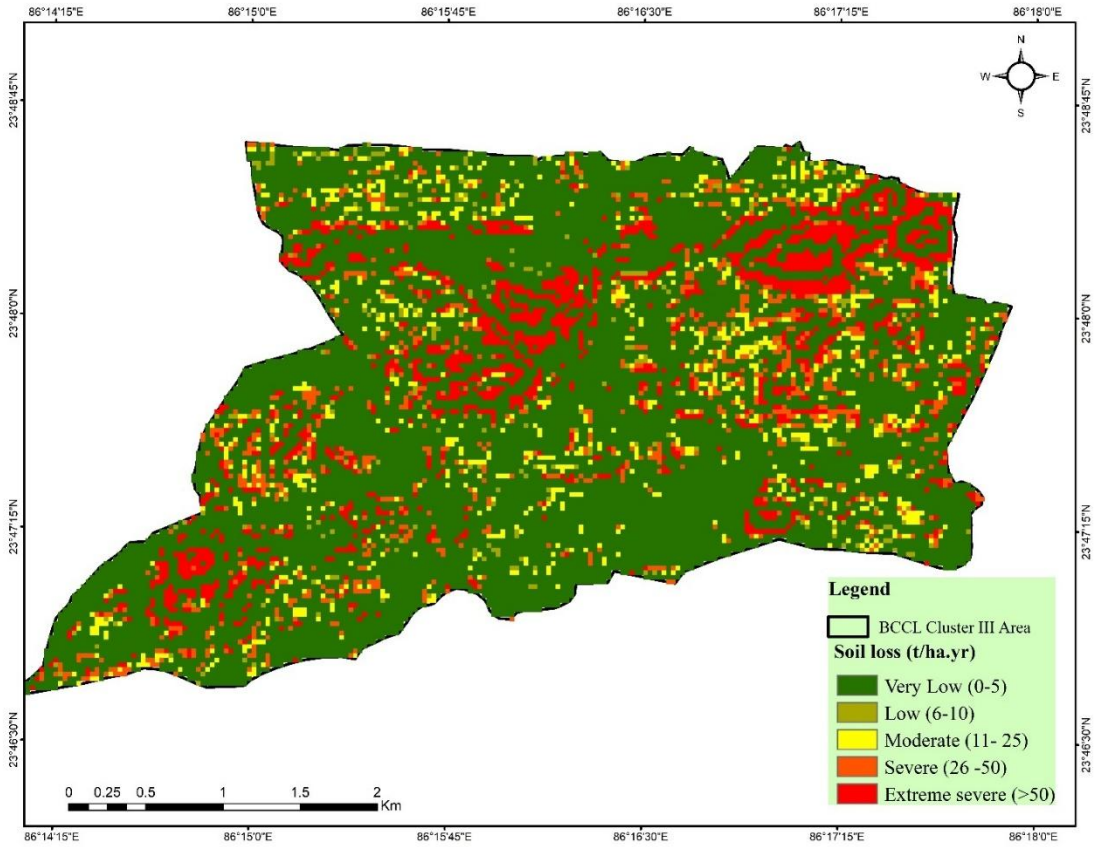


Fig. 5.4: Distribution of annual soil loss (tons ha^{-1} year^{-1}) in the Cluster III area of BCCL

5.4 Conclusion

Based on the Erosion Potential Index (EPI) and soil loss estimations, the Cluster-III area exhibits varying degrees of erosion vulnerability. The accurate estimation and spatial mapping of these zones are essential for prioritizing conservation efforts and implementing sustainable land and watershed management strategies. Approximately 25.43% (361.08 ha) of the Cluster-III area falls under the low erosion potential category (EPI: 3.0–3.38), indicating relatively stable regions with minimal risk of soil erosion. A significant portion, 42.66% (605.81 ha), is classified under the moderate EPI zone (EPI: 3.39–3.75), requiring targeted soil conservation interventions. About 28.74% (408.22 ha) of the total study area is in the high EPI zone, and 3.17% (45.08 ha) is in the very high EPI zone (EPI > 4.12), indicating the most vulnerable regions with high risk of soil erosion.

Regarding soil loss, a substantial 74.46% (1057.51 ha) of the Cluster-III area falls under the very low soil loss category (0-5 tons/hectare/year), suggesting minimal soil degradation and relatively stable regions. The low soil loss category (6-10 t ha^{-1} yr^{-1}) accounts for 1.90% (26.92 ha) of the area. Moderate soil loss (11-25 t ha^{-1} yr^{-1}) is observed in 6.20% (88.10 ha) of the area, necessitating targeted soil conservation interventions. Areas experiencing severe (26-50 t ha^{-1} yr^{-1}) and extremely severe (>50 t ha^{-1} yr^{-1}) erosion are relatively limited, covering only 6.88% (97.67 ha) and 10.56% (150 ha) area of the Cluster-III area respectively.

Critical observations reveal that the northern, north-western, and south-eastern regions of the basin exhibit the highest EPI values, indicating these areas are most vulnerable to erosion due to a combination of topographic and land-use factors. As expected, areas near natural drainage lines and overburden showed elevated erosion potential, confirming that runoff concentration significantly impacts sediment transport and erosion. These findings provide spatially explicit information on high-risk areas, thus supporting targeted soil and water conservation interventions within the watershed of the Cluster-III area. This aligns with the study's aim to provide information that assists in implementing sustainable land and watershed management strategies.



Chapter 6: Site Suitability Analysis for Conservation Structures in Watersheds under Cluster-III Area, BCCL

6.1 Introduction

Effective watershed management is contingent upon the strategic placement of conservation structures to mitigate hydrological extremes, enhance water availability, and promote sustainable land utilization. The Cluster-III of Govindpur area in the Jharia Coalfield regions are affected by mining and require proper water management to reduce land degradation, conserve soil, and enhance the water availability for the local commodities. One of the most effective ways to achieve this is by constructing the conservation structures i.e., check dams, farm ponds, and contour bunds. However, the success of these structures largely depends on selecting the most suitable locations based on physical and environmental factors. This chapter focuses on identifying the best locations for conservation structures within the watersheds of Cluster-III, using a scientific and spatial approach. The analysis is based on multiple criteria such as slope, land-use land cover, soil type, drainage density, flow accumulation, runoff potential, and soil erosion risk.

The study uses an integrated method combining Geographic Information System (GIS) and the Analytical Hierarchy Process (AHP) to evaluate and prioritize potential sites. GIS helps to process and visualize spatial data, while AHP provides a way to assign importance (weights) to each factor based on expert judgment and literature. The site suitability map highlighting the expected suitable areas for the construction of conservation structures will be the main outcome of the present chapter.

Applying this approach, the study aims to support better planning and implementation of water conservation efforts in the mining-affected landscape. This will improve local water resources and contribute to sustainable development and environmental restoration in the Cluster-III area.

6.2 Materials and Methodology

The methodological framework adapted for this study is depicted in Fig. 6.1. It comprises several sequential stages: data acquisition & preparation, derivation of thematic layers corresponding to the selected parameters, assignment of weights using AHP, and finally, integrating these layers through a weighted overlay analysis to generate the final site suitability map.

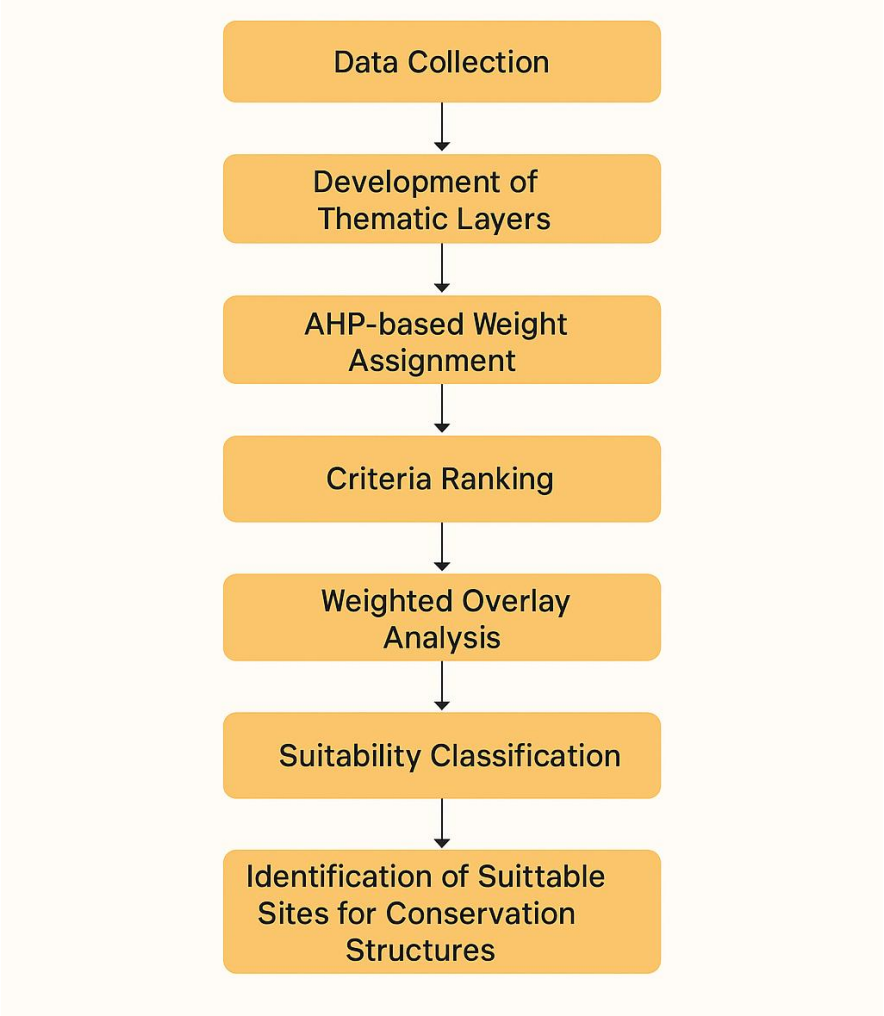


Fig. 6.1: A detailed flowchart illustrating the methodology for site suitability analysis

6.2.1 Data Acquisition and Preparation

Planet satellite data of 12th April 2025 was obtained from PlanetScope archive of European space agency (https://earth.esa.int/eogateway/missions/planetscope, accessed: 13th May 2025). The study area covers approximately 80 km², hence a single scene was downloaded to cover the entire study area. Captured image with a ground sampling distance (GSD) of 3.9 m, the image exhibits 100% clear sky conditions with no cloud, haze, or shadow interference, ensuring high-quality

visual data. CartoSat-1_PAN_CartoDEM-30m is the Digital Elevation Model (DEM) data of the study area that was downloaded from the Indian Space Research Organization's (ISRO) Bhoonidhi portal (http://bhoonidhi.nrsc.gov.in/data/download/index.php, accessed 12th May 2025). However, daily gridded rainfall data of 10 years (2015 - 2024) of the study area (Cluster-III) was taken from 9395 grid cell number of IMD of high spatial resolution (0.25×0.25 degree). Soil data were obtained from State Agricultural Management & Extension Training Institute (SAMETI), Jharkhand (https://www.sameti.org/Soil_Inventory/Dhanbad_Soil_Analysis.pdf, accessed on 12th May 2025). All datasets were projected to a standard coordinate system (UTM Zone 45 WGS 84) and resampled to a uniform spatial resolution to ensure geometric consistency for the overlay analysis.

6.2.2 Thematic Layer Generation and Parameter Influence

The selection of parameters was done on their established influence on hydrological and geomorphological processes pertinent to water conservation. Eight key parameters were identified, and their corresponding thematic layers were generated within the ArcGIS environment. The rationale for their inclusion is detailed in Table 6.1.

Table 6.1: Parameters for Site Suitability Analysis and their Hydro-geomorphological Influence

Parameter	Influence on Site Suitability for Conservation Structures
Slope	Governs runoff velocity, soil erosion potential, and the engineering feasibility of water impoundment. Gentle slopes are preferred to facilitate greater retention time and reduce construction costs.
Land-use/Land Cover (LULC)	Determines the rainfall-runoff coefficient. Barren and agricultural lands generate higher runoff than forested areas, making them priority zones for intervention.
Soil Texture	Controls infiltration rates and water holding capacity. Loamy and clayey soils with lower permeability are more suitable for water storage structures than sandy soils.
Drainage Density	Represents the total length of streams per unit area. Higher drainage density indicates a well-developed drainage network and concentrated surface flow, offering potential impoundment sites.

Flow Accumulation	A proxy for the volume of upstream water that would flow to a given point. Areas with moderate to high flow accumulation are ideal for capturing significant quantities of runoff.
Distance from Stream	Proximity to existing drainage channels is critical for building structures like check dams. Locations closer to streams are more suitable for intercepting and storing channel flow.
10-Year Surface Runoff	Represents the estimated surface runoff for a 1-in-10-year rainfall event. This hydrological parameter directly quantifies the water yield potential, with higher runoff zones being prime targets.
Soil Erosion Zones	Identifies areas with high rates of soil loss. Placing structures in these zones serves a dual purpose of water conservation and critical soil stabilization.

6.2.3 Factor Reclassification and Standardization

To facilitate a comparative analysis, each thematic layer was standardized onto a standard five-point numerical scale, ranging from 1 (Very Low Suitability) to 5 (Very High Suitability). The classification thresholds were established based on the existing literatures, standard hydrological guidelines, and expert judgment specific to the agro-ecological conditions of the study region. The reclassification scheme is detailed in Table 6.2.

Table 6.2 Reclassification Criteria and Suitability Scores for Thematic Layers

Parameter	Class/Range	Suitability Score	Suitability Class
Slope (%)	>15	1	Very Low
	10 – 15	2	Low
	5 – 10	3	Moderate
	2 – 5	4	High
	0 – 2	5	Very High
Land-use/Land Cover (LULC)	Forest/Water Body	1	Very Low
	Built-up Area	2	Low
	Scrubland	3	Moderate
	Fallow Land	4	High
	Agricultural Land	5	Very High
Soil Texture	Sandy	1	Very Low
	Sandy Loam	2	Low
	Clay / Silty Clay	3	Moderate
	Clay Loam	4	High
	Loam / Silty Loam	5	Very High
Drainage Density (km/km^2)	0 – 0.5	2	Low
	0.5 – 1.5	5	High
	>1.5	3	Moderate
	<500	1	Very Low

Flow Accumulation (cells)	500 – 1000	3	Moderate
	>1000	5	High
Distance from Stream (m)	>300	1	Low
	100 – 300	3	Moderate
	0 – 100	5	High
10-Year Surface Runoff (mm)	Low Runoff (<100 mm)	2	Low
	Medium Runoff (100–250 mm)	4	High
	High Runoff (>250 mm)	5	Very High
Erosion Potential Index (EPI)	3.00 -3.38	1	Very Low
	3.39-3.75	3	Moderate
	3.76-4.12	4	High
	>4.12	5	Very High Priority

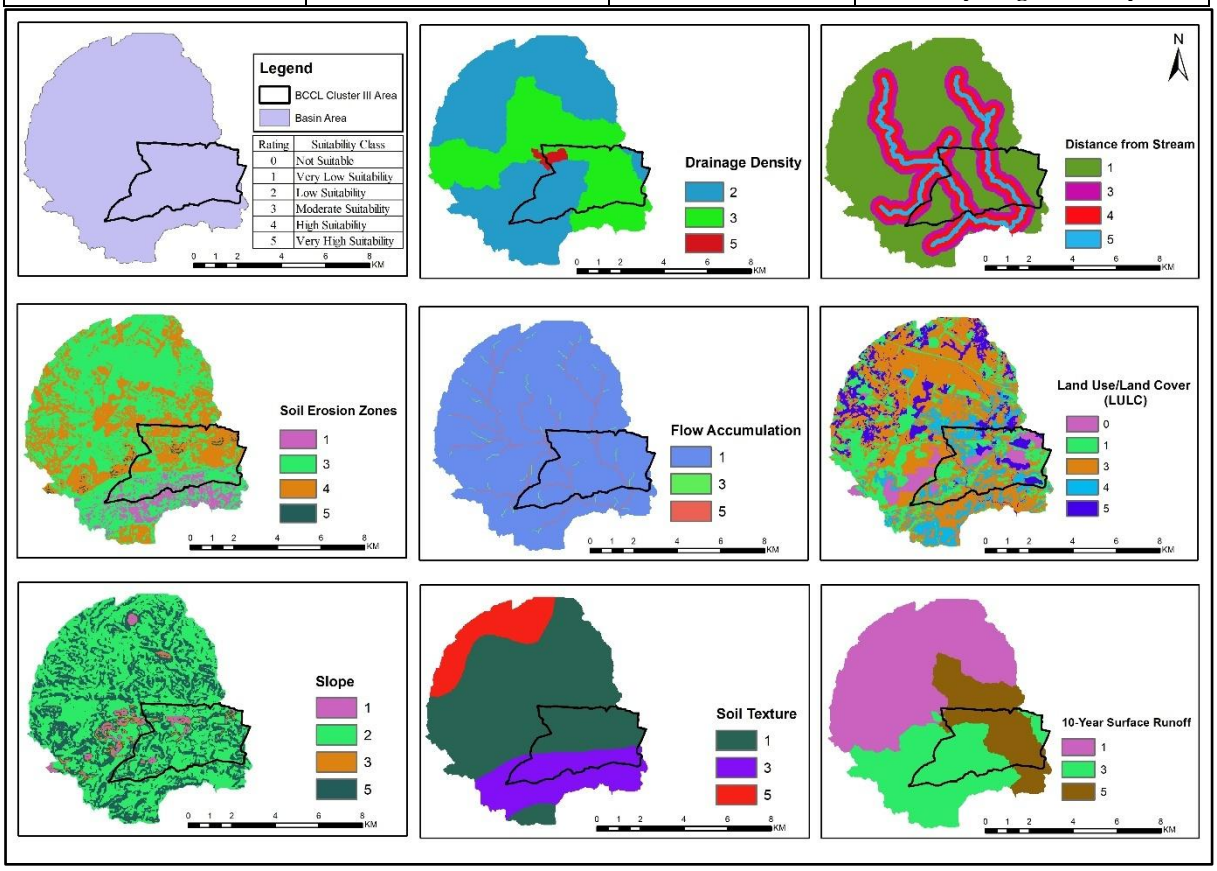


Fig. 6.2: Thematic Layers Used for Site Suitability Analysis in BCCL Cluster-III Watershed Region

6.2.4 Weight Assignment Using Analytical Hierarchy Process (AHP)

The determination of the relative importance of each parameter is a critical step that significantly influences the outcome of the analysis. The AHP, a multi-criteria decision-making technique developed by Saaty (1980), was employed for this purpose. The process involved constructing a pairwise comparison matrix where

each parameter was compared against every other parameter based on a 5-point scale of relative importance. The consistency of these judgments was evaluated by calculating the Consistency Ratio (CR) (Eq. 6.1).

$$\boldsymbol{CR = \frac{CI}{RI}} \quad \textbf{…….. (Eq. 6.1)}$$

Where, CI is the Consistency Index and RI is the Random Inconsistency Index.
A CR value of less than 0.10 indicates an acceptable level of consistency in the pairwise judgments. For this study, the calculated CR value was 0.021, which is well within the acceptable threshold, validating the robustness of the derived weights. The final normalized principal eigenvectors, representing the weights of the parameters, are presented in Table 6.3.

Table 6.3: Final Weights of Parameters Derived from AHP

Parameter	Weight (%)
Slope	27
Land-use/Land Cover (LULC)	15
Soil Texture	11
Drainage Density	15
Flow Accumulation	9
Distance from Stream	5
10-Year Surface Runoff	10
Soil Erosion Zones	8
Total	100

Table 6.4: AHP matrix for assigning weight to site suitability analysis.

Criteria	Slope	LULC	Soil Texture	Drainage Density	Flow Accumulation	Distance from Stream	Surface Runoff	Soil erosion
Slope	1	2	3	2	4	5	3	2
LULC	0.5	1	2	1	2	3	2	2
Soil Texture	0.33	0.5	1	1	2	2	1	1
Drainage Density	0.5	1	1	1	2	3	2	2
Flow Accumulation	0.25	0.5	0.5	0.5	1	2	1	1

Distance from Stream	0.2	0.33	0.5	0.33	0.5	1	0.5	0.5
Surface Runoff	0.3	0.5	1	0.5	1	2	1	2
Soil Erosion	0.5	0.5	1	0.5	1	2	0.5	1

6.2.5 Weighted Overlay Analysis

The final stage involved integrating the reclassified thematic layers using the weighted overlay tool in GIS. The suitability index (S) for each pixel was computed by summing the product of the reclassified raster value (suitability score) and its corresponding AHP-derived weight for each parameter (Eq. 6.2).

$$S = \sum_{i=1}^{n} (W_i \times C_i) \quad \text{..... (Eq. 6.2)}$$

Where, S = Final suitability index; W_i = Weight of the i^{th} parameter; C_i = Reclassified suitability score of the i^{th} parameter; and n = Total number of parameters.

The resulting composite suitability index values were then grouped into four final suitability classes: Very Low, Low, Moderate, and High. No areas with Very High suitability were identified across the region.

6.3 Results and Discussion

The application of the weighted overlay analysis yielded a final site suitability map for the Cluster-III watershed region, as depicted in Fig. 6.3. The produced map delineates the distinct zones of suitability for implementing soil and water conservation structures.

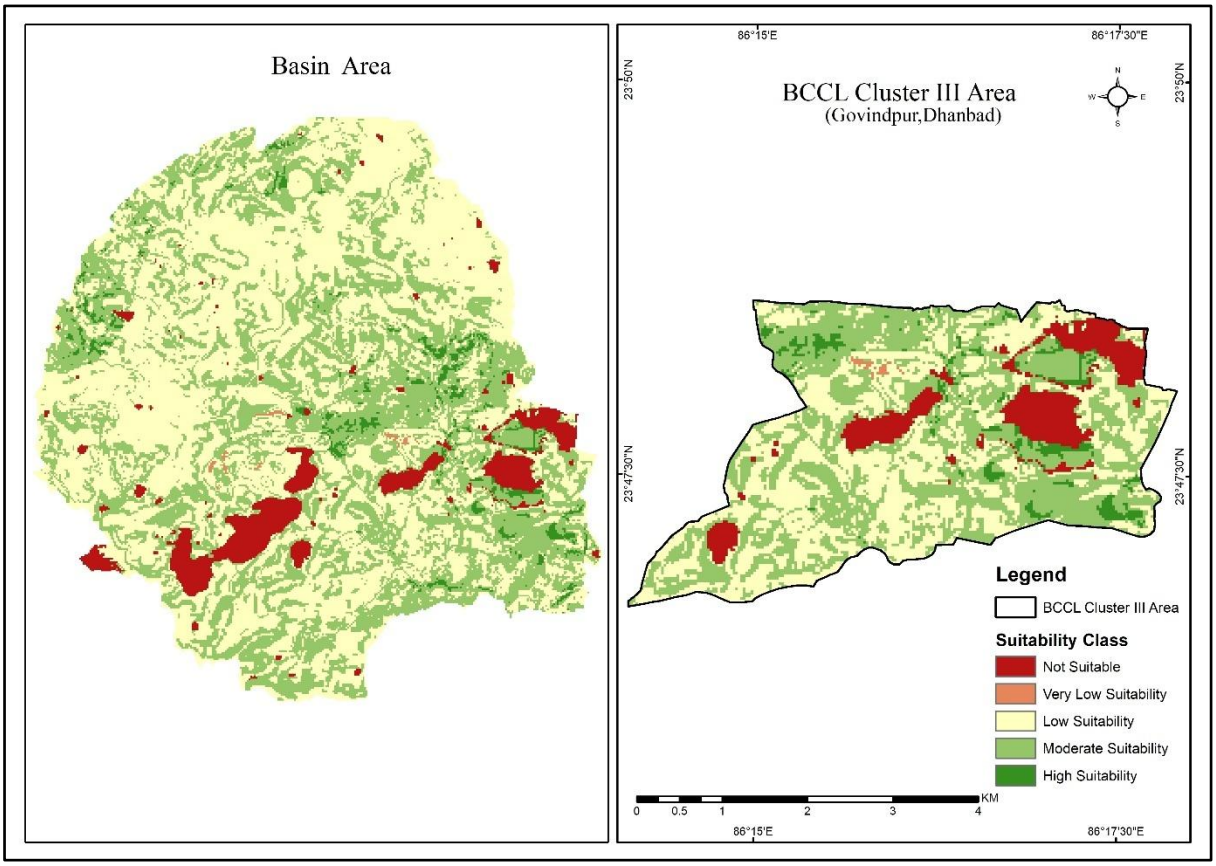


Fig. 6.3: The final Site Suitability Map for Conservation Structures in Cluster-III Watershed

6.3.1 Spatial Distribution of Suitability Classes

The weighted overlay analysis, conducted using 30 m spatial resolution raster data across eight thematic layers, categorized the watershed into four suitability classes for the implementation of conservation structure. The classification reflects the integrated influence of slope, land use/land cover, soil texture, flow accumulation, drainage characteristics, proximity to streams, runoff potential, and erosion vulnerability.

The spatial distribution of suitability classes within the Cluster III Area is as follows:

- **Not Suitable (Value 0):** 11.26% (1,776 pixels; 159.84 ha), mainly comprising built-up areas and water bodies that are excluded from final intervention planning.
- **Very Low Suitability (Value 1):** 0.26% (41 pixels; 3.69 ha)
- **Low Suitability (Value 2):** 40.38% (6,368 pixels; 573.12 ha)
- **Moderate Suitability (Value 3):** 44.15% (6,963 pixels; 626.67 ha)

- **High Suitability (Value 4):** 3.96% (624 pixels; 56.16 ha)

The 'Moderate' and 'Low' suitability zones constitute most of the watershed, indicating the presence of moderately favourable terrain and hydrological conditions, which may be improved through engineered interventions. The 'High Suitability' zones, covering approximately 4% of Cluster III, are regarded as top-priority areas for conservation interventions, such as check dam or contour bund construction, based on their favourable site characteristics. The 'Very Low' and 'Not Suitable' zones collectively account for ~11.5 % of the area, primarily due to steep slopes, mining area, settlements, or permanent water coverage, and thus, were excluded from physical intervention recommendations.

6.3.2 Delineation of Priority Zones

The analysis identified that zones classified as 'High' suitability closely correspond with biophysical conditions favourable for water conservation interventions. These priority areas are primarily characterized by gentle slopes (0 – 5%), loamy soil textures, and land-use types such as agriculture or fallow land, which enhance their potential for surface water harvesting, infiltration, and trapping of the sediments. Spatially, these zones are aligned with regions of moderate to high flow accumulation and are located near natural drainage lines. Furthermore, these areas demonstrate high 10-year surface runoff potential and moderate to high vulnerability to soil erosion. This combination of factors confirms their strategic suitability for conservation structures to improve water availability and stabilize soil in the mining-impacted Cluster-III region.

6.3.3 Identification and Validation of Intervention Sites

Based on the suitability model and subsequent field validation, specific sites for two types of conservation structures were identified.

Check Dams (CDs): Three strategic locations were identified through the analysis. The model's predictive accuracy was confirmed, as two sites (CD1 and CD2) coincided with existing check dams. The third site (CD3) was in a high-priority zone with substantial runoff convergence and favourable biophysical conditions. However, field investigations revealed that this location (CD3) is unsuitable for the

construction of a Check Dam because of active coal mining activities. Fig. 6.4 shows an overview of all the identified and existing Check Dam sites. Fig. 6.5 presents the detailed spatial context and surroundings of the CD3 location.

Contour Bunding / Retaining wall (CB): Four locations were identified as suitable for contour bunding, which functions as retention wall along natural slope. These structures intercept & slow down the velocity of surface runoff and prevent erosion of soil and overburden material. In mining-impacted areas, retention walls also act as barriers to stabilize loose overburden dumps, control gully formation, and reduce sedimentation in nearby streams and reservoirs. Thus, they play a dual role, conserving soil moisture for agriculture and supporting slope stabilization in mine reclamation efforts.

Field verification was done to verify the model outputs that led to the following site-specific recommendations:

- **CB1:** New bund construction is strongly recommended at this site. Field inspection revealed concentrated runoff and significant erosion risks impacting the adjoining Bagdighi Nala. A retention wall of approximately 850 meters in length is proposed to stabilize the soil, enhance water conservation and to minimize erosion potential.
- **CB2:** Although, this site was identified as suitable during the analysis but, this site is located near active mining and overburden dumps. Any constructed bund at this site may be destabilized due to the existing mining activities as the mining operations are progressing towards the proposed site located at CB2. Thus, the site CB2 is unsuitable for constructing contour bund.
- **CB3:** An existing bund of approximately 450 meters was observed at this site, validating the model's prediction. However, reinforcement and possible extension are recommended to improve its effectiveness and ensure long-term stability.
- **CB4:** Partial bunding of approximately 250 meters already exists at this location, further validating the model's output. It is recommended that the

bund be strengthened and extended by an additional 150 meters to provide enhanced protection against erosion and overburden movement.

Fig. 6.6 to Fig. 6.9 present detailed spatial views of the four contour bunding sites. Collectively, these interventions are expected to minimize soil erosion, stabilize mine dumps, reduce overburden failures, and enhance land productivity in the Cluster-III watershed.

Table 6.4: Identified Locations for Check Dams and Contour Bunding in Cluster-III Watershed Region

Sites Name	Latitude	Longitude
Check Dams (CD)		
CD1	23°48'21.35"N	86°16'21.20"E
CD2	23°47'5.29"N	86°15'45.48"E
CD3	23°47'26.96"N	86°17'2.33"E
Contour Bunding (CB)		
CB1	23°47'15.88"N	86°17'14.74"E
CB2	23°48'13.05"N	86°17'18.57"E
CB3	23°47'48.21"N	86°16'39.37"E
CB4	23°48'13.47"N	86°16'20.12"E

6.3.4 Interpretation and Implications

The spatial distribution of identified intervention sites highlights the strong influence of critical factors such as 10-year surface runoff and soil erosion potential, which carried higher weights in the AHP framework. These parameters guided prioritization towards zones with high water yield and urgent stabilization needs. The use of AHP ensured that decision-making was scientifically embedded in the spatial model, producing results that are not only robust but also management-relevant. The suitability map and identified intervention points provide actionable guidance for implementing climate-resilient water conservation structures in a mining-impacted environment.

In particular, the identification of retention wall sites underscores their importance in mining reclamation and watershed management. By reducing runoff velocity, enhancing infiltration, and stabilizing overburden dumps, retention walls reduce erosion hazards while improving agricultural productivity. Their effectiveness in controlling sediment transport also supports downstream ecosystem health.

Thus, the combined implementation of check dams and retention walls offers a synergistic approach to land restoration, mine reclamation, and sustainable watershed development in the Cluster-III region.

6.4 Conclusion

This chapter demonstrated the effectiveness of an integrated GIS–AHP-based methodology for robust site suitability analysis of water conservation structures in a mining-impacted watershed. By systematically evaluating eight critical biophysical parameters, the study produced a spatially explicit and quantitative decision-support tool, moving beyond generalized recommendations. The results were further validated in the field, enhancing confidence in the model outputs. For check dams, two existing sites (CD1 and CD2) were accurately captured, while a new site (CD3) was proposed at a high-priority runoff-convergent zone. But field visit confirmed that construction of check dam at location CD3 is not possible due to active coal mining activities and other mining operation difficulties. For contour bunding/retention walls, the model identified four suitable sites, which were refined through field observations. A new contour bund construction at location CB1 with approximate length of 850 m has been proposed and two existing bunds located at CB3 and CB4 have been recommended for strengthening and extending the length. The model based identification of location for contour bund at CB2 was found unsuitable as the mining activities are progressing towards to proposed site.

The strong consistency of the AHP model (CR = 0.021) underscores the reliability of the analysis. More importantly, the incorporation of retention walls adds a critical dimension to watershed management in mining regions, as they simultaneously serve soil conservation, slope stabilization, and mine land reclamation functions. In conclusion, the suitability analysis provides a scientifically grounded, field-validated, and policy-relevant framework for the planning and implementation of

water conservation structures in the Cluster-III watershed. These findings form a crucial input for subsequent phases of research, including detailed hydrological modelling and impact assessment of the proposed interventions.

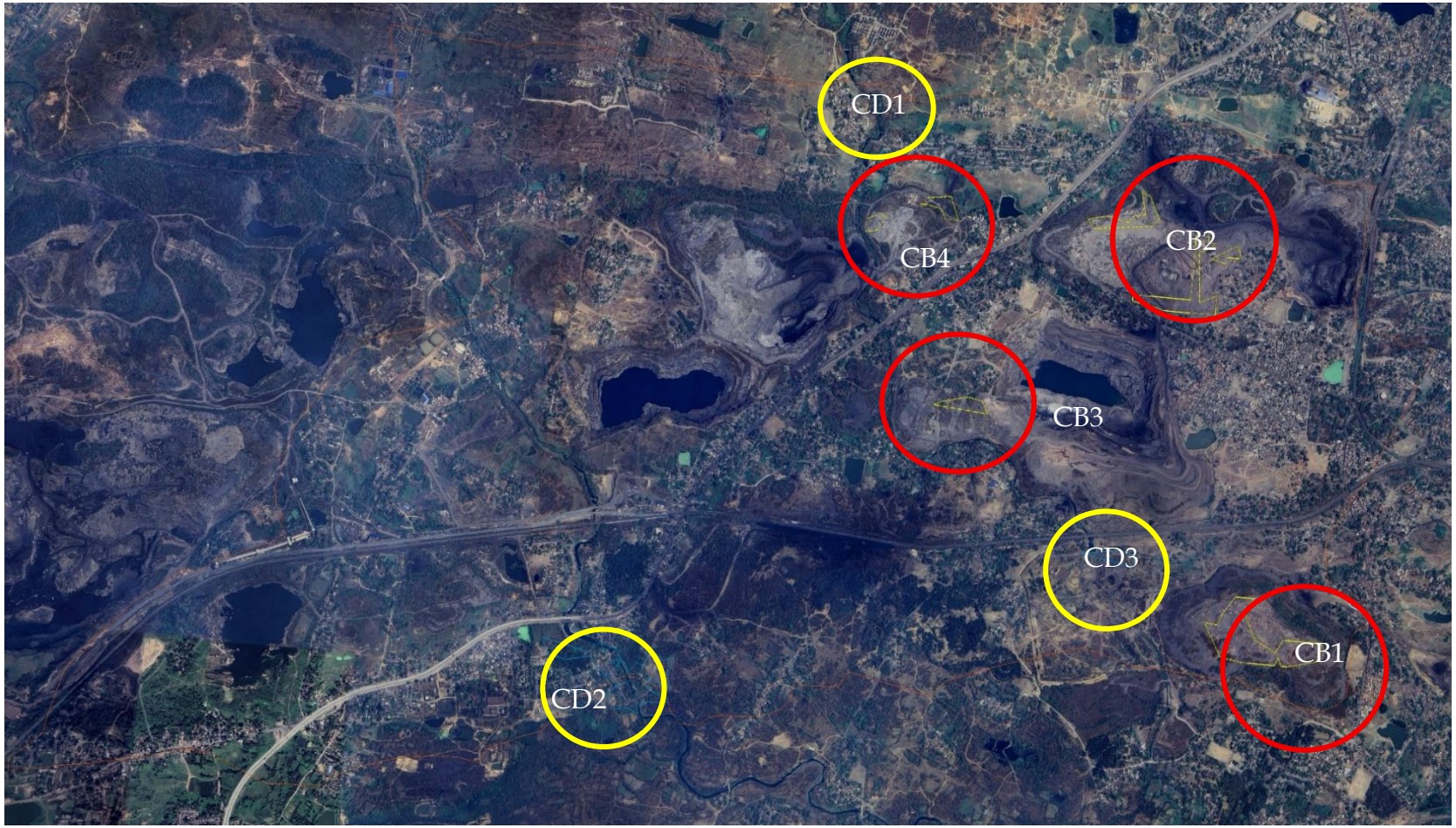


Fig. 6.4: Overall site suitability map showing locations of conservation structures (CD1–CD3 and CB1–CB4)



Fig. 6.5: Detailed location of the initially proposed Check Dam site CD3 (excluded due to existing coal mining activities)



Fig. 6.6: Detailed location of the proposed Contour Bund site CB1



Fig. 6.7: Detailed location of the initially proposed Contour Bund site CB2 (excluded due to proximity to active mining and overburden dumping).

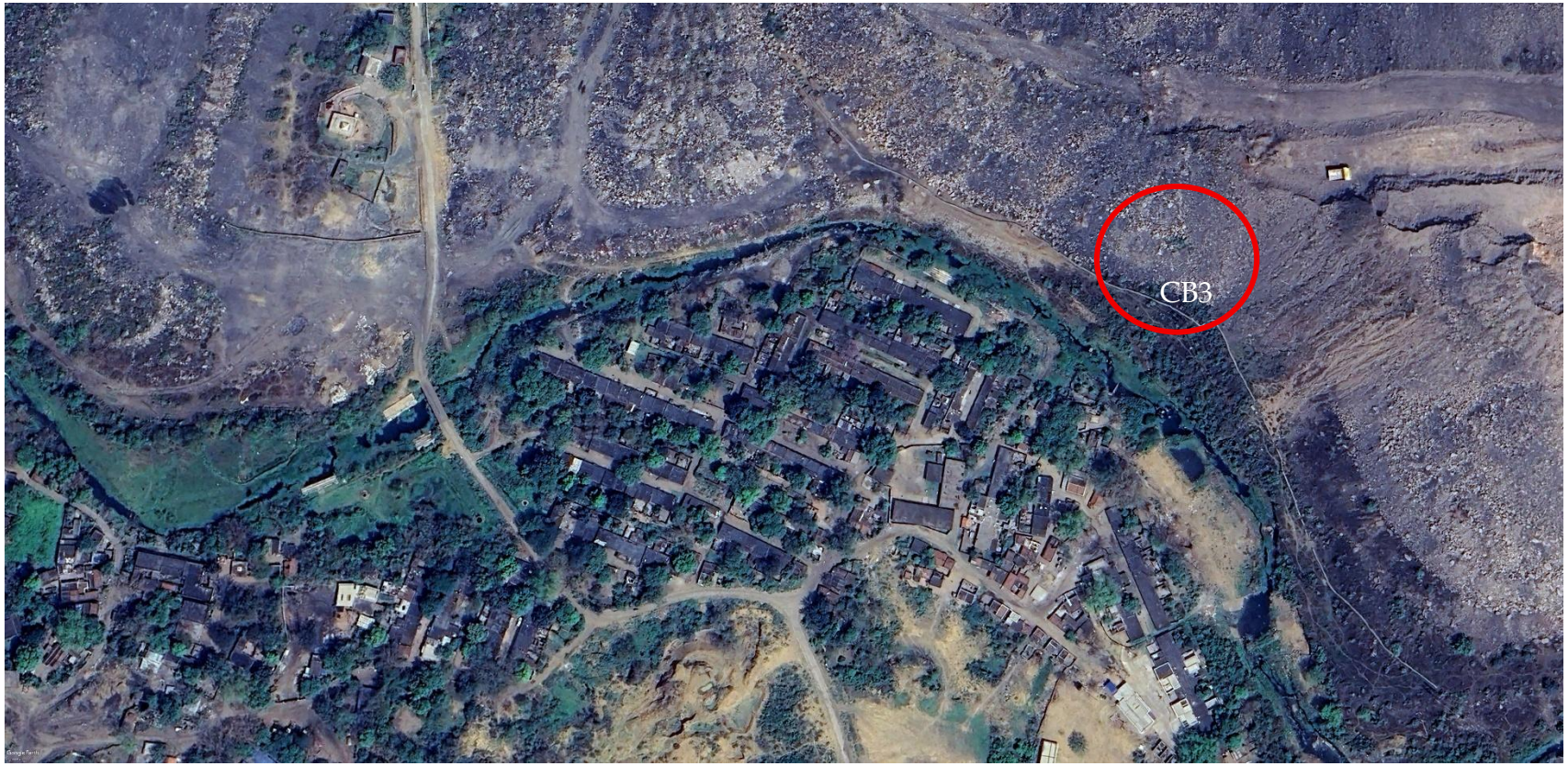


Fig. 6.8: Detailed location of the existing Contour Bund site CB3 (with recommended reinforcement and extension).

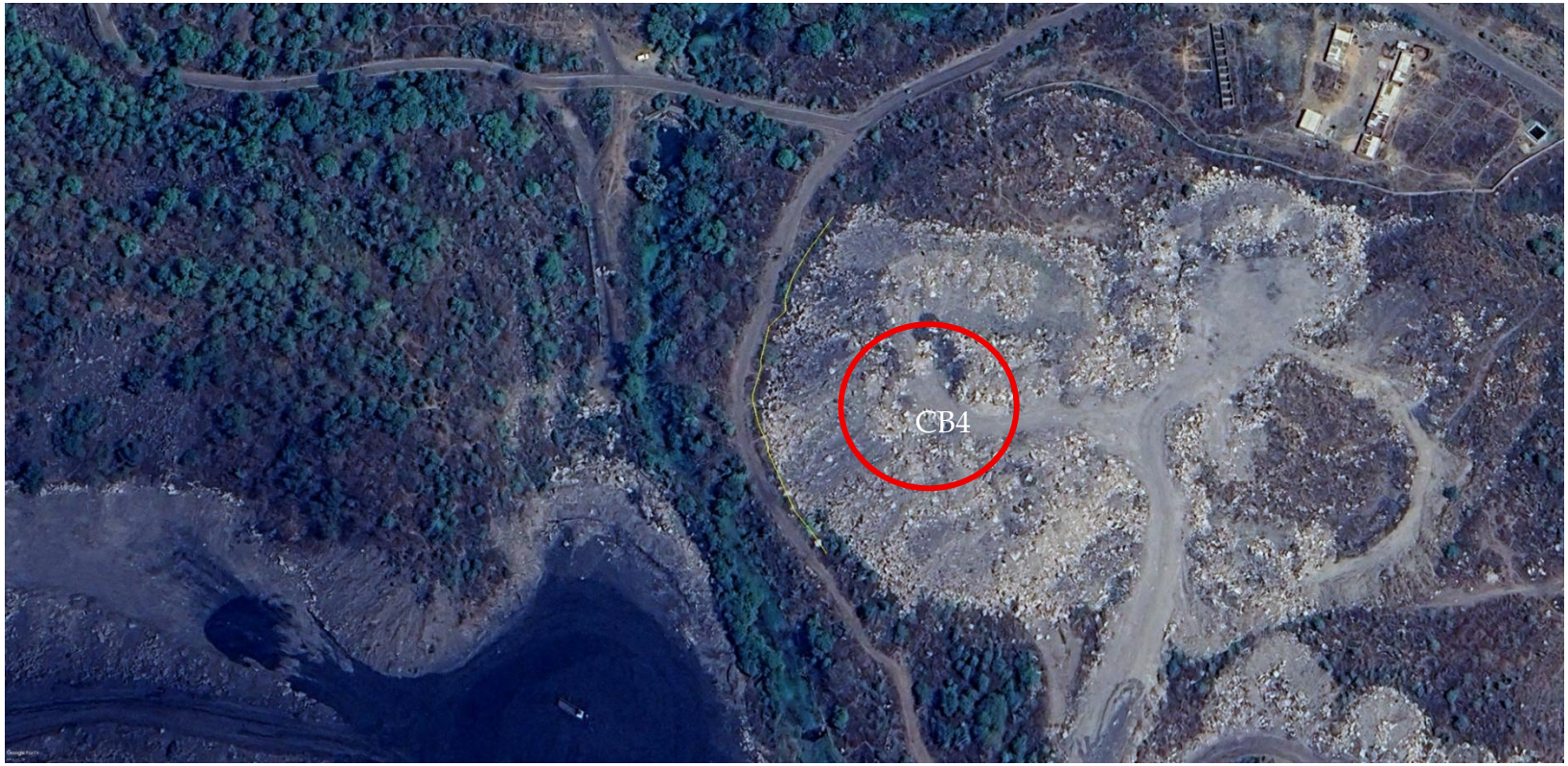


Fig. 6.9: Detailed location of the partially existing Contour Bund site CB4, identified for reinforcement

Chapter 7: Identification of Suitable Locations for Plantation in Different Watershed Regions at Cluster-III (BCCL, Govindpur Area)

7.1 Introduction

The Cluster-III region of BCCL, located in the Govindpur Area of Jharkhand, has experienced significant ecological degradation due to decades of coal mining operations. The large-scale excavation, removal of topsoil, formation of overburden dumps, and exposure of sub-surface geological strata have led to disruption of the natural landscape. This disturbance has significantly altered the hydrological balance and increased the area's vulnerability to soil erosion and uncontrolled surface runoff with sediment. The consequences are particularly pronounced during monsoon season, when the absence of adequate vegetation and poor surface retention exacerbate sediment transport and slope instability.

The existing Land use and Land Cover (LULC) patterns indicate a significant presence of degraded land types, including barren land, exposed overburden dumps, fallow areas, and sparsely vegetated regions. The absence of adequate vegetative cover in these areas has critical implications, as vegetation plays a key role in intercepting rainfall, stabilizing soil particles, minimizing soil erosion, and enhancing groundwater recharge. This degradation highlights the urgent need for sustainable, nature-based interventions, particularly afforestation and plantation initiatives, as essential bioengineering strategies for ecological restoration and landscape stabilization.

The decision to introduce plantation interventions arises directly from the need to stabilize slopes, reduce raindrop impact on bare soil, enhance infiltration, and limit sediment transport. Vegetation not only provides a protective ground cover but also contributes to long-term ecological recovery. Plantation, in combination with structural interventions such as contour bunding and check dams, forms a holistic watershed management strategy. Contour bunding reduces runoff velocity and promotes in-situ moisture conservation on undulating terrain, while check dams help in controlling

gully erosion, reducing downstream sedimentation, and facilitating groundwater recharge.

Empirical analysis of erosion dynamics based on the Erosion Potential Index (EPI) further validates the need for conservation interventions. Approximately 25.43% of the study area (361.09 ha) falls under the low erosion potential category, while a significant area of 42.66% (605.81 ha) is classified as moderate, and 28.74% (408.23 ha) as high. Additionally, about 3.17% (45.08 ha) of the area is under very high erosion risk, primarily concentrated near overburden dumps, natural drainage lines, and steep slopes. The soil loss pattern clearly indicates that topographic and anthropogenic factors are intensifying localized zones of severe to extremely severe erosion, necessitating immediate mitigation strategies such as vegetative barriers, check dams, and slope stabilization.

To identify Suitable Locations for Plantation in different watersheds, a GIS-based Analytic Hierarchy Process (AHP) model was developed, integrating eight key biophysical criteria such as slope, soil type, LULC, proximity to drainage, and erosion risk. The model produced a spatially explicit suitability map, validated with a high consistency ratio (CR = 0.021), enabling data-driven prioritization of restoration sites.
In this chapter, identification of the suitable sites for tree plantation within the watersheds of Cluster-III Area is systematically presented. A plantation suitability map has been developed using spatial analysis techniques, providing a scientifically grounded basis for site selection. This map is intended to function as a strategic tool to support planning and policy decisions, particularly in the context of integrated watershed management. By guiding the implementation of nature-based solutions, such as afforestation, the map contributes to ecological restoration and landscape stability. Furthermore, while the present focus is on plantation suitability, it forms an integral part of a broader watershed management framework. In this context, complementary interventions including contour bunds and check dams are also essential, and their technical details and spatial planning are elaborated in Chapter 6.

7.2 Materials and Methodology

The methodological framework adapted in this study, as illustrated in Figure 7.1, follows a structured and sequential approach integrating Geographical Information Systems (GIS) with the AHP based Multi-Criteria Decision Making (MCDM) technique. This approach was employed to identify optimal sites for plantation-based bioengineering interventions in the erosion-prone watersheds of Cluster-III, with the overarching objective of minimizing soil erosion and enhancing landscape resilience. The process originated with the acquisition and preprocessing of relevant spatial datasets, viz., slope, LULC, soil type, erosion potential zones, and drainage distance. These steps have already been described in detail in Chapter 6, Section 6.2.1, and serve as the foundational input for this stage of analysis. From these datasets, thematic layers were derived for each biophysical parameter, representing their spatial variation across the study area.

Each thematic layer was then reclassified and ranked according to its relative influence on plantation suitability. AHP was applied to construct a pairwise comparison matrix, facilitating the derivation of normalized weights based on expert judgment. To ensure logical consistency, the consistency ratio (CR) was computed and verified to be within acceptable limits. Subsequently, the weighted overlay analysis (WOA) was performed in the GIS environment, integrating the reclassified layers using the derived weights to produce a composite plantation suitability map. To validate the reliability of the output, an accuracy assessment was undertaken using actual field data.

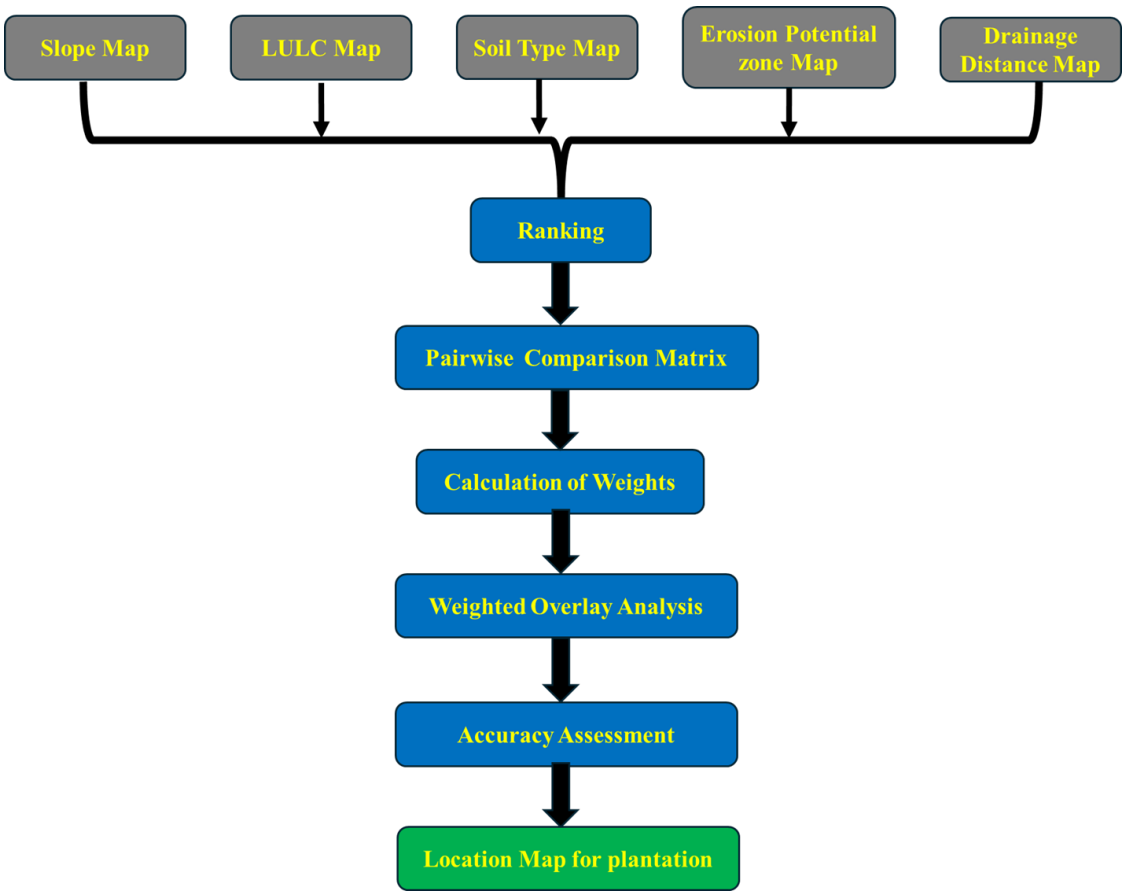


Fig. 7.1: Methodology adapted for locating suitable sites for plantation

7.2.1 Thematic Layer Generation and Parameter Influence

Five key biophysical parameters, namely slope, soil type, LULC, drainage distance, and erosion potential, were selected as primary criteria for the spatial analysis using the WOA technique. These parameters were identified based on their critical influence on plantation success and their direct association with soil erosion dynamics and hydrological processes, particularly within a mining-impacted landscape. Each parameter was spatially represented through thematic mapping and subsequently reclassified into discrete suitability classes with AHP-derived scores (ranging from 1 to 5) assigned to their respective sub-categories to reflect relative suitability and presented in Fig. 7.2; where, 1 indicates low suitability and 5 indicates high suitability. The rationale for the selection of each parameter is summarized in Table 7.1, while the associated scoring and reclassification criteria are summarized in Table 7.2.

7.2.1.1 Slope

Slope is a pivotal topographic factor controlling runoff intensity, erosion risk, and planting feasibility. Gentle slopes promote infiltration and enhance plantation viability due to reduced runoff velocity, enhanced moisture content, and increased soil stability. Conversely, steeper slopes are associated with increased runoff energy, less moisture content, and reduced soil stability, posing greater challenges for plantation establishment and success.

For this study, slope gradients were derived from a 30-meter resolution CartoDEM (CartoSat-1) dataset. The continuous slope data was categorized into five suitability classes, reflecting the ease of planting and erosion control potential across varying slopes. AHP ratings, ranging from 1 (very low suitability) to 5 (very high suitability), were assigned to each class.

7.2.1.2 Soil Type

Soil type plays a vital role in determining the suitability of an area for plantation due to its direct influence on crucial factors such as water retention, aeration, and nutrient availability and all these factors are essential for healthy plant growth and survival. Based on the SAMETI soil dataset, the study area's soil was categorized into two predominant textural classes, viz., Loam and Sandy Clay Loam. In the present study, Loam soil was assigned the highest AHP suitability rating of 5, indicating its very high suitability for plantation. This is primarily attributed to its optimal balance of sand, silt, and clay, which collectively support root development, superior moisture retention capacity, and adequate aeration. Sandy Clay Loam received a suitability rating of 3, signifying moderate suitability due to its comparatively lower water-holding capacity and reduced nutrient availability (FAO, 2006; Brady & Weil, 2016). The AHP ratings represent suitability scores assigned to each soil textural class based on their inherent properties to support successful plantation and growth.

7.2.1.3 Land-use Land Cover (LULC)

LULC is an important parameter for site suitability analysis as it provides insights into the existing land condition, human activity, and inherent potential for ecological restoration. AHP suitability ratings were assigned to each LULC class based on its appropriateness as a target for new plantation interventions aimed at rehabilitation and erosion control. Non-vegetated or built-up features, such as Water bodies, Railways, Nala, Village Road, National Highways, and Settlements, were assigned a very low suitability score of 1, as they are restricted areas where plantation is not possible. Agricultural lands were similarly rated low (1) to avoid disrupting their productive use. The existing vegetation on overburden dumps was also assigned a very low suitability rating of 1 for a new plantation, as these areas are already under some form of rehabilitation and are not primary targets for additional interventions.

Conversely, degraded lands requiring urgent rehabilitation were assigned high suitability scores. Barren lands were assigned the highest suitability rating of 5, identifying them as prime targets for plantation due to their lack of vegetative cover and high erosion susceptibility. Mining areas, classified as severely disturbed and erosion-prone sites that exhibit a critical long-term need for restorative efforts, but mining areas were determined to possess very low suitability for immediate plantation due to ongoing mining activities. Overburden dumps, another significantly disturbed category, received a high suitability rating of 4. Areas with Sparse Vegetation and existing Vegetation were assigned moderate suitability ratings of 3, indicating potential for enrichment planting but lower priority for large-scale new plantations compared to severely degraded lands.

7.2.1.4 Drainage Distance

Proximity to drainage channels significantly affects plantation viability by influencing moisture availability and rooting conditions. In the present study, a 5-meter buffer on either side of drainage lines was excluded from plantation consideration due to high runoff concentration zones that may destabilize.

Beyond this buffer, the landscape was stratified into suitability zones based on proximity. Areas within 0 – 30 m (excluding the 0 – 5 m buffer) from drainage lines were rated very high (5), offering optimal moisture without erosion risk. Zones between 30 – 100 m were rated high (4), while 100 – 250 meters were rated moderate (3). Areas beyond 250 meters, where moisture support diminishes, were considered low suitability (1). This classification balances hydrological benefit with risk mitigation of plantation success.

7.2.1.5 Erosion Potential Zone

The EPI quantifies susceptibility to soil erosion and thus, guides prioritization for vegetative intervention. While low erosion areas present lesser risks, high erosion zones demand urgent stabilization through the plantation. Accordingly, areas with very high EPI values > 4.12 were assigned top suitability scores (5), reflecting their need for soil-binding vegetation. Conversely, low-risk areas with EPI < 3.38 were assigned lower suitability scores (1), as they are not immediate targets for erosion control. This logic ensures resource allocation is aligned with landscape vulnerability.

Table 7.1: Parameters for Site Suitability Analysis and their Influence on Plantation

Parameter	Influence on Plantation Suitability
Slope (Degree)	Governs surface runoff velocity and soil stability. Lower slopes (gentle terrain) enhance water infiltration and reduce erosion, promoting easier establishment and survival of planted vegetation. Higher slopes pose increased erosion risk and logistical challenges for the plantation.
Soil Type	Directly impacts plant growth and survival through its influence on water retention capacity, aeration, and nutrient availability. Optimal soil types (e.g., Loam) provide balanced conditions for root development and moisture supply.
Land Use/Land Cover (LULC)	Reflects the existing land condition and its degradation status. Degraded or barren lands (e.g., overburden dumps, barren lands) are highly susceptible to erosion and represent primary targets for rehabilitation through plantation.
Drainage Distance	Proximity to natural drainage lines ensures access to soil moisture, which is vital for plant establishment and growth, particularly during the periods other than the monsoon season. Closer proximity generally indicates higher suitability due to enhanced water availability.
Erosion Potential Index (EPI)	Quantifies the inherent susceptibility of an area to soil erosion. Higher EPI values indicate greater erosion risk, identifying critical zones where plantation interventions are most urgently required to stabilize soil and prevent further degradation.

Table 7.2: Reclassification Criteria and Suitability Scores for Thematic Layers

Parameter	Sub-Criteria	Class Name	Suitability Score (AHP Rating 1–5)
Slope	< 2 Degrees	Very High	5
	3 – 5 Degrees	High	4
	6 – 10 Degrees	Moderate	3
	10 – 20 Degrees	Low	2
	> 20 Degrees	Very Low	1
Soil Type	Loam	Very High	5
	Sandy Clay Loam	Moderate	3
Land Use/Land Cover (LULC)	Barren lands	Very High	5
	Overburden	High	4
	Sparse Vegetation	Moderate	3
	Waterbody including Nalla	Very Low	1
	Railways	Very Low	1
	Village Road	Very Low	1
	National Highways	Very Low	1
	Agricultural Land	Very Low	1
	Settlements	Very Low	1
	Plantation on Overburden	Very Low	1
	Mining	Very Low	1
Drainage Distance	0 – 30 m (excluding 0-5 m buffer)	Very High	5
	30 – 100 m	High	4
	100 – 250 m	Moderate	3
	> 250 m	Very Low	1
Erosion Potential Index (EPI)	> 3.50	Very High	5
	3.21 – 3.50	High	4
	2.91 – 3.20	Moderate	3
	< 2.90	Low	1

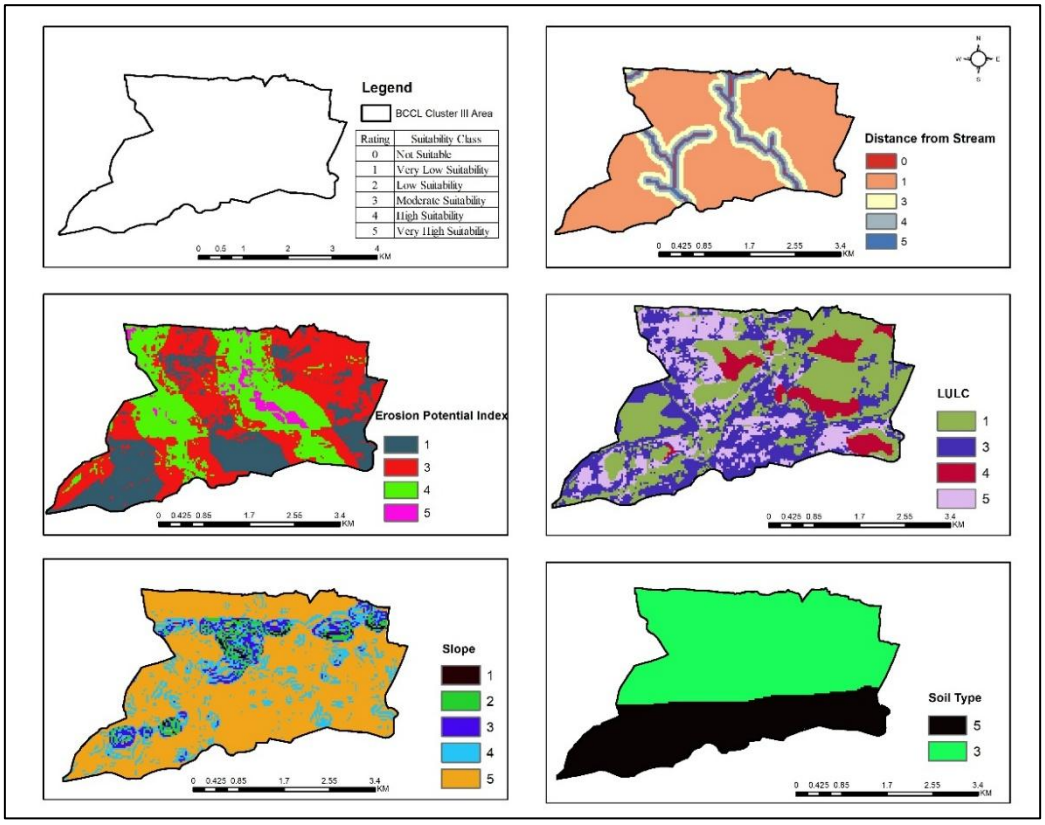


Fig. 7.2: Thematic Layers Used for Plantation Site Suitability Analysis in Cluster-III, Govindpur Area, BCCL

7.2.2 Weight Assignment Using AHP

The integration of thematic layers for plantation suitability analysis was enabled through the AHP, a structured multi-criteria decision-support technique used to derive criteria weights based on expert-driven pairwise comparisons. This methodological step builds upon the procedures described in Sections 6.2.4 and 6.2.5 of Chapter 6, where the construction of the AHP matrix and the operationalization of the WOA were previously outlined in detail.

In this chapter, five key thematic raster layers, slope, LULC, soil type, drainage distance, and erosion potential, were utilized to model plantation suitability. Each layer was first reclassified into discrete suitability classes and assigned a corresponding suitability score ranging from 1 (Very Low Suitable) to 5 (Very High Suitable), based on its influence on plantation success. These scores were then combined with AHP-derived criteria weights, which quantify the relative importance of each parameter as

determined through expert judgement. The complete pairwise comparison matrix and the resulting normalized weights for each parameter are presented in Table 7.3.

The integration of all weighted raster layers was conducted using the WOA tool in ArcGIS 10.2.2, which enables the normalization and aggregation of diverse spatial criteria onto a common evaluation scale. This technique is particularly effective for complex land suitability assessments in heterogeneous landscapes such as those influenced by coal mining activities.

To ensure comparability, all input rasters were standardized to the same scale (1 to 5), and each pixel value was multiplied by its corresponding criteria weight. The final Plantation Suitability Area (PSA) was computed through cell-wise summation of these weighted values using the Eq. 7.1.

$$\boldsymbol{PSA = \sum_{i=1}^{n} (W_i \times C_i)} \quad \textbf{..... (Eq. 7.1)}$$

Where, *PSA* = Final plantation suitability area, W_i = Weight of the ith parameter, C_i = Reclassified suitability score of the ith parameter, and, n = Total number of parameters. The resulting composite suitability index values were then grouped into five final suitability classes namely, Very Low, Low, Moderate, High, and Very High.

Table 7.3: AHP matrix for assigning weight to each parameter of PSA

Criteria	Land Use/Land Cover	Soil type	Slope (degree)	Erosion Potential Zone	Drainage Distance	Criteria Weight (CW)
Land Use/Land Cover	1	5	3	2	4	0.44
Soil type	0.2	1	2	1	2	0.17
Slope (degree)	0.33	0.5	1	1	2	0.14
Erosion Potential zone	0.5	1	1	1	2	0.17
Drainage Distance	0.25	0.5	0.5	0.5	1	0.08

7.3 Results and Discussion

The plantation suitability assessment was undertaken using the FAO land evaluation framework, integrated with a GIS-based multi-criteria evaluation approach. The Weighted Overlay Analysis (WOA), incorporating AHP-derived weights and parameter-specific scores, generated a spatially explicit Plantation Suitability Map (PSM) (Fig. 7.3). The final classification delineated the study area into five suitability categories: Very High, High, Moderate, Low, and Very Low. This stratification enables a prioritized ecological restoration strategy for degraded lands in the Cluster-III region.

7.3.1 Spatial Distribution of Suitability Classes

The spatial distribution of suitability classes was derived from the integrated overlay of five biophysical parameters: slope, land use/land cover (LULC), soil type, drainage proximity, and erosion potential. The areal extent of each class is summarized in Table 7.4.

Table 7.4: Areal Distribution of Plantation Suitability Classes

Suitability Class	Value	Pixel Count	Area (ha)	Percentage (%)
(Unsuitable)	0	347	31.24	2.20
Very Low	1	138	13.42	0.87
Low	2	5002	450.18	31.69
Moderate	3	5949	535.41	37.69
High	4	3959	356.31	25.08
Very High	5	390	35.1	2.47

The final site suitability map (Fig.7.3) clearly illustrates spatial variation in plantation feasibility, with a significant concentration of suitable land occurring along either side of the higher-order drainage channels. These zones are characterized by favourable biophysical conditions such as moderate slopes and accessible moisture regimes, all of which enhance the potential for successful plantation development. Approximately 69.38% of the total study area falls within the moderate to low suitability classes. These areas present moderate constraints for eco-restorative plantation interventions and may require additional site-specific treatments or conservation measures to improve

feasibility. On the other hand, a substantial 25.08% of the land area is categorized as highly suitable for plantation efforts. These zones are typically found in proximity (within 100 meters) to drainage lines and are often characterized by barren or fallow lands with gentle to moderate slopes, offering optimal conditions for eco-restorative initiatives.

In stark contrast, only 2.20% of the area is classified as unsuitable for plantations. These zones are primarily located within immediate buffer zones of drainage channels, where high surface runoff and frequent inundation hinder vegetation establishment and long-term plant survival.

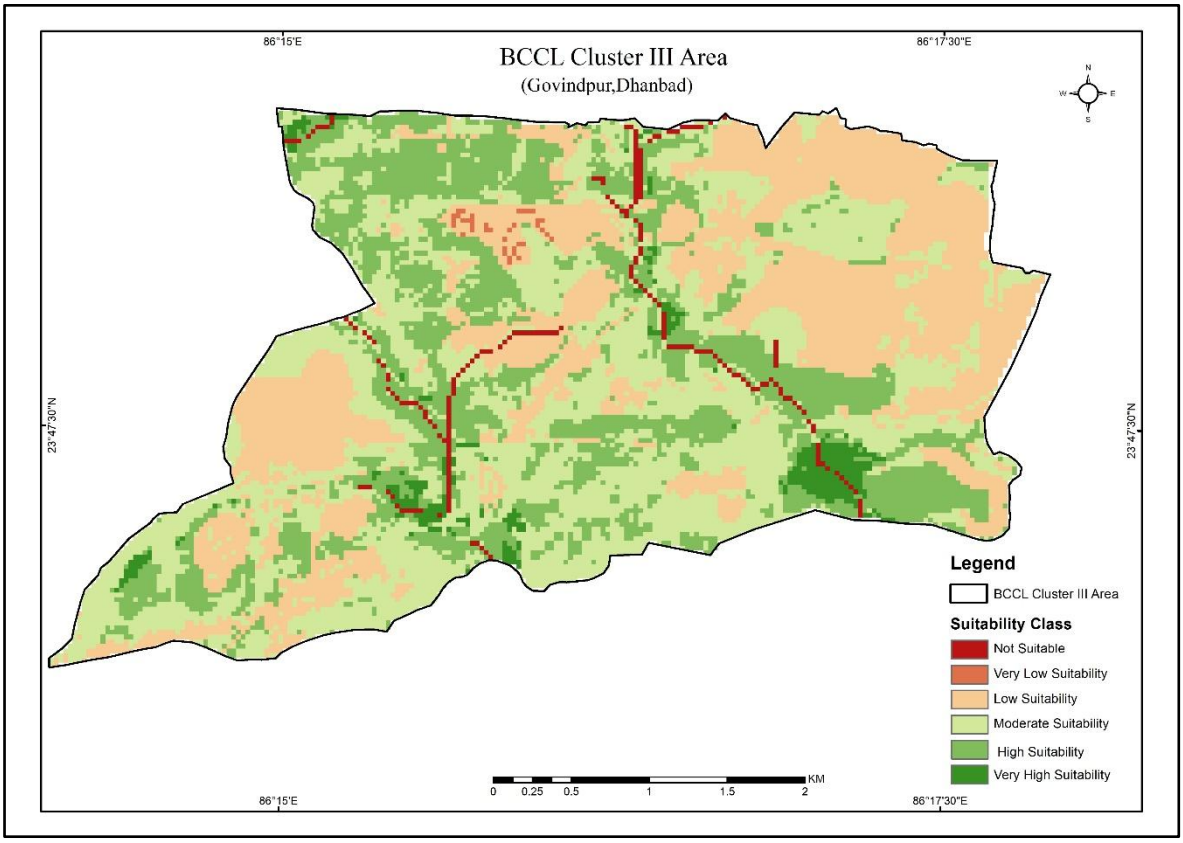


Fig. 7.3: The final Site Suitability Map for Plantation sites in Cluster-III Area

7.3.2 Delineation of Priority Zones

The Very High suitability class (Value = 5) was used to delineate plantation priority zones. These areas (35.1 ha; 390 pixels) represent optimal combinations of barren land, drainage proximity, loamy to sandy clay soils, and moderate erosion risk. The

identified zones were digitized and validated against high-resolution Google Earth imagery. Their spatial extent is shown in Fig. 7.4.

Within these zones, three plantation sites (PS-1 to PS-4) were identified (Fig. 7.4). While the GIS–AHP model initially classified all sites as highly suitable, but field visits and ground verification revealed the following observations:

PS-1 (23°48′30.70″N, 86°15′3.58″E): Not feasible, as the site is designated for a proposed opencast mining operation.

PS-2 (23°47′53.29″N, 86°16′28.86″E): Partially feasible. Based on the field assessments, areas located at the left side of the National Highway (NH) may be considered for plantation.

PS-3 (23°47′12.57″N, 86°15′38.89″E): Not feasible. Field verification confirmed that the land belongs to the Indian Railway and falls under the proposed mining expansion.

PS-4 (23°47′17.94″N, 86°17′5.62″E): Not feasible, owing to overlap with the existing mining activities.

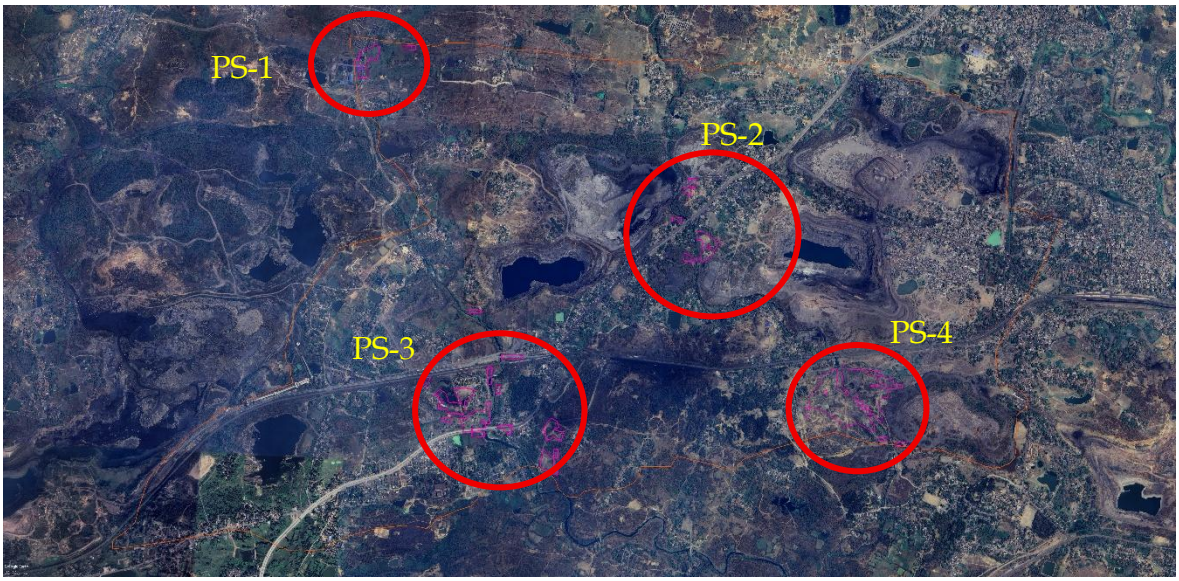


Fig. 7.4: ***Locations of the Plantation Zones in Cluster-III, Govindpur Area, BCCL***

7.4 Conclusion

The GIS–AHP plantation suitability model effectively delineated potential areas for eco-restorative interventions in the Cluster-III mining landscape. However, field visits revealed that land-use conflicts significantly constrain actual feasibility. Specifically, three sites (PS-1, PS-3, and PS-4) were deemed unfeasible due to overlaps with proposed & existing mining activities and railway land, while a portion of PS-2, situated on the left side of the NH, remains viable for plantation efforts.

These findings underscore the importance of integrating spatial modelling with rigorous field validation, ensuring that eco-restorative planning is grounded in both biophysical suitability and socio-economic realities. The results also emphasize the dynamic challenges of restoration planning in mining-affected areas, where operational activities frequently override biophysical potential. The approach demonstrated here thus, offers a replicable framework for prioritizing ecological interventions in complex and contested landscapes.



Chapter 8: Analysis of water quality parameters to ascertain the impact of mining upon local water quality

8.1 Introduction

Mining activities, particularly related to coal mining, have long been recognized as a major anthropogenic source of surface and groundwater contamination, especially in mineral-rich regions like Jharkhand, India. The Govindpur area, falling under Cluster-III of the Bharat Coking Coal Limited (BCCL) operational zone in Dhanbad district, is characterized by both open-cast and underground coal mining. This region is hydrologically influenced by the Khudia Nala, Bagdighi Nala, and by the discharge of mine water, all of which serve as the sources for agricultural and other ecological purposes.

The interaction between mining operations and the surrounding hydrological systems may result in the mobilization of various contaminants, including suspended solids, sulphates, nitrates, colours, phenolic compounds, etc. These pollutants significantly alter the physicochemical properties of water bodies, by degrading their quality and posing risks to aquatic ecosystems and human health. The Khudia and Bagdighi Nala, in particular, receive both surface runoff and effluents from mining sites, while the pumped-out mine water is often directly released into these streams or surrounding lowland areas.

Therefore, this chapter of the present study aims to systematically analyse key water quality parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), sulphates, nitrates, fluoride, and other parameters to evaluate the extent of mining-induced impacts on water quality in the Govindpur area. By comparing the observed values against standard permissible limits and identifying spatial trends, the study seeks to provide a scientific basis for understanding the environmental implications of mining and to support sustainable water resource management in the region.

8.2 Water Sampling from the Study Area

Water samples were collected from five locations to assess the impact of coal mining on local water quality of the study area. The five locations are (i) Upstream of Khudia Nala (SW1, surface water), (ii) Downstream of Khudia Nala (SW2, surface water), (iii) Upstream of Bagdighi Nala (SW3, surface water), (iv) Downstream of Bagdighi Nala (SW4, surface water), and (v) Mine Water at Cluster-III area (MW, groundwater). The mine water (MW) is basically the seepage water that is accumulated inside the mine pits and thus, this has been considered as the groundwater in the present study.

The selection of five specific sampling locations in the Cluster-III, Govindpur area of BCCL is scientifically rational and strategically optimized to evaluate the spatial and anthropogenic influence of mining on local water quality. These sites were chosen to ensure comprehensive representative sampling of both surface water and direct mine effluents (groundwater) within the study area.

The Khudia and Bagdighi Nala are the two principal surface water bodies passing through the mining region, making them hydrologically and environmentally significant receptors of potential contamination from mining operations. By incorporating both upstream (SW1 and SW3) and downstream (SW2 and SW4) points of each of the two water bodies, the sampling design facilitates a gradient-based analysis that distinguishes natural baseline water quality from downstream degradation attributable to mining discharge, sediment runoff, and associated anthropogenic activities. This upstream–downstream comparative approach is widely recognized in environmental monitoring for its effectiveness in identifying pollution sources and quantifying their impacts. The inclusion of the mine water sample (MW) provides critical information on the physicochemical characteristics of effluents discharged directly from the mining operation, serving as a control to correlate observed changes in surface water quality with specific pollutants originating from mining activities. Such a source-pathway-receptor linkage enables a mechanistic understanding of contaminant transport within the aquatic environment. Moreover,

the sampling strategy is scientifically consistent and ensures feasibility, cost-effectiveness, avoids redundancy, and focuses on hydrologically relevant locations. This aligns with national and international environmental monitoring guidelines (e.g., CPCB, MoEF&CC), which advocate for representative sampling along critical exposure pathways to support impact assessment and regulatory compliance. Therefore, the selected five sampling points provide a balanced, scientifically robust, and practically implementable framework for assessing the impact of coal mining on local water resources in the study area.

8.3 Methodology of sampling and analysis

Water samples were collected as per the standard method. The surface and mine water samples were collected and analysed in the laboratory of the Department of Environmental Science and Engineering, IIT(ISM), Dhanbad. The water quality parameters and their measured values (in triplicate) are presented in the Table 8.1. The sampling locations have been shown in Fig. 8.1.

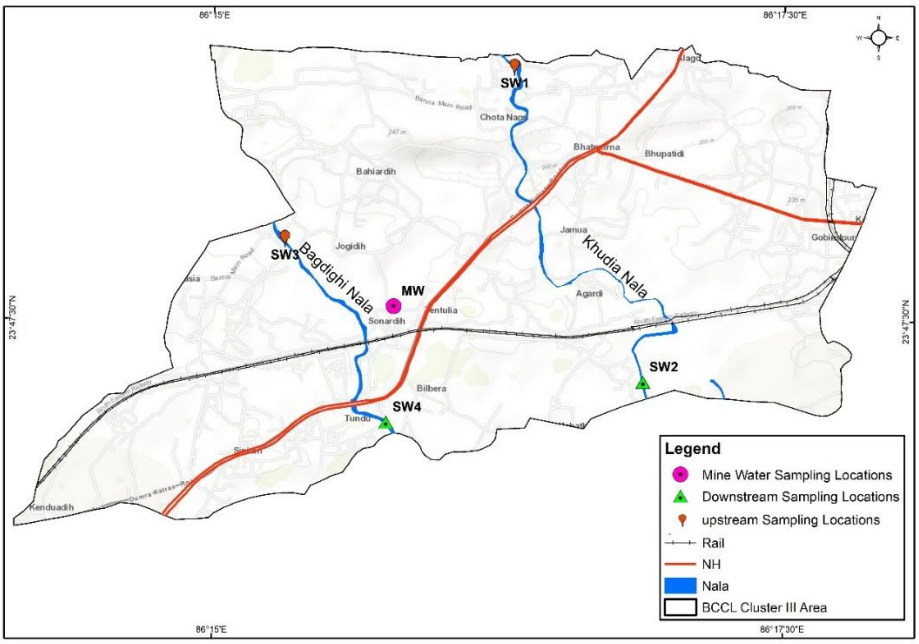


Fig. 8.1: Water sampling locations at upstream (SW1 & SW3) & downstream (SW2 & SW4) of Khudia and Bagdighi Nalas and Mine Water (MW)

Table 8.1: Results of the surface water and mine water (groundwater) quality analysis

Water Quality Parameters	SW1	SW2	SW3	SW4	IS: 2296 INLAND SURFACE WATER [1982] Class 'C	MW	MOEF -SCH-VI STANDARDS Class 'A'
PH	6.62	7.02	7.1	7.41	6.5-8.5	7.18	5.5 to 9.0
TDS (ppm)	486	790	476	651	1500	872	_
EC (µS/cm)	686	1090	670	918	-	1202	_
Alkalinity (mg/L as $CaCO_3$)	260	246	240	250	-	438	_
Hardness (mg/L as $CaCO_3$)	314	386	352	366	-	840	_
Salinity (ppt)	245	348	264	358	-	497	_
Colour (Hazen Units)	1	2	1	1	10	1	_
Nitrate (mg/l)	38.22	35.50	24.14	36.62	50	<0.5	10
Sulphate (mg/l)	262.30	356	236	342	400	46	_
Fluoride (mg/l)	0.46	0.68	0.34	0.48	1.5	0.52	2
Phenolic compounds (mg/l, as C_6H_5OH)	<0.002	<0.002	<0.002	<0.002	0.005	<0.001	_

8.4 Results & Discussions

The detailed assessment of water quality parameters at the upstream (SW1 and SW3) and downstream (SW2 and SW4) locations of Khudia and Bagdigi Nala, along with mine water (MW) from the study area, reveals an anthropogenic influence of mining activities on local surface water systems. Upstream, water samples at SW1 (Khudia Nala) and SW3 (Bagdigi Nala), show relatively lower concentrations of the water quality parameters, indicating minimal disturbance and representing natural background conditions. In contrast, downstream sites, SW2 and SW4, exhibit slight deterioration in water quality, with increases in total dissolved solids (TDS), electrical conductivity (EC), salinity, alkalinity, and hardness. The results of various individual water quality parameters are discussed below for both surface water and mine water.

8.4.1 pH:

The pH levels across all surface water samples (SW1–SW4) remained within the acceptable range of 6.5 to 8.5 as prescribed by IS:2296:1982 (BIS standard for inland surface water quality), indicating a near-neutral nature of the water bodies. Specifically, Khudia Nala recorded pH values of 6.62 upstream (SW1) and 7.02 downstream (SW2), while Bagdighi Nala showed slightly higher readings of 7.1 upstream (SW3) and 7.41 downstream (SW4). The pH of mine water (MW) was measured at 7.18, which also falls well within the permissible limits of 5.5 to 9.0 set under Schedule VI of the Environment (Protection) Rules, 1986 by MoEFCC for effluent discharge. These consistent results suggest that mining operations in the Govindpur Cluster-III region have not significantly influenced the acid–base balance of local surface or mine water systems.

8.4.2 Total Dissolved Solids (TDS):

TDS values across surface water samples ranged from 476 ppm to 790 ppm, remaining below the IS:2296 permissible limit of 1500 ppm. However, a noticeable increase in TDS was observed at downstream locations, which reflects the contribution of dissolved minerals from mining activities. In Khudia Nala, TDS increased from 486 ppm at SW1 to 790 ppm at SW2, and in Bagdighi Nala, from 476 ppm (SW3) to 651 ppm (SW4). The mine water (MW) sample exhibited a TDS concentration of 872 ppm, which, while exceeding the acceptable drinking water limit of 500 ppm, remains well within the general permissible threshold of 2000 ppm for groundwater and mine effluents.

8.4.3 Electrical Conductivity (EC):

Electrical conductivity values in surface water ranged from 670 µS/cm to 1090 µS/cm, indicating moderate ionic concentration. Although, IS:2296 standard does not prescribe a standard for EC, a clear upward trend was evident at downstream points SW2 (1090 µS/cm) compared to SW1 (686 µS/cm), and SW4 (918 µS/cm) versus SW3 (670 µS/cm). Mine water exhibited the highest EC at 1202 µS/cm. This elevated EC signifies an

increased ionic burden associated with mining activities and mineral dissolution processes.

8.4.4 Alkalinity:

The alkalinity of surface water samples, expressed as $CaCO_3$, ranged between 240 mg/L and 260 mg/L. Though IS:2296 standard does not specify a limit for alkalinity, elevated values were found at downstreams (SW2: 246 mg/L, SW4: 250 mg/L), compared to upstream sites (SW1: 260 mg/L, SW3: 240 mg/L). Mine water recorded a substantially higher alkalinity of 438 mg/L, which exceeds the acceptable limit of 200 mg/L and approaches the upper threshold of 600 mg/L. The increase in alkalinity is likely due to carbonate dissolution and buffering reactions facilitated by coal seam interactions with water.

8.4.5 Hardness:

Surface water hardness varied between 314 mg/L and 386 mg/L, though it is not regulated under IS:2296 standards. Minor increase in hardness was observed at downstreams, with Khudia Nala showing a rise from 314 mg/L (SW1) to 386 mg/L (SW2), and Bagdighi Nala from 352 mg/L (SW3) to 366 mg/L (SW4). Mine water exhibited high hardness at 840 mg/L. This might have resulted due to leaching of calcium and magnesium ions from geological formations.

8.4.6 Salinity:

Salinity, measured in milligrams per liter (mg/L), ranged from 245 mg/L to 358 mg/L in surface water. Although the IS:2296 standard does not prescribe limits for salinity, the increasing concentrations at downstream locations—348 mg/L at SW2 and 358 mg/L at SW4 compared to 245 mg/L (SW1) and 264 mg/L (SW3) upstream—suggest salt accumulation, likely influenced by mining runoff. Mine water exhibited an even higher salinity of 497 mg/L, indicating a strong influence of anthropogenic salt loading with potential implications for aquatic ecosystems and water usability.

8.4.7 Colour:

The color of surface water samples, measured in Hazen Units, remained low across all sites (1–2 Hazen Units), well within the IS:2296 aesthetic limit of 10 Hazen Units for surface water. Mine water also exhibited minimal coloration (1 Hazen Unit), complying with the permissible limit of 5 Hazen Units specified under Schedule VI of the Environment (Protection) Rules, 1986 (MoEFCC). This indicates negligible visual impact or discoloration due to mining activities, despite underlying chemical alterations in water quality..

8.4.8 Nitrate (NO_3^-):

Nitrate concentrations in surface water ranged from 24.14 mg/L to 38.22 mg/L, remaining below the IS:2296 permissible limit of 50 mg/L for Class 'C' inland surface waters. Notably, elevated nitrate levels were observed at both upstream (SW1: 38.22 mg/L) and downstream (SW2: 35.50 mg/L) locations of Khudia Nala, and to a lesser extent in Bagdighi Nala (SW4: 36.62 mg/L). The relatively high values at upstream sites might have resulted from non-mining sources such as agricultural runoff, domestic sewage intrusion, or nutrient leaching from the surrounding catchment, rather than from mining activities. In contrast, the mine water (MW) sample showed a very low nitrate concentration (<0.5 mg/L), well below the MOEF SCH-VI standard of 10 mg/L, confirming that mining effluents are not a significant contributor to nitrate levels in the region's water bodies. These findings highlight the role of land use practices and sanitation conditions in influencing nutrient loads, particularly in upstream stretches outside of the mine lease area).

8.4.9 Sulphate (SO_4^{2-}):

Sulphate levels in surface water ranged from 236 mg/L to 356 mg/L, all within the IS:2296 standard permissible limit of 400 mg/L. Higher concentrations were evident in downstream locations SW2 (356 mg/L) and SW4 (342 mg/L), likely due to oxidation of sulphide-bearing rocks exposed during mining. Mine water showed a comparatively

low sulphate level of 46 mg/L, indicating that localized sulphate enrichment mainly affects the surrounding surface water rather than direct mine discharge.

8.4.10 Fluoride (F^-):

Fluoride levels in all surfaces and mine water samples were below respective permissible limits. Surface water fluoride concentrations ranged from 0.34 mg/L to 0.68 mg/L, and mine water had a value of 0.52 mg/L, well within the IS:2296 standard limit of 1.5 mg/L and MOEF SCH-VI standard of 2 mg/L. These results suggest minimal fluoride pollution and indicate that mining operations do not significantly influence fluoride concentrations in the region.

8.4.11 Phenolic Compounds:

Phenolic compounds in surface water were found to be below 0.002 mg/L, and in mine water, below 0.001 mg/L. These values are significantly under the IS:2296 standard permissible limit of 0.005 mg/L for surface water and the MOEF SCH-VI limit of 0.002 mg/L for mine water. The extremely low concentrations indicate that phenolic contamination is not a concern in the study area, and mining activities are not contributing to organic pollutant loads in this category.

8.5 Conclusion

The analysis demonstrates that mining activities in the Govindpur Cluster-III region are exerting measurable physicochemical pressure on local water bodies, particularly evident in parameters such as Total Dissolved Solids (TDS), Electrical Conductivity (EC), hardness, and alkalinity, with downstream sites consistently reflecting higher as compared to upstream. While the overall quality of local water bodies remains within permissible limits, certain parameters—specifically TDS and EC—were notably elevated at downstream locations compared to upstream reference points, suggesting localized impacts from mining activities. However, other parameters such as pH, color, nitrate, sulphate, fluoride, and phenolic compounds remained within acceptable

regulatory thresholds, indicating only partial or site-specific effects. These findings underscore the need for continuous water quality monitoring and the implementation of mitigation measures, including proper effluent treatment and runoff control, to safeguard surface water resources in mining-influenced zones.



Chapter 9: Final Recommendations for Preparation of the Watershed Management Plan for Cluster-III, Govindpur Area, BCCL, Dhanbad

9.1 Introduction

Integrated watershed management has emerged as a critical pillar of sustainable environmental governance, particularly in areas where Land-use Land Cover transformation is very frequent. Mining-impacted landscapes are especially vulnerable to hydrological imbalances, accelerated soil erosion, and long-term ecosystem instability. In this context, the development and implementation of spatially explicit, scientifically grounded strategies is essential not only to mitigate existing environmental risks but also to guide future operational planning and policy integration.

This study is based on geospatial technology, environmental modelling, and climate-adaptive land management. Through the integration of advanced tools such as remote sensing, digital terrain analysis, hydrological modelling, and multi-criteria evaluation, the study establishes a comprehensive and systems-based approach for watershed planning for the present study area, i.e., Cluster-III, Govindpur Area, BCCL. The methodology recognizes the interrelated dynamics of terrain morphology, land cover patterns, rainfall variability, and anthropogenic interventions, offering an actionable framework for ecological restoration and resource optimization.

A distinctive contribution of this study is its application of multiple modelling techniques, namely morphometric analysis, the Revised Universal Soil Loss Equation (RUSLE), the Soil Conservation Service Curve Number (SCS-CN) method, and climate projection scenarios to understand current and future watershed behaviors. The Analytic Hierarchy Process (AHP) also enables a transparent, object-oriented, and spatially optimized prioritization of areas suitable for conservation structures and afforestation.

Beyond its technical contributions, the study aligns with broader national and institutional policy frameworks such as Environmental Management Plans (EMPs), mine closure guidelines, and climate adaptation strategies. By demonstrating the applicability of geospatially enabled and science-driven approaches to long-term planning & decision support systems, the study offers a replicable model for integrated watershed management in other resource-intensive regions. The analytical components of watershed delineation, erosion risk zoning, runoff modeling, and land suitability analysis collectively inform a climate-adaptive, operationally feasible, and policy-aligned watershed management plan for Cluster-III in the Govindpur Area of BCCL.

The final set of strategic recommendations presented in the following sections is grounded in the detailed, multi-dimensional analysis conducted throughout this study. Each preceding chapter has identified critical environmental and hydrological challenges to the Cluster-III region. The morphometric analysis (Chapter 2) revealed that those micro-watersheds with steep gradients and complex drainage networks are increasingly vulnerable to runoff and erosion. Rainfall-runoff modelling (Chapter 3) demonstrated pronounced spatial and temporal variability, with watersheds draining into Khudia and Bagdighi Nala showing particularly high runoff during peak rainfall years like 2024. Near-future climate projections (Chapter 4) indicate a slight increase in daily rainfall intensity, which is expected to intensify surface runoff and exacerbate soil erosion. The soil erosion assessment (Chapter 5) identified over 31.91 % of the area as being at high to very high erosion risk, particularly in exposed and disturbed mining zones. Suitability analyses (Chapters 6 and 7) underscored the need for strategically placing conservation structures and plantations, as few high-risk zones are currently inadequately managed. Finally, water quality evaluations (Chapter 8) indicated that the quality of local water bodies remains within permissible limits; however, some parameters such as TDS and conductivity were elevated compared to upstream reference points, suggesting localized impacts from mining activities.

These insights reinforce the necessity of implementing a scientifically informed, spatially targeted, and climate-resilient watershed management plan to address the challenges and opportunities within the Cluster-III mining landscape. The following sections outline the final set of strategic recommendations derived from this comprehensive analysis. These recommendations directly and indirectly respond to the challenges identified in the previous chapters and represent actionable measures necessary to address the study area's current and emerging environmental concerns.

9.2 Soil Erosion Risk Reduction and Sediment Control

In the fifth objective (Chapter 5), the RUSLE-based modelling identified that more than 31.91% of the landscape falls under high and very high erosion potential zones. These areas, particularly overburden dumps and exposed mining slopes, are critically vulnerable and require stabilization. Recommended interventions, such as constructing check dams along natural drainage channels and contour bunding around the unstable overburden, are advised. These measures will help mitigate soil loss, enhance slope stability, and support long-term ecological restoration in mining-disturbed areas.

9.3 Suitability for Conservation Structures

A crucial component of the watershed management strategy for Cluster-III is the identification and prioritization of locations suitable for implementing soil and water conservation structures. Using a GIS-based Multi-Criteria Evaluation (MCE) framework integrated with the Analytic Hierarchy Process (AHP), eight key biophysical parameters viz. slope, land use/land cover, soil texture, drainage density, runoff potential, erosion risk, and proximity to drainage lines, were analysed to generate a spatial suitability model. The AHP framework achieved a high consistency ratio (CR = 0.021), indicating reliable weight assignments and internal coherence.Field validation of the model outputs confirmed the appropriateness of two categories of conservation structures for this mining-impacted watershed: check dams and contour bunds (retention walls). These structures were identified as ecologically and

geomorphologically relevant for regulating runoff, reducing erosion, and stabilizing overburden dumps.

Check Dams (CDs): The suitability model initially identified three locations for check dams. Field surveys confirmed the presence of existing check dams at two sites (CD1 and CD2), thereby validating the predictive accuracy of the model. The third location (CD3), although delineated as highly suitable due to its hydrological convergence and favourable slope conditions, was found unsuitable during field visits for constructing check dam due to existing and proposed coal mining activities.

CD1 (23°48′21.35″N, 86°16′21.20″E): Existing check dam (validated).

CD2 (23°47′05.29″N, 86°15′45.48″E): Existing check dam (validated).

CD3 (23°47′26.96″N, 86°17′02.33″E): Initially identified as suitable but excluded due to existing and proposed coal mining activities.

For a comprehensive discussion and validation details, it is suggested to refer Section 6.3.3: Identification and Validation of Intervention Sites. Fig. 9.1 shows the spatial distribution of the identified check dam sites in Cluster-III. CD1 and CD2 represent existing check dams (validated), while CD3 was initially identified by the analysis but excluded during field verification due to existing and proposed coal mining activities.

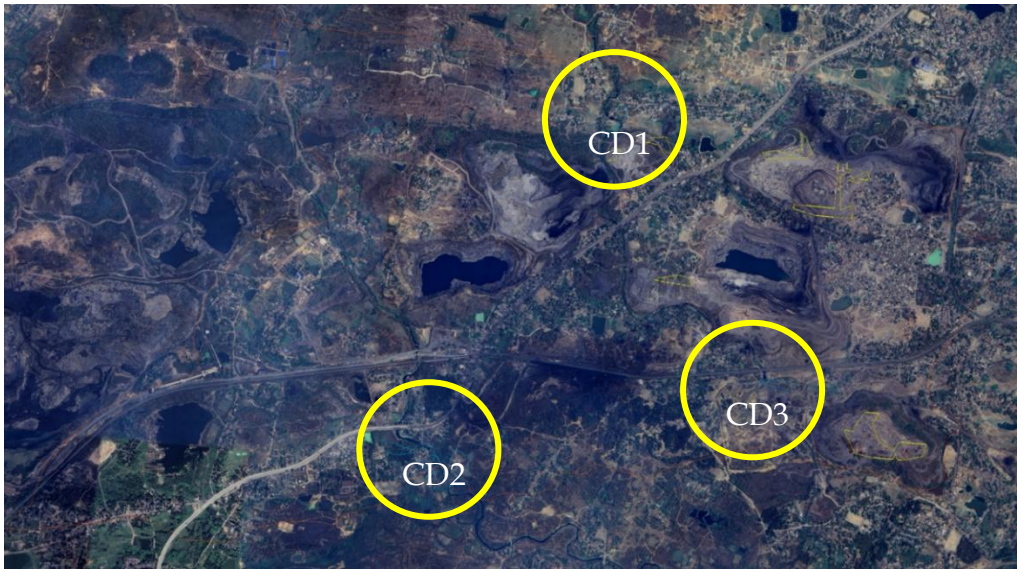


Fig. 9.1: Location map of (CD1–CD3)

Identification of Contour Bunding / Retention Wall Sites: The model further delineated four sites as suitable for contour bunding. These structures act as slope-aligned retention walls to intercept runoff, reduce flow velocity, promote infiltration, and prevent erosion of soil and overburden. In mining-impacted areas, they also stabilize loose dumps and reduce sediment inflow into drainage channels.

Field verification was done to verify the model outputs that led to the following site-specific recommendations:

- **CB1 (23°47′15.88″N, 86°17′14.74″E):** New bund construction is strongly recommended at this site. Field inspection revealed concentrated runoff and significant erosion risks impacting the adjoining Bagdighi Nala. A retention wall of approximately 850 m in length is proposed to stabilize the soil, enhance water conservation and to minimize erosion potential.
- **CB2 (23°48′13.05″N, 86°17′18.57″E):** Although, this site was identified as suitable during the analysis but, this site is located near active mining and overburden dumps. Any constructed bund at this site may be destabilized due to the existing mining activities as the mining operations are progressing towards the proposed site located at CB2. Thus, the site CB2 is unsuitable for constructing contour bund.
- **CB3 (23°47′48.21″N, 86°16′39.37″E):** An existing bund of approximately 450 m was observed at this site, validating the model's prediction. However, reinforcement and possible extension are recommended to improve its effectiveness and ensure long-term stability.
- **CB4 (23°48′13.47″N, 86°16′20.12″E):** Partial bunding of approximately 250 m already exists at this location, further validating the model's output. It is recommended that the bund be strengthened and extended by an additional 150 m to provide enhanced protection against erosion and overburden movement.

- For a comprehensive discussion and validation details, it is requested to refer Section 6.3.3: Identification and Validation of Intervention Sites. Fig. 9.2 presents the location map of CB1–CB4.

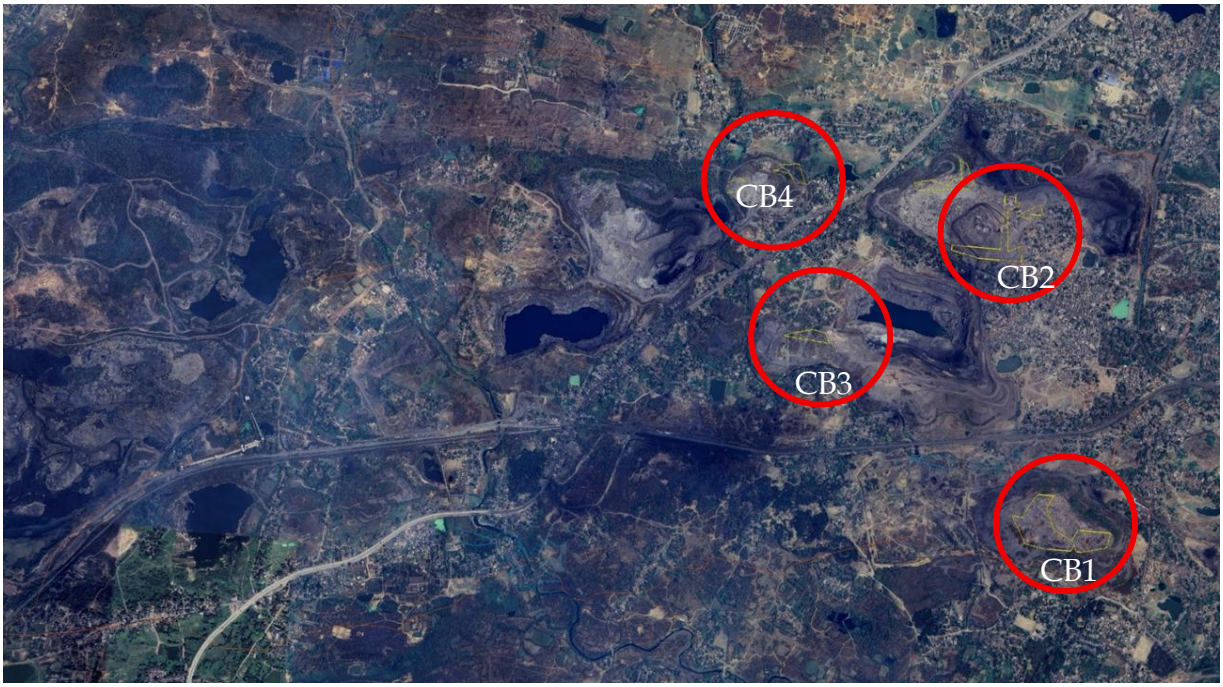


Fig. 9.2: Location map of CB1–CB4.

The spatial distribution of check dams and contour bunding sites highlights the dominant role of parameters such as runoff potential, erosion potential, and field validation in driving the final site suitability. The validation of existing structures (CD1, CD2, CB3, CB4) lends strong credibility to the model outputs, while the exclusion of sites such as CD3 and CB2 underscores the importance of field verification in mining landscapes. The identification of retention walls is particularly significant for mining reclamation, as they provide dual benefits: reducing soil erosion and runoff while stabilizing overburden dumps. Together with check dams, these structures form a complementary strategy to enhance soil moisture retention, control sediment transport, and support agricultural productivity in reclaimed areas. These outputs are of direct operational relevance for BCCL Environmental Management Plans (EMPs), providing scientific guidance for design, phasing, and budgeting of eco-hydrological interventions in the Cluster-III watershed.

9.4 Afforestation and Ecological Restoration

Afforestation and ecological restoration represent critical components of integrated watershed management, particularly in coal mining-impacted landscapes where degradation, erosion, and disruption of ecological services are evident. Following the objective of identifying and prioritizing suitable plantation sites, a comprehensive land evaluation was undertaken using the FAO framework integrated with GIS-based multi-criteria decision-making. This approach generated a spatially explicit Plantation Suitability Map (PSM) for the Cluster-III region of the Govindpur Area, BCCL.The analysis incorporated five biophysical parameters viz. slope, land use/land cover (LULC), soil type, proximity to drainage, and erosion potential with their relative weights derived using the Analytic Hierarchy Process (AHP). The Weighted Overlay Analysis (WOA) classified the study area into five suitability classes: Very High, High, Moderate, Low, and Very Low. This stratification provides the foundation for a prioritized, evidence-based afforestation strategy.

Spatial Distribution and Priority Classification

The areal distribution of suitability classes (Table 9.1) shows that 25.08% of the study area is classified as highly suitable and 2.47% as very highly suitable for plantation. These zones are predominantly situated near higher-order drainage channels and characterized by gentle to moderate slopes, barren or fallow land, and loamy to sandy-clay soils, which are conducive to plant establishment. By contrast, 2.20% of the area is deemed unsuitable, largely due to frequent inundation, high runoff, or poor rooting conditions within drainage buffers.

Table 9.1: Areal Distribution of Plantation Suitability Classes

Suitability Class	Value	Pixel Count	Area (ha)	Percentage (%)
(Unsuitable)	0	347	31.24	2.20
Very Low	1	138	13.42	0.87
Low	2	5002	450.18	31.69
Moderate	3	5949	535.41	37.69
High	4	3959	356.31	25.08
Very High	5	390	35.1	2.47

Identification of Priority Plantation Zones

Within the Very High suitability class (Value = 5), a total of 35.10 ha was delineated as priority plantation zones (Fig. 9.3). Four plantation sites (PS-1 to PS-4) were initially identified through GIS-based analysis, supported by high-resolution imagery interpretation. However, based on the field visits and ground validation, the following recommendations are made:

- **PS-1 (23°48′30.70″N, 86°15′3.58″E):** Not feasible, as the site is designated for a proposed opencast mining operation.
- **PS-2 (23°47′53.29″N, 86°16′28.86″E):** Partially feasible. Based on the field assessments, areas located at the left side of the National Highway (NH) may be considered for plantation initially.
- **PS-3 (23°47′12.57″N, 86°15′38.89″E):** Not feasible. Field verification confirmed that a part of the land belongs to the Indian Railway and the remaining land falls under the proposed mining expansion.
- **PS-4 (23°47′17.94″N, 86°17′5.62″E):** Not feasible, owing to overlap with the existing and proposed mining activities.

Thus, only a part of the area under PS-2 (as mentioned above) is feasible for afforestation under current and proposed land-use pattern.

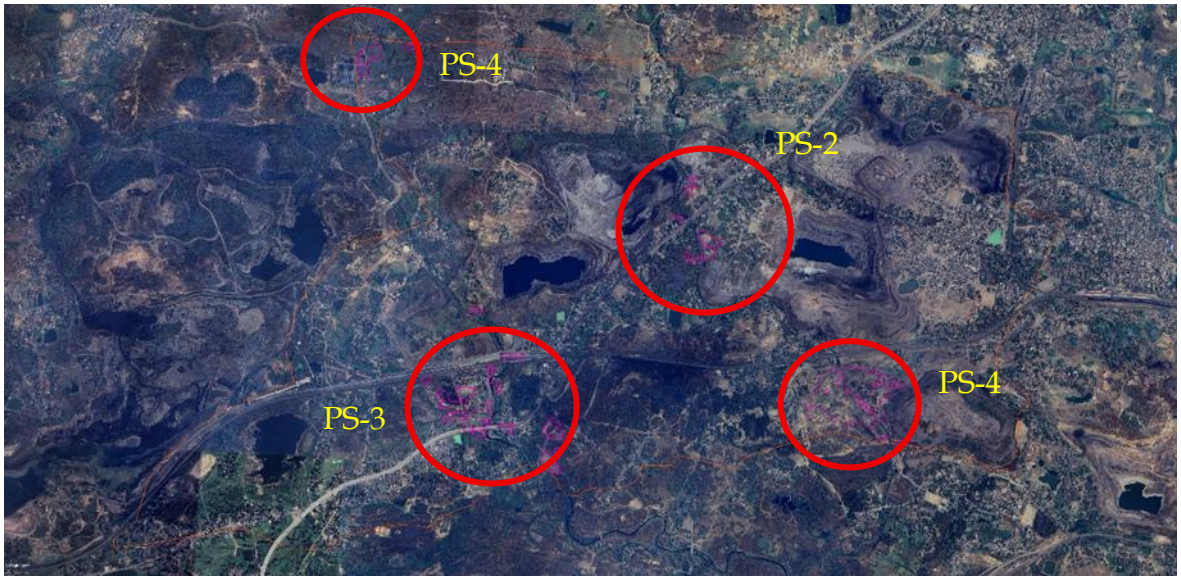


Fig. 9.3: Locations of the Plantation Zones in Cluster-III, Govindpur Area, BCCL

Implementation Strategy and Species Selection

For the partially feasible PS-2 zone, species selection is guided by ecological resilience and restoration potential. Recommended native species include the following:

Azadirachta indica (Neem) – valued for drought resistance and soil improvement.

Tectona grandis (Teak) – for long-term timber value and canopy cover.

Terminalia arjuna – effective in riparian and erosion-prone areas.

In the context of coal mining regions, the prioritized plantation zones can play a crucial role in stabilizing overburden dumps, reducing dust emissions, and reclaiming degraded land. These interventions not only support environmental compliance but also enhance the ecological restoration of the post-mining landscape.

9.5 Conclusion

The preparation of a watershed management plan for Cluster-III in the Govindpur Area of BCCL represents a proactive step towards sustainable ecological management in a mining-impacted region. Although, the area does not currently exhibit severe environmental stress, the cumulative impacts of coal mining, evolving land-use dynamics, and localized vulnerabilities such as overburden dumps, steep slopes, and

sparsely vegetated zones necessitate targeted interventions to safeguard ecological stability. The integrated methodology employed in this study, combining geospatial analysis with CMPI6, RUSLE, SCS-CN, and AHP-based site prioritization, proved effective in generating spatially explicit, technically robust, and context-specific guidance for watershed-scale management. Conservation measures such as check dams, contour bunds, and afforestation were identified as critical interventions, with field validation confirming both the reliability of the model outputs and the necessity of adaptive refinements based on field visits.

The plantation suitability analysis further highlighted that, despite the model delineating four suitable sites (PS-1 to PS-4), field verification restricted feasibility to only a portion of PS-2, while PS-1, PS-3, and PS-4 were excluded due to overlaps with existing & proposed mining activities and railway land. This underscores the essential role of ground-truthing in translating model predictions into actionable strategies in mining-affected landscapes.

Afforestation within the feasible PS-2 zone, supported by native species such as *Azadirachta indica*, *Tectona grandis*, and *Terminalia arjuna*, can contribute to ecological restoration by stabilizing degraded slopes, reducing erosion, and enhancing biodiversity. In parallel, the incorporation of structural measures such as check dams and contour bunds offers synergistic benefits for runoff regulation, soil conservation, and slope stabilization. In conclusion, the Cluster-III watershed exemplifies how science-based modelling, integrated with rigorous field validation, provides a scalable and policy-relevant framework for ecological restoration in coal mining regions. While spatial analysis identifies potential opportunities, adaptive management and continuous monitoring remain vital to address the dynamic land-use pressures that characterize such landscapes. The framework developed here not only strengthens site-specific restoration planning but also serves as a transferable model for long-term land and water management in similar mining-affected regions across India.



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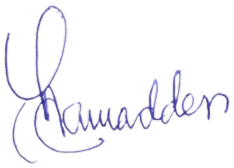
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End of the Report



Prof. S. R. Samadder, Professor,
Centre for Water Resource Management (CWRM)
(Consultant In-charge of the Project)
Department of Environmental Science & Engineering
IIT(ISM) Dhanbad
Email: samadder@iitism.ac.in

Annexure-IV

भारत कोकिंग कोल लिमिटेड
(कोल इण्डिया लिमिटेड की एक अनुषंगी कंपनी)
Bharat Coking Coal Limited
(A Subsidiary of Coal India Limited)
(एक मिनीरत्न कंपनी / A Miniratna Company)
(भारत सरकार का उपक्रम / A Government of India Undertaking)

बीसीसीएल BCCL
Bharat Coking Coal Limited

पत्र संख्या: BCCL/Ar.III/GM/Envt/25-26/ 12

Date: 19.04.2025

सेवा में,

वन प्रमंडल पदाधिकारी,

धनबाद

विषय: **Work Order for carrying afforestation over 1.755 Ha land in Maheshpur Colliery under Govindpur Area, BCCL.**

संदर्भ:

(i) BCCL letter vide letter **no. BCCL/GM/Ar.III/Envt./24-25/120 dated 04.02.2025**
(ii) Your letter vides no. letter no. **694 dated 19.03.3025**

माननीय महोदय,

This has reference to the aforesaid letters; the Competent Authority is pleased to award the work for **"1.755 ha plantation in Maheshpur Colliery under Govindpur Area, BCCL"** for a total value of **Rs. 19,06,745.00 (Nineteen Lakh Six Thousand Seven hundred and Forty-Five rupees only)** with the following terms and conditions in respect of above-mentioned work: -

1. The Period of work from the date of acceptance of work order will be 6 years (as advance and completion work will be done in FY 2025-26) and subsequent Five years maintenance work as per the estimate provided by Forest Department.

2. The aforesaid work is to be carried out at 1.755 Ha land in Maheshpur Colliery Under Govindpur Area.

3. The Forest department shall conduct all its afforestation activities subject to all laws, rules, statutory orders and regulations applicable to the site and the nature of the work.

4. The Forest department shall take up afforestation works with due expertise and supervision as per the scheme & estimates duly sanctioned as per the estimate submitted by forest department.

5. The Forest Deparment Shall submit the surface plan/location plan for the aforesaid sites.

6. **SCOPE OF WORK**
This work shall be done with the following attributes:

(i) Self-sustaining / healthy plantation at the end of project period.

(ii) As the site is degraded protected forest land, therefore, plants planted shall be of native species, high root density, soil binding species, thick canopy and/or fruit bearing. The forest department shall identify such native species and plant at the site with the purpose of regeneration of the forest with native flora and fauna.

पंजीकृत कार्यालय: कोयला भवन, कोयला नगर, बीसीसीएल टाउनशिप, धनबाद, झारखंड -826005, भारत, फोन : 0326-2236000, वेबसाइट : www.bcclweb.in
Registered Office: Koyla Bhawan, Koyla Nagar, BCCL Township, Dhanbad, Jharkhand-826005, India, CIN: U10101JH1972GOI000918

(iii) Survival of the plantation shall not be less than 80 per cent at the end of the project period.

7. Annual Joint Inspection report of the inspection carried out by joint team of Forest Department and representatives of GM, Govindpur Area, BCCL after the completion of each year work with the report indicating name of the site, year of plantation, number of plants, name of the species present, date of inspection and survival rate.

8. The display boards shall be installed at sites indicating the name of the site, the no. of plantation, species planted, funded by BCCL and plantation year.

9. All the materials & manpower required with regard to the aforesaid work shall be arranged by you at your own cost.

10. At the end of the project period, a certificate for successful completion of the project shall be submitted to BCCL.

11. The Forest Department Shall engaged local community/people or SHGs wherever possible, for aforesaid work.

12. At the end of the each year, no. of local community/people or SHG's engaged in aforementioned work may be provided to BCCL for onward submission to the concerned regulatory authorities.

13. TERMS OF PAYMENT

Total project cost is as per the estimate submitted by Forest Department. The payment schedule will be as follows: -

S No	Year of work	Financial Year	Name of the work	Estimated Amount (₹) by DFO, Dhanbad including contingency @ 5%
1.	1st year	2025-26	Advance and Completion work	13,14,085.68
2.	2nd year	2026-27	Maintenance work-1	2,12,008.78
3.	3rd year	2027-28	Maintenance work-2	1,93,847.24
4.	4th year	2028-29	Maintenance work-3	83,722.80
5.	5th year	2029-30	Maintenance work-4	51,540.30
6.	6th year	2030-31	Maintenance work-5	51,540.30
	TOTAL			**19,06,745.00**

14. The Forest department shall pay wages not less than the minimum wages fixed by the Govt of Jharkhand to the labourers engaged in the execution of the aforesaid work and it will be the responsibility of the Forest department to ensure the compliance of the payment of wages to its workmen/labourers as per law and company shall not be held responsible for the same.

15. The estimate has been submitted by Forest Department based on annual increment of 15% on prevailing labour wages of Govt of Jharkhand. However, the payment of Completion work, subsequent years' maintenance work will be made as per the actual labour wages of Govt of Jharkhand prevailing in the corresponding year. Therefore, the forest department shall certify the rate of labour wages for the corresponding year and raise demand letter/ bill based on the actual rates of labour wages to that corresponding year.

पंजीकृत कार्यालय: कोयला भवन, कोयला नगर, बीसीसीएल टाउनशिप, धनबाद, झारखंड -826005, भारत, फोन : 0326-2236000, वेबसाइट : www.bcclweb.in

16. In case of revision of minimum wages by the Govt of Jharkhand during the work, a revised estimate of the corresponding year of the scheme as per the work order shall be submitted to the company by Forest Department and claim/adjust the amount of difference in wages payable/paid due to increase in labour wages on the basis of man days works on revised wage for which the forest department shall certify.

17. **Paying Authority:** AFM, Govindpur Area, BCCL

18. All the payment will be made by ELECTRONIC MODE through bank in the account of DFO, Dhanbad. You are required to fill the format of Electronic Fund Transfer (EFT) in triplicate which is enclosed as annexure-A.

19. For release of the payment, you have to submit
    a) Utilization certificate of the preceding payment made to you in respect of this work order
    b) Joint inspection report of preceding year's work.
    c) Demand letter/Bill based on the actual rates of minimum wages by the Govt of Jharkhand to that corresponding year for payment.

    The utilization certificates along with joint inspection report shall be accepted by the accepting authority i.e. General Manager, Govindpur Area, BCCL.

20. BCCL shall not have any liability in case of any accident etc. towards Forest Department's personnel/ staffs /workers during the execution of the work.

21. As Child labour is prohibited and shall not be deployed in the aforesaid work.

22. All other conditions stipulated in aforementioned reference letters shall be complied.

23. Matter relating to any dispute or difference arising out of this work order shall be subject to the jurisdiction of Dhanbad court only.

19/04/2025

General Manager
Govindpur Area, BCCL

Copy to: -
1. GM (Envt), BCCL- for kind information please.
2. Project officer, Maheshpur Colliery
3. AM(Env)/AFM, Govindpur Area
4. Office copy

ANNEXURE-A

PROFORMA FOR COLLECTING PAYMENT THROUGH ELECTRONIC MODE INCLUDING ELECTRONIC FUND TRANSFER (ETF) & ELECTRONIC CLEARING SYSTEM (ECS)

1	VENDOR/SUPPLIER/CONTRACTOR/CUSTOMER'S NAME & ADDRESS (With Telephone No. and Fax No.)	
2	PARTICULARS OF BANK ACCOUNT	
	A) BANK NAME	
	B) BRANCH NAME (Including RTGS Code)	
	ADDRESS	
	TELEPHONE No. & FAX No.	
	C) 9 – DIGIT CODE NUMBER OF THE BANK & BRANCH (Appearing on the MICR cheque issued on the bank) OR 5 – digit code No. OF SBI	
	D) ACCOUNT TYPE (S.B. Account/Current Account OR Cash Credit with code 10/11/13)	
	E) LEDGER No./LEDGER FOLIO No.	
	F) ACCOUNT NUMBER (CORE BANKING) & STYLE OF ACCOUNT (As appearing on the cheque Book)	
3	DATE OF EFFECT	

I hereby declare that the particulars given above are correct and complete. If the transaction is delayed or not effected at all for reasons of incomplete or incorrect information, I would not hold the user institution responsible. I have read the option invitation letter and agree to discharge responsibility expected of me as a participant under the scheme. Any Bank charges levied by the Bank of such e-transfer shall be borne by us.

Date:

Signature of the Contractor

Certified that the particulars furnished above are correct as per our records.

Signature of the Authorized Officials
from the Bank

BHARAT COKING COAL LIMITED
(A Subsidiary of Coal India Ltd.)
भारत कोकिंग कोल लिमिटेड
Bharat Coking Coal Ltd
Govindpur area,,
PO: Sonardih,Dist- Dhanbad,Jharkhand,India-828125

Coal India Limited
A Maharatna Company
www.coalindia.in

Phone :
Fax :
Website : Email :
CIN : U10101JH1972GOI000918 GSTN : 20AAACB7934MFZB

SERVICE PURCHASE ORDER

PO No. : 5700440227 Date : 25/07/2025

To,
MANOJ KUMAR SINGH

AT.- SALANPUR, PO.- KATRASGARH

DHANBAD
DHANBAD
828113
Jharkhand
India

Vendor Code: 10021723
PAN: JMXPS9952M
GSTIN: 20JMXPS9952M1ZQ
Delivery Date: 31/03/2026
Department: Environment

Header Text:

Work order for plantation work at South Govindpur Colliery, Govindpur Area.

Detailed terms and conndition are prescribed in work order issued by Area Manager (Civil), Govindpur Area.

Item	Material/Service		Qty	Unit	Unit Price	Value	Net Value
10	plantation work at south govindpur						
	10	digging holes in ordinary soil	7500	NO	17.04 per 1 unit	127800.00	
	20	supplying & stacking at site good earth	357.670	M3	478.60 per 1 unit	171180.86	

	30	supply and stack cow dung manure	178.830	M3	246.57 per 1 unit	44094.11	933759.96
	40	mixing earth and sludge	536.500	M3	31.30 per 1 unit	16792.45	
	50	spreading of sludge	536.500	M3	45.03 per 1 unit	24158.60	
	60	earth work in excavation by mechanical	1312.200	M3	154.90 per 1 unit	203259.78	
	70	surface dressing of ground	6750	M2	20.40 per 1 unit	137700.00	
					Gross Price	724,985.8	
					Quoted Rate in %(9.15)	66,336.2	
					Goods & Services Tax	142,437.96	
					Value exclusive of Tax	791,322	
					Inp-Eligible- CGST-9%, SGST-9%, No TCS	142,437.96	

Net value	**933759.96**	INR

Amount in words :NINE LAKH THIRTY THREE THOUSAND SEVEN HUNDRED FIFTY NINE RUPEES NINETY SIX PAISE

Released By : OF(ENV)_2007

Annexure-V

भारत कोकिंग कोल लिमिटेड
(कोल इंडिया लिमिटेड की एक अनुषंगी कंपनी)
Bharat Coking Coal Limited
(A Subsidiary of Coal India Limited)
(एक मिनीरत्न कंपनी / A Miniratna Company)
(भारत सरकार का उपक्रम / A Government of India Undertaking)

BCCL/GM/AR.III/ENVT/25-26/ 14

Dated: 22.04.2025

To
HoD (Department of Mining Engineering)
IIT Kharagpur

Subject: Work Order for "Conducting Carbon Sequestration Study including carbon emissions from coal mining" in Cluster-III, Govindpur Area, BCCL

Ref: 1. Our E-mail dated 24.02.2025
2. Your Offer vide E-mail dated 13.03.2025
3. LOA issued to IIT Kharagpur vide BCCL/GM/AR. II/ENVT/25-26/07 dated 07.04.2025
4. Corrigendum in LOA vide email dated 09.04.2025
5. Your E-mail dated 19.04.2025 regarding acceptance of LOA.

Dear Sir

With reference to the above referred emails, this is to bring to your kind attention that competent authority is pleased to award the work for **"Conducting Carbon Sequestration Study including carbon emissions from coal mining"** in Cluster-III, Govindpur Area, BCCL to IIT Kharagpur for a value of Rs. 11,50,500 (Rs. Eleven Lakh Fifty Thousand and Five Hundred only) including GST@18% with following terms and condition:

1. **Scope of Work:**
   (i) **Quantification of Carbon Emissions:** Estimation of carbon emissions from coal mining operations based on Direct Emissions from Coal Mining and Processing including transportation of coal, Indirect Emissions from Purchased Electricity for mining operations.
   (ii) **Current Carbon Sequestration Estimation:** (a) Evaluation of the existing carbon sequestration activities undertaken by BCCL, including afforestation, land reclamation, and soil carbon enhancement. (b) Quantification of CO_2 absorbed through plantation programs based on species type, age, and density. (c) Assessment of carbon storage in rehabilitated mine-overburden dumps and reclaimed lands.
   (iii) **Carbon Sequestration Potential Enhancement:** (a) Identification of additional carbon sequestration techniques such as expanded afforestation, biochar application, and carbon capture and storage (CCS). (b) Potential for increasing sequestration through improved plantation models, agroforestry, and soil carbon enhancement practices.
   (iv) **Compliance with International and National Standards:** Carbon accounting methodology aligned with ISO 14064-1:2018 (Greenhouse Gases –

Quantification and Reporting of GHG Emissions and Removals at the Organizational Level).

(v) **Policy and Strategic Recommendations:** Development of a carbon-neutral roadmap for coal mining operations in Cluster-III, BCCL.

2. Duration of the work shall be 9 months i.e., shall be completed by 21.01.2026.
3. Paying Authority: AFM, Govindpur Area
4. BCCL shall provide local accommodation and travel arrangement for visiting the site.
5. BCCL shall not be liable to any loss/damage caused to IIT Kharagpur during your site visits for the work.
6. Data generated during the study shall be property of BCCL only. The copyright of all documents prepared by the consultant in connection with the study shall rest with the BCCL.
7. The study report will be submitted to MoEF&CC. Any modification suggested by MoEF&CC in the report shall be incorporated by IIT Kharagpur without any additional cost.
8. 50 % advance payment shall be made to IIT Kharagpur after submitting advance payment request/invoice by you.
9. Final 50% payment will be made after acceptance of the study report by General Manager, Govindpur Area.
10. Any dispute shall be in jurisdiction of Dhanbad Court Only.
11. **Deliverable:** 02nos. hard copies (Colour) of draft report & 05nos. hard copies (Colour) of final report.
12. All the studies, data generated during study and the final study report shall be submitted to BCCL in editable soft copies.
13. If due to any reason beyond control of BCCL and IIT Kharagpur, work can not be completed after 50% advance payment, IIT Kharagpur shall return the amount to BCCL after deduction of expenses incurred by IIT Kharagpur.
14. **Force Majeure:** For the purpose of and within the scope of the contract by way of indication and not of limitation, the term `Force Majeure' shall mean acts of nature, strikes, Lockouts, or other industrial disturbances, act of public/enemy, wars, blockades, insurrection, riots, epidemics, landslides, earthquakes, storms, lightening, flood, washouts, civil disturbances, explosions and any other similar event not within the control of either party and which by exercises of due care and diligence neither party is able to prevent or overcome. Should the occurrence of force majeure last more than 15 days, extension of time will be given with the mutual consent of IIT, Kharagpur and BCCL.

Yours faithfully

22/4/2025

General Manager
Govindpur Area

CC to:

1. GM(Min)/HoD (Env), BCCL
2. Area Manager (Env)/Area Survey Officer, Govindpur Area

BHARAT COKING COAL LIMITED
(A Subsidiary of Coal India Ltd.)
भारत कोकिंग कोल लिमिटेड
Bharat Coking Coal Ltd
Govindpur area,,
PO: Sonardih,Dist- Dhanbad,Jharkhand,India-828125

Coal India Limited
A Maharatna Company
www.coalindia.in

Phone :
Fax :
Website : Email :
CIN : U10101JH1972GOI000918 GSTN : 20AAACB7934MFZB

SERVICE PURCHASE ORDER

PO No. : 5700418574 Date : 22/04/2025

To,

INDIAN INSTITUTE OF TECHNOLOGY

KHARAGPUR

NALANDA COMPLEX

KHARAGPUR

2ND FLOOR, ADMINISTRATIVE BUILDING
WEST MIDNAPORE

WEST MIDNAPORE

721302

West Bengal

India

Vendor Code: 10001497

PAN: AAAJI0323G

GSTIN: 19AAAJI0323G1ZM

Delivery Date: 31/03/2026

Department: Environment

Header Text:

Work order for conducting carbon sequestration study in Cluster-III, BCCL.

1. Scope of Work:

(i) Quantification of Carbon Emissions: Estimation of carbon emissions from coal mining operations based on Direct Emissions from Coal Mining and Processing including transportation of coal, Indirect Emissions from Purchased Electricity for mining operations.

(ii) Current Carbon Sequestration Estimation: (a) Evaluation of the existing carbon sequestration activities undertaken by BCCL, including afforestation, land reclamation, and soil carbon enhancement. (b) Quantification of CO_2 absorbed through plantation programs based on species type, age, and density. (c) Assessment of carbon storage in rehabilitated mine-overburden dumps and reclaimed lands.

(iii) Carbon Sequestration Potential Enhancement: (a) Identification of additional carbon sequestration techniques such as expanded afforestation, biochar application, and carbon capture and storage (CCS). (b) Potential for increasing sequestration through improved plantation models, agroforestry, and soil carbon enhancement practices.

(iv) Compliance with International and National Standards: Carbon accounting methodology aligned with ISO 14064-1:2018 (Greenhouse Gases – Quantification and Reporting of GHG Emissions and Removals at the Organizational Level).

(v) Policy and Strategic Recommendations: Development of a carbon-neutral roadmap for coal mining operations in Cluster-III, BCCL.

2. Duration of the work shall be 9 months i.e., shall be completed by 21.01.2026.

3. Paying Authority: AFM, Govindpur Area

4. BCCL shall provide local accommodation and travel arrangement for visiting the site.

5. BCCL shall not be liable to any loss/damage caused to IIT Kharagpur during your site visits for the work.

6. Data generated during the study shall be property of BCCL only. The copyright of all documents prepared by the consultant in connection with the study shall rest with the BCCL.

7. The study report will be submitted to MoEF&CC. Any modification suggested by MoEF&CC in the report shall be incorporated by IIT Kharagpur without any additional cost.

8. 50 % advance payment shall be made to IIT Kharagpur after submitting advance payment request/invoice by you.

9. Final 50% payment will be made after acceptance of the study report by General Manager, Govindpur Area.

10. Any dispute shall be in jurisdiction of Dhanbad Court Only.

11. Deliverable: 02nos. hard copies (Colour) of draft report & 05nos. hard copies (Colour) of final report.

12. All the studies, data generated during study and the final study report shall be submitted to BCCL in editable soft copies.

13. If due to any reason beyond control of BCCL and IIT Kharagpur, work can not be completed after 50% advance payment, IIT Kharagpur shall return the amount to BCCL after deduction of expenses incurred by IIT Kharagpur.

14. Force Majeure: For the purpose of and within the scope of the contract by way of indication and not of limitation, the term `Force Majeure' shall mean acts of nature, strikes, Lockouts, or other industrial disturbances, act of public/enemy, wars, blockades, in other similar event not within the control of either party and which by exercises of due care and diligence neither party is able to prevent or overcome. Should the occurrence of force majeure last more than 15 days, extension of time will be given with the mutual consent of IIT, Kharagpur and BCCL.

Item	Material/Service		Qty	Unit	Unit Price	Value	Net Value
10	carbon sequestration study cluster III						1150500
	10	carbon sequestrationstudy	1	NO	975000.00 per 1 unit	975000.00	
				Gross Price		975,000	
				Goods & Services Tax		175,500	
				Value exclusive of Tax		975,000	
				Inp-Not Eligible-CGST-9%, SGST-9%, No TCS		175,500	

Net value	**1150500.00**	INR

Amount in words :ELEVEN LAKH FIFTY THOUSAND FIVE HUNDRED RUPEES

Released By : OF(ENV)_2007

Annexure-I

HALF-YEARLY REPORT OF MINE CLOSURE ACTIVITIES

Monitoring of Mine Closure Activities based on different Milestones and timeframe as per approved Mine Closure Plan for the period 2025-26

a) Brief description of Mine: -

1. Name of Mine: - Block IV Colliery Name of Company: - BCCL 3. Mine Type (OC/UG/Mixed): Mixed 4. GR (Mill Tonnes): - 34.33

5. Mineable Reserve & PRC (MT): 28.597 6. Lease Hold Area (Ha)-149 7. Total Surface Area (Ha): 149 8. Life of Mine: -OCP/UG: 66 9. Balance Life:

b) Milestones wise parameters for progressive mine closure activities against approved Mine Closure Plan are given as under: -

Sl. No.	Name of Mine Closure Activity Milestones	Status of Completion during the Current Year (2025-26) (Progressive/Final) 01.04.2025-30.09.2025		Reasons for any shortfall	Progressive Total for the year 2025-26
		Target	Achievement		Achievement
1.	Coal Produced (in Million Te)		0.043825		0.043825
2.	Void area (in Ha)		NIL		NIL
3	Top soil removed (m^3)	NIL	35688		35688
4.	Spreading of Topsoil (m^3)	NIL	NIL		NIL
5.	Removal of OB (m^3)		313671		313671
6.	Void backfilled (m^3)				
7.	Land reclaimed (in Ha)		NIL		NIL
8.	Type of Reclamation		NIL		NIL
a.	Physical Reclamation		NIL		NIL
b.	Biological Reclamation		NIL		NIL
9.	**Plantation**				
a.	Plantation in safe zone		NIL		NIL
b.	Plantation in OB dump area		NIL		NIL
c.	Others (within the project area)		NIL		NIL

10.	Air Quality Management (Descriptive report to be submitted)		CMPDI report enclosed herewith		CMPDI report enclosed herewith
11.	Water quality Management (Descriptive report to be submitted)		CMPDI report enclosed herewith		CMPDI report enclosed herewith
12.	Fencing of Mine Void Area	NIL	NIL		NIL
13.	Stowing for U Mines in m3	NIL	NIL		NIL
14.	Surface filling area, if any, for caving mines (m^3) (Descriptive report to be submitted)	NIL	NIL		NIL
15.	Other Mine Closure activities, If any	NIL	NIL		NIL

Note: The copy of EC Compliance Report must also be submitted.

Date: -

15/10/25

Signature

परियोजना पदाधिकारी
Project Officer
एबीजीसी, कोलियरी
A.B.G. Colliery

Annexure-I

HALF-YEARLY REPORT OF MINE CLOSURE ACTIVITIES

Monitoring of Mine Closure Activities based on different Milestones and timeframe as per approved Mine Closure Plan for the period 2024-25

a) Brief description of Mine: -

1. Name of Mine: - Jogidih
2. Name of Company: - BCCL
3. Mine Type (OC/UG/Mixed): - UG
4. GR (Mill Tonnes): -
5. Mineable Reserve & PRC (MT):3.26
6. Lease Hold Area (Ha):167
7. Total Surface Area (Ha): -
8. Life of Mine: -66
9. Balance Life: -

b) Milestones wise parameters for progressive mine closure activities against approved Mine Closure Plan are given as under: -

Sl. No.	Name of Mine Closure Activity Milestones	Status of Completion during the Current Year (2024-25) (Progressive/Final) 01.04.2023-30.09.2023		Reasons for any shortfall	Progressive Total for the year 2024-25
		Target	Achievement		Achievement
1.	Coal Produced (in Million Te)		**0.002281**		**0.002281**
2.	Void area (in Ha)	NA	NA		NA
3	To soil removed (m^3)	NA	NA		NA
4.	Spreading of Topsoil (m^3)	NA	NA		NA
5.	Removal of OB (m^3)	NA	NA		NA
6.	Void backfilled (m^3)	NA	NA		NA
7.	Land reclaimed (in Ha)	NA	NA		NA
8.	Type of Reclamation	NA	NA		NA
a.	Physical Reclamation	NA	NA		NA
b.	Biological Reclamation	NA	NA		NA
9.	**Plantation**	NA	NA		NA
a.	Plantation in safe zone	NA	NA		NA
b.	Plantation in OB dump area	NA	NA		NA
c.	Others (within the project area)	NA	NA		NA
10.	Air Quality Management		CMPDI report enclosed		CMPDI report enclosed

	(Descriptive report to be submitted)		herewith		herewith
11.	Water quality Management (Descriptive report to be submitted)		CMPDI report enclosed herewith		CMPDI report enclosed herewith
12.	Fencing of Mine Void Area	NIL	NIL		NIL
13.	Stowing for U Mines in m3	NIL	NIL		
14.	Surface filling area, if any, for caving mines (m^3) (Descriptive report to be submitted)	NIL	NIL		NIL
15.	Other Mine Closure activities, If any	NIL	NIL		NIL

Note: The copy of EC Compliance Report must also be submitted.

Date: -

Signature

01/01/2025

Manager
Jogidih Colliery
Sobindpur Area II
B.C.C.L

Annexure-I

HALF-YEARLY REPORT OF MINE CLOSURE ACTIVITIES

Monitoring of Mine Closure Activities based on different Milestones and timeframe as per approved Mine Closure Plan for the period 2025-26

a) Brief description of Mine: -

1. Name of Mine: - Govindpur | Name of Company: - BCCL | 3. Mine Type (OC/UG/Mixed): Mixed | 4. GR (Mill Tonnes): - 43.329

5. Mineable Reserve & PRC (MT):38.178 | 6. Lease Hold Area (Ha): 159.55 | 7. Total Surface Area (Ha): - 159.55 | 8. Life of Mine: UG: 66 9. Balance Life: -

b) Milestones wise parameters for progressive mine closure activities against approved Mine Closure Plan are given as under: -

Sl. No.	Name of Mine Closure Activity Milestones	Status of Completion during the Current Year (2025-26) (Progressive/Final) 01.04.2025-30.09.2025		Reasons for any shortfall	Progressive Total for the year 2025-26
		Target	Achievement		Achievement
1.	Coal Produced (in Million Te)	NIL	NIL		NIL
2.	Void area (in Ha)	NIL	NIL		NIL
3	To soil removed (m^3)	NIL	NIL		NIL
4.	Spreading of Topsoil (m^3)	NIL	NIL		NIL
5.	Removal of OB (m^3)	NIL	NIL		NIL
6.	Void backfilled (m^3)	NIL	NIL		NIL
7.	Land reclaimed (in Ha)	NIL	NIL		NIL
8.	Type of Reclamation	NIL	NIL		NIL
a.	Physical Reclamation	NIL	NIL		NIL
b.	Biological Reclamation	NIL	NIL		NIL
9.	**Plantation**	NIL	NIL		NIL
a.	Plantation in safe zone	NIL	NIL		NIL
b.	Plantation in OB dump area	NIL	NIL		NIL
c.	Others (within the project area)	NIL	NIL		NIL

10.	Air Quality Management (Descriptive report to be submitted)		CMPDI report enclosed herewith		CMPDI report enclosed herewith
11.	Water quality Management (Descriptive report to be submitted)		CMPDI report enclosed herewith		CMPDI report enclosed herewith
12.	Fencing of Mine Void Area		NIL		NIL
13.	Stowing for U Mines in m3		NIL		NIL
14.	Surface filling area, if any, for caving mines (m^3) (Descriptive report to be submitted)		NIL		NIL
15.	Other Mine Closure activities, If any		NIL		NIL

Note: The copy of EC Compliance Report must also be submitted.

Date: -

15/X/25

Signature

परियोजना पदाधिकारी
Project Officer
ए०बी०जी०. कोलियरी
A.B.G. Colliery

Annexure-I

HALF-YEARLY REPORT OF MINE CLOSURE ACTIVITIES

Monitoring of Mine Closure Activities based on different Milestones and timeframe as per approved Mine Closure Plan for the period 2025-26

a) Brief description of Mine: -

1. Name of Mine: **- Maheshpur** Name of Company: - BCCL 3. Mine Type (OC/UG/Mixed): **UG** 4. GR (Mill Tonnes): - 72.33

5. Mineable Reserve & PRC (MT):1.54 6. Lease Hold Area (Ha): 292.68 7. Total Surface Area (Ha): - 292.68 8. Life of Mine: 66 9. Balance Life: -

b) Milestones wise parameters for progressive mine closure activities against approved Mine Closure Plan are given as under: -

Sl. No.	Name of Mine Closure Activity Milestones	Status of Completion during the Current Year (2024-25) (Progressive/Final) 01.04.2024-30.09.2024		Reasons for any shortfall	Progressive Total for the year 2024-25
		Target	Achievement		Achievement
1.	Coal Produced (in Million Te)		0.016248		0.016248
2.	Void area (in Ha)	NA	NA		NA
3	To soil removed (m^3)	NA	NA		NA
4.	Spreading of Topsoil (m^3)	NA	NA		NA
5.	Removal of OB (m^3)	NA	NA		NA
6.	Void backfilled (m^3)	NA	NA		NA
7.	Land reclaimed (in Ha)	NA	NA		NA
8.	Type of Reclamation	NA	NA		NA
a.	Physical Reclamation	NA	NA		NA
b.	Biological Reclamation	NA	NA		NA
9.	**Plantation**	NA	NA		NA
a.	Plantation in safe zone	NA	NA		NA
b.	Plantation in OB dump area	NA	NA		NA
c.	Others (within the project area)	NA	NA		NA
10.	Air Quality Management		CMPDI		CMPDI report

	(Descriptive report to be submitted)		report enclosed herewith		enclosed herewith
11.	Water quality Management (Descriptive report to be submitted)		CMPDI report enclosed herewith		CMPDI report enclosed herewith
12.	Fencing of Mine Void Area	NIL	NIL		NIL
13.	Stowing for U Mines in m3	NIL	NIL		
14.	Surface filling area, if any, for caving mines (m^3) (Descriptive report to be submitted)	NIL	NIL		NIL
15.	Other Mine Closure activities, If any	NIL	NIL		NIL

Note: The copy of EC Compliance Report must also be submitted.

Date: -

17/10/2023

Signature

Project Officer

Maheshpur Collie

Annexure-I

HALF-YEARLY REPORT OF MINE CLOSURE ACTIVITIES

Monitoring of Mine Closure Activities based on different Milestones and timeframe as per approved Mine Closure Plan for the period 2025-26

a) Brief description of Mine: -

1. Name of Mine: - NAKC

Name of Company: - BCCL

3. Mine Type (OC/UG/Mixed): Mixed

4. GR (Mill Tonnes): - 135.71

5. Mineable Reserve & PRC (MT):72.52

6. Lease Hold Area (Ha): 367.58

7. Total Surface Area (Ha): -

8. Life of Mine: OCP/UG: 66 9. Balance Life: -

b) Milestones wise parameters for progressive mine closure activities against approved Mine Closure Plan are given as under: -

Sl. No.	Name of Mine Closure Activity Milestones	Status of Completion during the Current Year (2025-26) (Progressive/Final) 01.04.2025-30.09.2025		Reasons for any shortfall	Progressive Total for the year 2025-26
		Target	Achievement		Achievement
1.	Coal Produced (in Million Te)		0.210528		0.210528
2.	Void area (in Ha)				
3	To soil removed (m^3)				
4.	Spreading of Topsoil (m^3)		NIL		
5.	Removal of OB (m^3)		**1833466**		**1833466**
6.	Void backfilled (m^3)		NIL		NIL
7.	Land reclaimed (in Ha)				
8.	Type of Reclamation				
a.	Physical Reclamation				
b.	Biological Reclamation		NIL		NIL
9.	**Plantation**				
a.	Plantation in safe zone		0		0
b.	Plantation in OB dump area				0
c.	Others (within the project area)		0		0
10.	Air Quality Management		CMPDI		CMPDI report

	(Descriptive report to be submitted)		report enclosed herewith		enclosed herewith
11.	Water quality Management (Descriptive report to be submitted)		CMPDI report enclosed herewith		CMPDI report enclosed herewith
12.	Fencing of Mine Void Area		NIL		NIL
13.	Stowing for U Mines in m3		NIL		NIL
14.	Surface filling area, if any, for caving mines (m^3) (Descriptive report to be submitted)		NIL		NIL
15.	Other Mine Closure activities, If any		Landscaping of plantation site		NIL

Note: The copy of EC Compliance Report must also be submitted.

Date: -

15/1/2025

Signature

PROJECT OFFICER
NAKC COLLIERY
AREA No. III

STRICTLY RESTRICTED
FOR COMPANY USE ONLY RESTRICTED
The information given in this report is not to be communicated either directly or indirectly to the press or to any person not holding an official position in the CIL /GOVERNMENT.

ENVIRONMENTAL MONITORING REPORT OF BHARAT COKING COAL LIMITED, CLUSTER – III

(FOR THE MONTH SEPTEMBER, 2025)

E. C. no. J-11015/213/2010-IA.II (M) dated 03.03.2025.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

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EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the fauna and flora. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal Limited (BCCL), a Subsidiary company of Coal India Limited is operating Underground and Opencast Mines in Jharia Coalfield (JCF) is a part of Gondwana Coalfields located in Dhanbad district of Jharkhand, the JCF is bounded by $23^0$37' N to $23^0$52' N latitudes and $86^0$09' E to $86^0$30' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Jharia Coalfield (JCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEF&CC while granting environmental clearance of project, consent letter issued by the respective SPCB, and other statutory requirements.

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

The ambient air quality monitoring stations were selected to represent core, buffer zone area. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

2.2 Water sampling stations

The Water sampling stations were selected for mine sump water.

2.3 Noise level monitoring locations

Noise levels vary depending on the various activities in mining areas. The monitoring of noise level in different locations will be helpful to take appropriate mitigating measures. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_x). Respirable Dust Samplers (RDS) and Fine Dust Sampler ($PM_{2.5}$

sampler) were used for sampling of $PM_{10,}$ SO_2, & NO_x and Fine Dust Sampler ($PM_{2.5}$ sampler) were used for sampling of $PM_{2.5}$ at 24 hours interval once in a fortnight and the same for the gaseous pollutants. The samples were analysed in Environmental Laboratory of CMPDI, RI-II, Dhanbad.

3.2 Water quality

Water samples were collected as per standard practice. The Mine effluent samples were collected and analysed for four parameters on fortnightly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory of CMPDI, RI- II, Dhanbad.

3.3 Noise level monitoring

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB(A).

4.0 Results and interpretations

4.1 Air quality

It has been seen from the analysis results that the 24 hours average concentration parameters like $PM_{10,}$ $PM_{2.5}$, SO_2 and NO_x are mostly within the permissible limits in all sampling locations as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines and National Ambient Air Quality Standard -2009. Sometimes the concentration of PM_{10}& $PM_{2.5}$ exceeds the limits due to heavy public traffic, poor road condition, coke oven plants, burning of coal by surrounding habitants, brick making, municipal waste dumps and industries like Steel Plant, thermal Plants including their fly ash etc.

The following preventive and suppressive mitigative measures can be undertaken to contain the pollution level within prescribed level:-

- Wet drilling and controlled blasting should be practice.
- Explosive used should be optimised to restrict the dust generation.
- Transportation roads should be permanently asphalted free of ruts, potholes etc.
- Water should be sprayed on coal transportation road, service road more frequently and at regular interval.
- Dust from roads should be removed physically or mechanically.
- Greenbelts around industrial sites, service building area besides Avenue plantation along roads should be created.
- Coal dust should be suppressed by using fixed sprinklers.
- Regular maintenance of plant and machinery should be undertaken.

4.2 Water quality

The test results indicate that the major parameters compared with MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines, are within permissible limits.

4.3 Noise Level

During the noise level survey it has been observed that the noise level in the sampling locations is within the permissible limits prescribed as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines for Industrial Area and Noise pollution (Regulation and Control) Rules, 2000.

INTRODUCTION

Any industry and development activities including coal mining is bound to affect environmental attributes. There are positive as well as negative impacts of such operations. For controlling the adverse impacts a regular monitoring is essential. The environmental monitoring is being done as per the guide-lines stipulated by Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India.

The very purpose of environmental monitoring is to assess the quality of various attributes which affects the environment. As per quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well-equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.
The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akasshkinaree Mine and Block IV Kooridih Mixed Mine as per **E. C. no. J-11015/213/2010-IA.II**(M) dated 06.02.2013 and later all seven mines are amalgamated to single mine Named Cluster III with OC cum UG with Highway Mining method with no change in lease area and production capacity. The cluster – III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster-III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and Bagdighi Nala.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity of 2.769 MTPA (normative) and 3.6 MTPA peak capacity of coal production vide letter no **E. C. no. J-11015/213/2010-IA. II**(M) dated 06.02.2013 later with **E. C. no. J-11015/213/2010-IA. II**(M) dated 03.03.2025.

Ministry of Environment, Forest and Climate Change while granting environmental clearance has given one of the General conditions that “Four ambient air quality monitoring stations should be established in the core zone as well as in the buffer zone for PM_{10}, $PM_{2.5}$, SO_2, NOx monitoring. Location of the stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets, other conditions regarding water / effluent and noise level monitoring in consultation with the State Pollution Control Board.”

In compliance of these conditions the Environmental Monitoring has been carried out & report prepared for submission to MoEF&CC & JSPCB and other statutory authorities.

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

(As per G.S.R. 742 (E) dt. 25th December, 2000)

2.1.1 Ambient Air Quality Sampling Locations

CORE ZONE Monitoring Location

i) Block IV Kooridih OCP (A6): Industrial Area

The location of the sampling station is at 23°47'54.00"N & 86°16'20.00"E. The sampler was placed at 1.5 m above the ground level near Safety office of Block IV OCP.

BUFFER ZONE Monitoring Location

i) Muraidih OCP (A5) : Industrial Area

The sampler was placed at a height of 1.5 m from the ground level at Muraidih project office.

ii) Ramkanali Workshop (A7) : Industrial area

The location of the sampling station is 23°48'34.00"N & 86°18'22.00"E. The sampler was placed at height of 1.5 m above the ground level at AARC agent Office, Ramkanali.

iii) Kharkharee(A21): **Industrial Area**

The location of the sampling station is 23°46'29.00"N & 86°14'37.08"E. The sampler was placed at a height of 1.5 m above the ground level at Kharkharee Colliery.

AMBIENT AIR QUALITY DATA

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**9/2025**	**Cluster**	**Cluster III**	**ULR NO.**	**TC1432125000002134F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**31.10.2025**
Project	**Block-IV**	**Sample Ref. No.**	**REM/BCCL/2025/09**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	08.09.25	23.09.25	**Period of Analysis**	08.09.2025 – 25.10.25	**Zone of Station:** **Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4514	**A4593**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	75	70	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	37	35	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	21	33	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

Test Report for Ambient Air Samples

Month & Year	**09/2025**	**Cluster**	**Cluster III**			**ULR No.**	**TC1432125000002134F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**31.10.2025**
Project	**Muraidih**		**Sample Ref. No.**	**REM/BCCL/2025/09**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	04.09.25		19.09.25	**Date of Sampling**	04.09.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4498	**A4577**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	71	69	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	30	29	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	30	27	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY | (Gaurav Kant) ***REVIEWED BY*** | (Kumar Vaibhav) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850

Test Report for Ambient Air Samples

Month & Year	**09/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000002134F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**31.10.2025**
Project	**Ramkanali Workshop**		**Sample Ref. No.**	**REM/BCCL/2025/09**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	09.09.25		24.09.25	**Period of Analysis**	09.09.25 – 25.10.25	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4522	**A4600**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	70	73	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	34	37	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	28	30	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**09/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000002134F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**31.10.2025**
Project	**Kharkharee**		**Sample Ref. No.**	**REM/BCCL/2025/09**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	05.09.2025		22.09.2025	**Period of Analysis**	05.09.2025 – 25.10.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4506	**A4584**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	73	70	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	35	35	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	11	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	28	31	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

***All units are in µg/m3, 24 hourly Average, * LDL indicates Lower Detection Limit,*

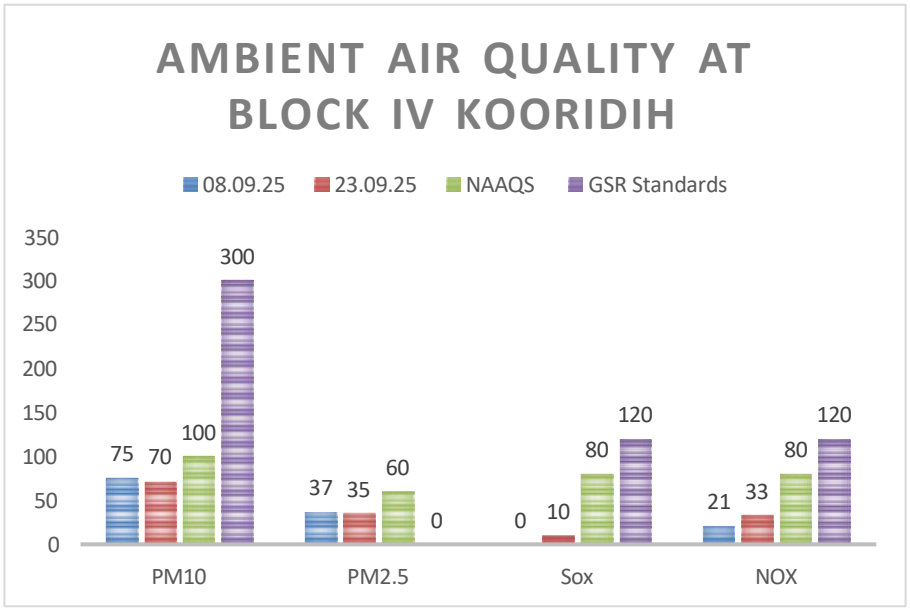
(Gaurav Kant)

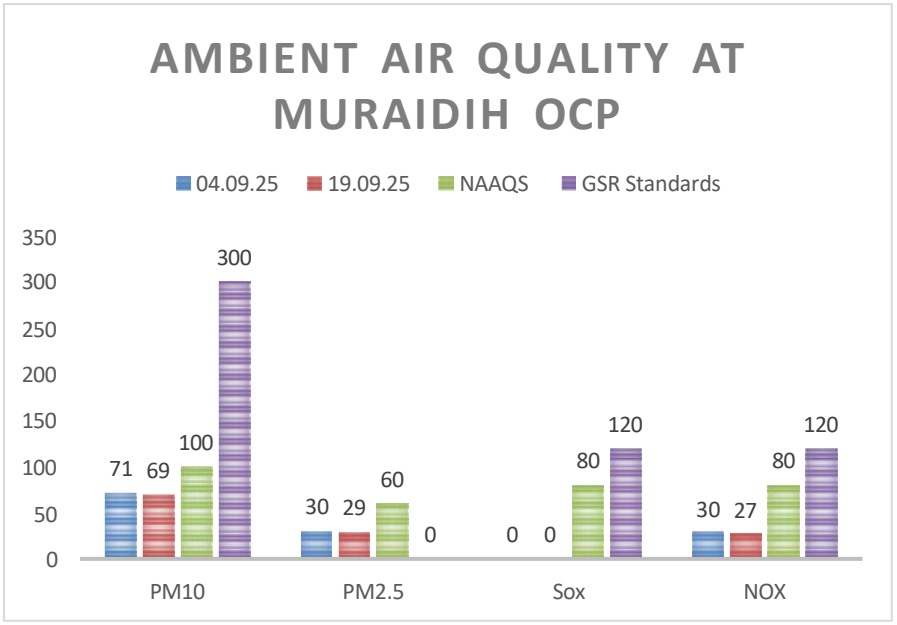
ANALYSED BY ***REVIEWED BY*** (Kumar Vaibhav) ***Authorised Signatory***

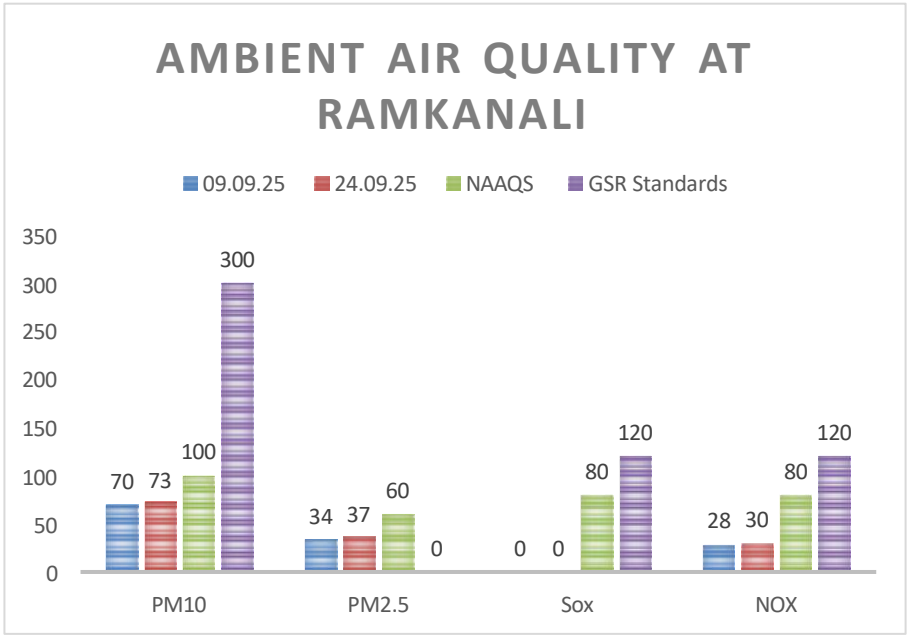
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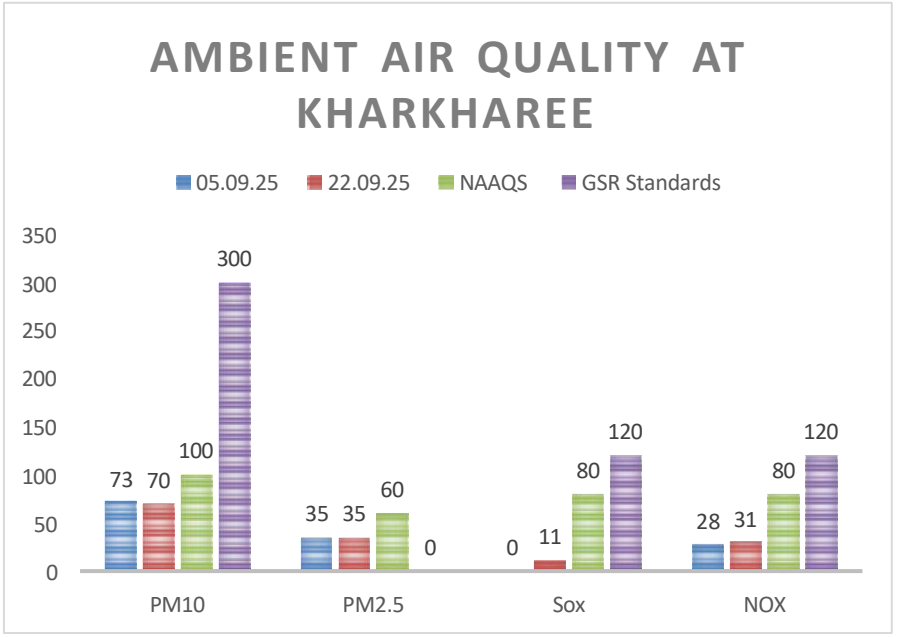
---- End of Report ----

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AMBIENT AIR QUALITY AT BLOCK IV KOORIDIH
08.09.25
23.09.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
75 70 100 300
37 35 60 0
0 10 80 120
21 33 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT MURAIDIH OCP
04.09.25
19.09.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
71 69 100 300
30 29 60 0
0 0 80 120
30 27 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT RAMKANALI
09.09.25
24.09.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
70 73 100 300
34 37 60 0
0 0 80 120
28 30 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT KHARKHAREE
05.09.25
22.09.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
73 70 100 300
35 35 60 0
0 11 80 120
28 31 80 120
PM10
PM2.5
Sox
NOX

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) Mine Discharge of Govindpur (MW3)

A sampling point is fixed to assess the effluent quality of Mine discharge. This location is selected to monitor effluent discharge in to Khudia Nala and Bagdighi Nala.

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. The effluent samples were collected and analysed for four parameters on fortnightly basis at the Environmental Laboratory of CMPDI RI-II, Dhanbad.

3.3 Results & Interpretations

The results are given in tabular form along with the applicable standards. Results are compared with Schedule - VI, effluent prescribed by MoEF&CC. Results show that most of the parameters are within the permissible limits.

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
MINE EFFLUENT TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Mine Effluent samples

Month & Year	**09/2025**	**Cluster**	**Cluster III**	**ULR NO.**		**TC1432125000002152F**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**31.10.2025**
Project		**Sampling Ref. No.**	**REM/BCCL/2025/09**	**Sampling Method**	**IS 3025 (Part-1) CMPDI/RI-II/LPM 13**		
Sampling Stations	**(i)**	**Govindpur**	**Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent**			**Period of Analysis**	**15.09.25 TO 30.09.2025**
			Date of Sampling	15.09.25	29.09.25		

Sl. No.	Parameter	Method of Analysis	Observed Values M1734	Observed Values M1761	STANDARDS FOR COAL MINES (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)	LDL
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	45	47	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.88	7.86	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<4.0	<4.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	48	44	*250 (Max)*	4

***All units in mg/L unless specified otherwise. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*
***Grab sampling carried out for water samples.*



ANALYSED BY



(Gaurav Kant)
REVIEWED BY



(Kumar Vaibhav)
Authorised Signatory

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---- End of Report ----

NOISE LEVEL QUALITY MONITORING

4.1 Location of sampling sites

i) **Block-IV (N6)**

ii) **Nichitpur (N5)**

iii) **Govindpur Village (N7)**

i) Kharkharee (N21)

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter during day time & night time. Noise levels were measured for the complete day & night time, the Intergration time taken was one hour or 3600 seconds. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB (A).

4.2 Results & Interpretations

Ambient noise levels were recorded during day time & night time and the observed values were compared with standards prescribed by MoEF&CC. The results of Noise levels recorded during day & night time on fortnightly basis are presented in tabular form along with the applicable standard permissible limits. The observed values in terms of L_{EQ} are presented**.** The observed values at all the monitoring locations are found to be within permissible limits.

TC-14321

cmpdi A Mini Ratna Company

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**09/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000002168F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**31.10.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/09**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Block IV**	**Date of Sampling**	08.09.25	23.09.25	**Zone Category of Station:**	**Core Zone**

Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A)) First Fortnight**	**Observed Values (in Leq dB(A)) Second Fortnight**	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards**	
								Zones	**Limits in dB**
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	47.5	46.9	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	47.2	47.4					
3		08:00 - 09:00	48.4	46.9					
4		09:00 – 10:00	50.4	51.5					
5		10:00 - 11:00	57.7	54.1					
6		11:00 - 12:00	55.7	56.6					
7		12:00 - 13:00	62.7	62.3					
8		13:00 - 14:00	60.1	58.2					
9		14:00 - 15:00	62.3	64.3					
10		15:00 - 16:00	58.9	60.2					
11		16:00 - 17:00	67.1	67.9					
12		17:00 - 18:00	50.3	51.2					
13		18:00 - 19:00	47.2	50.7					
14		19:00 - 20:00	48	48.3					
15		20:00 - 21:00	48.3	47.2					
16		21:00 - 22:00	46.9	47.5					
		Leq DAY	58.8	59.3					
1	Noise Level dB(A)Leq -Night	22:00-23:00	42.3	41.8	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	41.9	40.1					
3		00:00- 01:00	41.5	39.2					
4		01.00-02.00	41.4	40					
5		02.00-03.00	41	38.9					
6		03.00-04.00	40.5	39.7					
7		04.00-05.00	42.1	41.4					
8		05:00-06:00	42.1	39					
		Leq NIGHT	41.6	40.1					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**09/2025**	**Cluster**	**Cluster III**			**ULR No.**	**TC1432125000002168F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**31.10.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/09**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Muraidih OCP**	**Date of Sampling**	04.09.25	19.09.25	**Zone Category of Station:**	**Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	47.5	46.9	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	47.2	47.4					
3		08:00 - 09:00	48.4	46.9					
4		09:00 – 10:00	50.4	51.5					
5		10:00 - 11:00	57.7	54.1					
6		11:00 - 12:00	55.7	56.6					
7		12:00 - 13:00	62.7	62.3					
8		13:00 - 14:00	60.1	58.2					
9		14:00 - 15:00	62.3	64.3					
10		15:00 - 16:00	58.9	60.2					
11		16:00 - 17:00	67.1	67.9					
12		17:00 - 18:00	50.3	51.2					
13		18:00 - 19:00	47.2	50.7					
14		19:00 - 20:00	48	48.3					
15		20:00 - 21:00	48.3	47.2					
16		21:00 - 22:00	46.9	47.5					
		Leq DAY	58.8	59.3					
1	Noise Level dB(A)Leq - Night	22:00-23:00	42.3	41.8	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	41.9	40.1					
3		00:00- 01:00	41.5	39.2					
4		01.00-02.00	41.4	40					
5		02.00-03.00	41	38.9					
6		03.00-04.00	40.5	39.7					
7		04.00-05.00	42.1	41.4					
8		05:00-06:00	42.1	39					
		Leq NIGHT	41.6	40.1					

**LDL indicates Lower Detection Limit*
***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

Month & Year	**09/2025**	**Cluster**	**Cluster III**				**ULR No.**	**TC1432125000002168F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**						**Date of Issue**	**31.10.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/09**		**Sampling Method**		**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Ramkanali**	**Date of Sampling**	09.09.25	24.09.25	**Zone Category of Station:**	**Buffer Zone**	

Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A))**	**Observed Values (in Leq dB(A))**	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards**	
			First Fortnight	**Second Fortnight**				**Zones**	**Limits in dB**
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	47.3	47.1	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	49.2	49					
3		08:00 - 09:00	47.5	47.4					
4		09:00 – 10:00	48.1	50					
5		10:00 - 11:00	52.8	58.8					
6		11:00 - 12:00	56	56.4					
7		12:00 - 13:00	61.5	62.8					
8		13:00 - 14:00	60.9	59.7					
9		14:00 - 15:00	62.2	63.3					
10		15:00 - 16:00	64	64					
11		16:00 - 17:00	70.7	70.5					
12		17:00 - 18:00	50	50.3					
13		18:00 - 19:00	50.6	49					
14		19:00 - 20:00	44.8	48.6					
15		20:00 - 21:00	47.4	46.9					
16		21:00 - 22:00	48.6	46.6					
		Leq DAY	60.9	61.1					
1	Noise Level dB(A)Leq -Night	22:00-23:00	51.1	50.4	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	51	50.2					
3		00:00- 01:00	48	48.1					
4		01.00-02.00	46	45.8					
5		02.00-03.00	45.5	45.5					
6		03.00-04.00	45.5	45.5					
7		04.00-05.00	47.4	47.1					
8		05:00-06:00	48.4	48.2					
		Leq NIGHT	48.4	48.0					

**LDL indicates Lower Detection Limit*
***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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---- End of Report ----

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**09/2025**	**Cluster**	**Cluster III**	**ULR No.**	**TC1432125000002168F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**31.10.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/09**	**Sampling Method**	**CMPDI/RI-II/LPM 13**
Sampling Stations	**i**	**Kharkharee**	**Date of Sampling**	05.09.25 / 22.09.25	**Zone Category of Station:** **Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	46.9	46.2	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	47.2	47.7					
3		08:00 - 09:00	49.3	48.1					
4		09:00 – 10:00	51.6	52.6					
5		10:00 - 11:00	54.4	54.9					
6		11:00 - 12:00	55.6	53.5					
7		12:00 - 13:00	62.7	62.3					
8		13:00 - 14:00	63.5	61.2					
9		14:00 - 15:00	63.9	63.8					
10		15:00 - 16:00	58.9	59.2					
11		16:00 - 17:00	72.5	62.7					
12		17:00 - 18:00	60.5	58.5					
13		18:00 - 19:00	46.9	47.5					
14		19:00 - 20:00	47.1	46.9					
15		20:00 - 21:00	46.6	47.2					
16		21:00 - 22:00	49.8	47.5					
		Leq DAY	62.3	57.9					
1	Noise Level dB(A)Leq -Night	22:00-23:00	45.1	42.9	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	42.4	42.8					
3		00:00- 01:00	42.5	42.8					
4		01.00-02.00	40.8	41.9					
5		02.00-03.00	40.4	37.3					
6		03.00-04.00	39.9	41.2					
7		04.00-05.00	39.7	38.6					
8		05:00-06:00	38.4	36.4					
		Leq NIGHT	41.6	41.1					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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---- End of Report ----

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Ambient Air Quality Standards for Jharia Coal Field
As per the Environment (Protection) Amendment Rules, 2000 notified vide notification G.S.R. 742(E), dated 25.9.2000.

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
	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. Improvedwest 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 clause2.

** 24hourly/8hourlyvaluesshallbemet 92%ofthetimeinayear.However,8% of the time it may exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981), and in supersession of the notification No(s).S.O.384(E), dated 11th April 1994 and S.O.935(E), dated 14th NOVEMBER 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

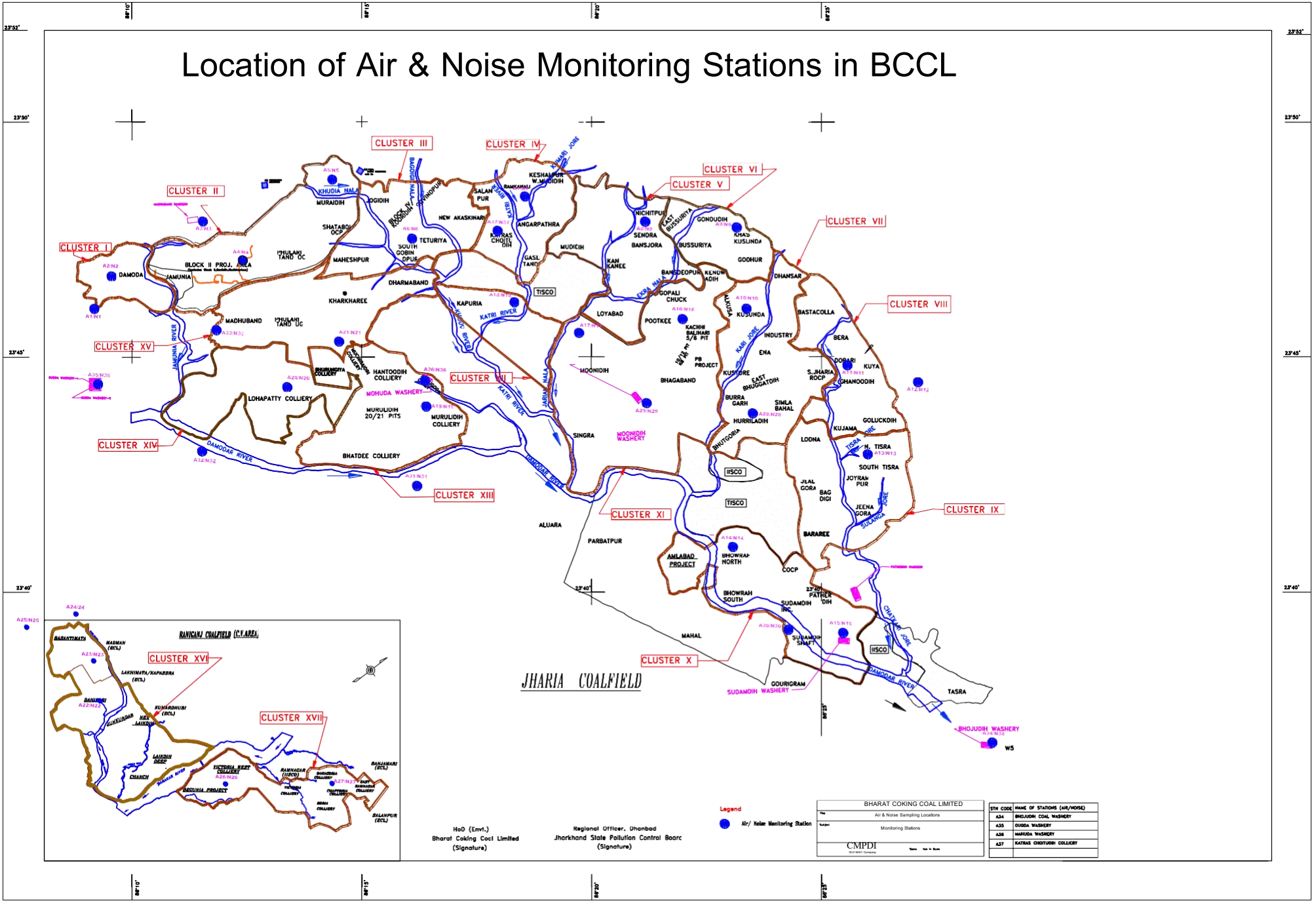
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogendioxide (NO_2), µg/m³	Annual * 24 Hours **	40 80	30 80	-Jacob &Hochheiser modified ($NaOH$-$NaAsO_2$) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM_{10}, µg/m³	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m³	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O_3) , µg/m³	8 Hours * 1 Hour **	100 180	100 180	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb) , µg/m³	Annual * 24 Hours **	0.50 1.0	0.50 1.0	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
Carbon Monoxide (CO), mg/m³	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m³	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C_6H_6), µg/m³	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m³	Annual *	01	01	-Solvent extraction followed byHPLC/GC analysis
Arsenic (As), ng/m³	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m³	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

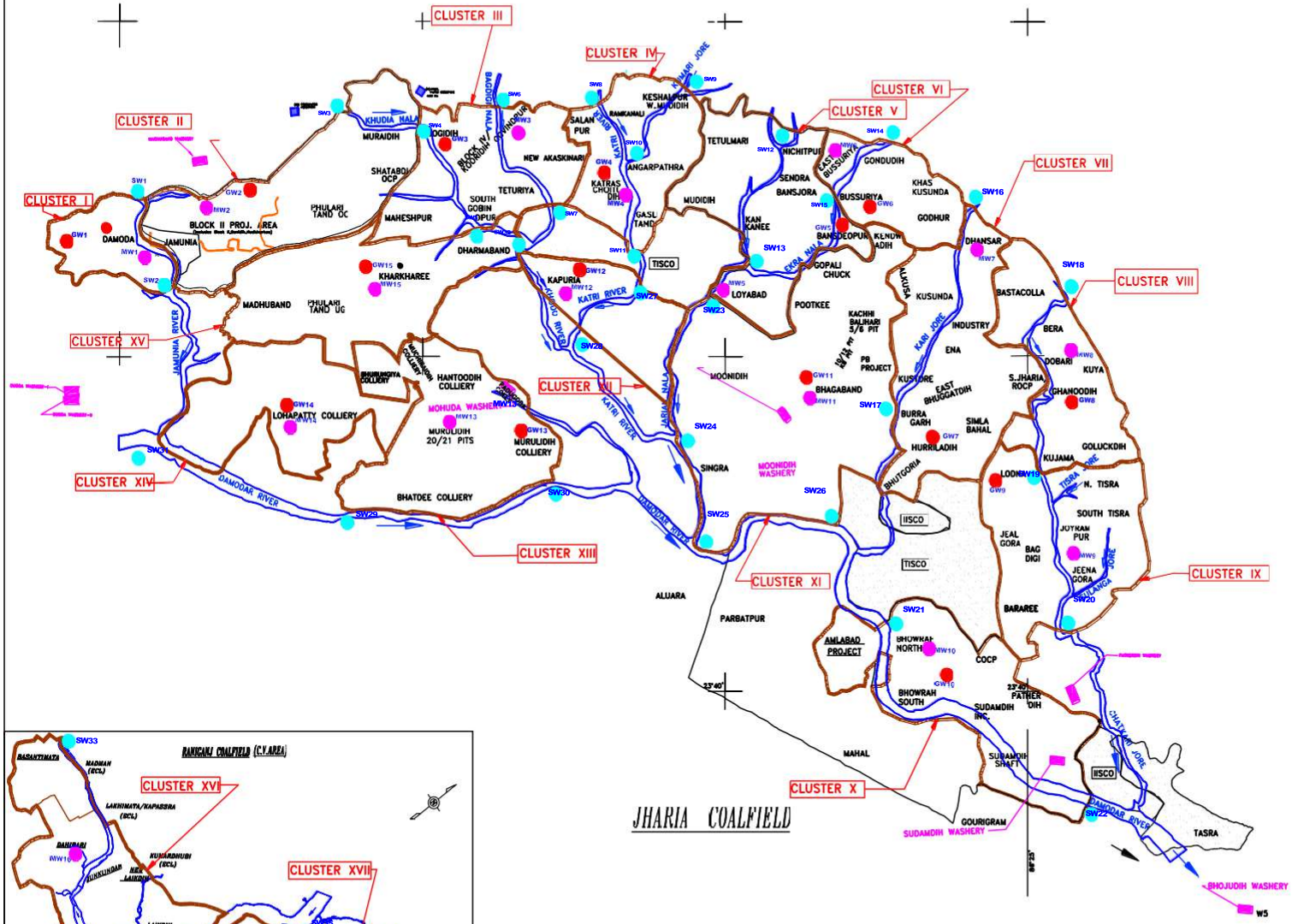
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they JUNE exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



INDEX

Cluster	Suface Water (U/S, D/S)	Name of River/ Nala / Jore	Mine/ Effluent Water	Sampling Location	Ground Water	Sampling Location
I	SW1, SW2	Jamunia River	MW1	Damoda Area	GW1	Ghutway Village
II	SW3, SW4	Khudia Nala	MW2	Block II OCP	GW2	Joyrampur Village
III	SW4, SW5, SW6, SW7	Khudia Nala, Bagdigi Nala	MW3	Govindpur Colliery	GW3	Jogidih Village
IV	SW8, SW11, SW9, SW10 SW12, SW13	Katri River, Kumari Jore Jarian	MW4	Chotudih	GW4	Kankanee Village
V	SW15	Nala, Ekra Nala	MW5	Mudidih	GW5	Nichitpur Bansjora
VI	SW14, SW15	Ekra Nala	MW6	Bassuria UGP	GW6	Borewell
VII	SW16, SW17	Katri Jore	MW7	Dhansar UGP	GW7	Murlidih
VIII	SW18, SW19	Katri Jore	MW8	Dobari UGP	GW8	Ghanoodih
IX	SW19, SW20	Kashi Jore	MW9	Jeenagora	GW9	Lodna
X	SW21, SW22	Damodar River	MW10	Bhowrah North	GW10	Bhowrah South
XI	SW23, SW24, SW25, SW26	Jarian Nala, Damodar River	MW11	Bhagabandh UGP	GW11	Bhagabandh
XII	SW27, SW28	Katri River	MW12	Kapuria	GW12	Kapuria
XIII	SW29, SW30	Damodar River	MW13	Murulidih (20/21)	GW13	Murlidih
XIV	SW31, SW29	Damodar River	MW14	Lohapatti	GW14	Lohapatti
XV	SW5, SW32	Khudia Nala	MW15	Kharkharee UGP	GW15	Kharkharee
XVI	SW33, SW34	Khudia River	MW16	Dahibari OCP	GW16	Patlabari Village
XVII	SW35, SW36	Barakar River	MW17	Damagoria Colliery	GW17	Chaptoria

HoD (Envt.)
Bharat Coking Coal Limited
(Signature)

Regional Officer, Dhanbad
Jharkhand State Pollution Control Board
(Signature)

Legend
- Sampling Locations of Surface Water (Upstream/ Downstream)
- Sampling Locations of Mine Water
- Sampling Locations of Ground/ Drinking Water

BHARAT COKING COAL LIMITED

Customer	WATER SAMPLING LOCATIONS
Title	MONITORING STATIONS
Subject	CMPDI
Scale	Not to Scale

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ENVIRONMENTAL MONITORING REPORT OF BHARAT COKING COAL LIMITED, CLUSTER – III

(FOR THE MONTH AUGUST, 2025)

E. C. no. J-11015/213/2010-IA.II (M) dated 06.02.2013.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

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3.	CHAPTER-III	RESULTS	7-19
4.	CHAPTER-IV	STANDARDS AND PLANS	20-21

EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the fauna and flora. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal Limited (BCCL), a Subsidiary company of Coal India Limited is operating Underground and Opencast Mines in Jharia Coalfield (JCF) is a part of Gondwana Coalfields located in Dhanbad district of Jharkhand, the JCF is bounded by $23^0$37' N to $23^0$52' N latitudes and $86^0$09' E to $86^0$30' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Jharia Coalfield (JCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEF&CC while granting environmental clearance of project, consent letter issued by the respective SPCB, and other statutory requirements.

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

The ambient air quality monitoring stations were selected to represent core, buffer zone area. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

2.2 Water sampling stations

The Water sampling stations were selected for mine sump water.

2.3 Noise level monitoring locations

Noise levels vary depending on the various activities in mining areas. The monitoring of noise level in different locations will be helpful to take appropriate mitigating measures. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_X). Respirable Dust Samplers (RDS) and Fine Dust Sampler ($PM_{2.5}$

sampler) were used for sampling of $PM_{10,}$ SO_2, & NO_x and Fine Dust Sampler ($PM_{2.5}$ sampler) were used for sampling of $PM_{2.5}$ at 24 hours interval once in a fortnight and the same for the gaseous pollutants. The samples were analysed in Environmental Laboratory of CMPDI, RI-II, Dhanbad.

3.2 Water quality

Water samples were collected as per standard practice. The Mine effluent samples were collected and analysed for four parameters on fortnightly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory of CMPDI, RI- II, Dhanbad.

3.3 Noise level monitoring

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB(A).

4.0 Results and interpretations

4.1 Air quality

It has been seen from the analysis results that the 24 hours average concentration parameters like $PM_{10,}$ $PM_{2.5}$, SO_2 and NO_x are mostly within the permissible limits in all sampling locations as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines and National Ambient Air Quality Standard -2009. Sometimes the concentration of PM_{10}& $PM_{2.5}$ exceeds the limits due to heavy public traffic, poor road condition, coke oven plants, burning of coal by surrounding habitants, brick making, municipal waste dumps and industries like Steel Plant, thermal Plants including their fly ash etc.

The following preventive and suppressive mitigative measures can be undertaken to contain the pollution level within prescribed level:-

- Wet drilling and controlled blasting should be practice.
- Explosive used should be optimised to restrict the dust generation.
- Transportation roads should be permanently asphalted free of ruts, potholes etc.
- Water should be sprayed on coal transportation road, service road more frequently and at regular interval.
- Dust from roads should be removed physically or mechanically.
- Greenbelts around industrial sites, service building area besides Avenue plantation along roads should be created.
- Coal dust should be suppressed by using fixed sprinklers.
- Regular maintenance of plant and machinery should be undertaken.

4.2 Water quality

The test results indicate that the major parameters compared with MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines, are within permissible limits.

4.3 Noise Level

During the noise level survey it has been observed that the noise level in the sampling locations is within the permissible limits prescribed as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines for Industrial Area and Noise pollution (Regulation and Control) Rules, 2000.

INTRODUCTION

Any industry and development activities including coal mining is bound to affect environmental attributes. There are positive as well as negative impacts of such operations. For controlling the adverse impacts a regular monitoring is essential. The environmental monitoring is being done as per the guide-lines stipulated by Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India.

The very purpose of environmental monitoring is to assess the quality of various attributes which affects the environment. As per quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.

The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akasshkinaree Mine and Block IV Kooridih Mixed Mine as per **E. C. no. J-11015/213/2010-IA.II**(M) dated 06.02.2013 and later all seven mines are amalgamated to single mine Named Cluster III with OC cum UG with Highway Mining method with no change in lease area and production capacity. The cluster – III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster-III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and Bagdighi Nala.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity of 2.769 MTPA (normative) and 3.6 MTPA peak capacity of coal production vide letter no **E. C. no. J-11015/213/2010-IA. II**(M) dated 06.02.2013 later with **E. C. no. J-11015/213/2010-IA. II**(M) dated 03.03.2025.

Ministry of Environment, Forest and Climate Change while granting environmental clearance has given one of the General conditions that " Four ambient air quality monitoring stations should be established in the core zone as well as in the buffer zone for PM_{10}, $PM_{2.5}$, SO_2, NOx monitoring. Location of the stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets, other conditions regarding water / effluent and noise level monitoring in consultation with the State Pollution Control Board."

In compliance of these conditions the Environmental Monitoring has been carried out & report prepared for submission to MoEF&CC & JSPCB and other statutory authorities.

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

(As per G.S.R. 742 (E) dt. 25th December, 2000)

2.1.1 Ambient Air Quality Sampling Locations

CORE ZONE Monitoring Location

i) Block IV Kooridih OCP (A6): Industrial Area

The location of the sampling station is at 23°47'54.00"N & 86°16'20.00"E. The sampler was placed at 1.5 m above the ground level near Safety office of Block IV OCP.

BUFFER ZONE Monitoring Location

i) Muraidih OCP (A5) : Industrial Area

The sampler was placed at a height of 1.5 m from the ground level at Muraidih project office.

ii) Ramkanali Workshop (A7) : Industrial area

The location of the sampling station is 23°48'34.00"N & 86°18'22.00"E. The sampler was placed at height of 1.5 m above the ground level at AARC agent Office, Ramkanali.

iii) Kharkharee(A21): **Industrial Area**

The location of the sampling station is 23°46'29.00"N & 86°14'37.08"E. The sampler was placed at a height of 1.5 m above the ground level at Kharkharee Colliery.

AMBIENT AIR QUALITY DATA

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**8/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000001998F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.09.2025**
Project	**Block-IV**		**Sample Ref. No.**	**REM/BCCL/2025/08**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	05.08.25		20.08.25	**Period of Analysis**	05.08.2025 – 02.09.2025	**Zone of Station:**	**Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4335	**A4404**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	75	70	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	37	35	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	35	32	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

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TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
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Phone:0326-223-850

Test Report for Ambient Air Samples

Month & Year	**08/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000001998F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.09.2025**
Project	**Ramkanali Workshop**		**Sample Ref. No.**	**REM/BCCL/2025/08**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	04.08.25		19.08.25	**Period of Analysis**	04.08.2025 – 02.09.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4327	**A4396**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	70	73	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	34	37	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	34	31	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY | (Gaurav Kant) ***REVIEWED BY*** | (Kumar Vaibhav) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

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Test Report for Ambient Air Samples

Month & Year	**08/2025**	**Cluster**	**Cluster III**			**ULR No.**	**TC1432125000001998F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.09.2025**
Project	**Muraidih**		**Sample Ref. No.**	**REM/BCCL/2025/08**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	13.08.2025		27.08.2025	**Date of Sampling**	13.08.2025 – 02.09.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4384	**A4451**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	71	69	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	30	29	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	28	28	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY | (Gaurav Kant) ***REVIEWED BY*** | (Kumar Vaibhav) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

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TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
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Test Report for Ambient Air Samples

Month & Year	**08/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000001998F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.09.2025**
Project	**Kharkharee**		**Sample Ref. No.**	**REM/BCCL/2025/08**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	06.08.25		21.08.25	**Period of Analysis**	06.08.2025 – 02.09.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4343	**A4412**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	73	70	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	35	35	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	11	10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	32	34	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

***All units are in µg/m3, 24 hourly Average, * LDL indicates Lower Detection Limit,*

ANALYSED BY

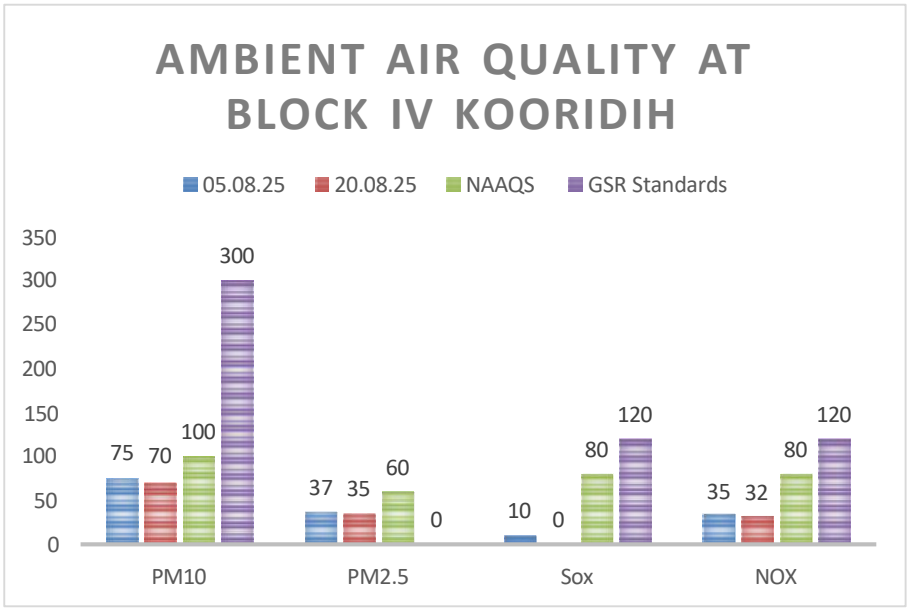
(Gaurav Kant)
REVIEWED BY

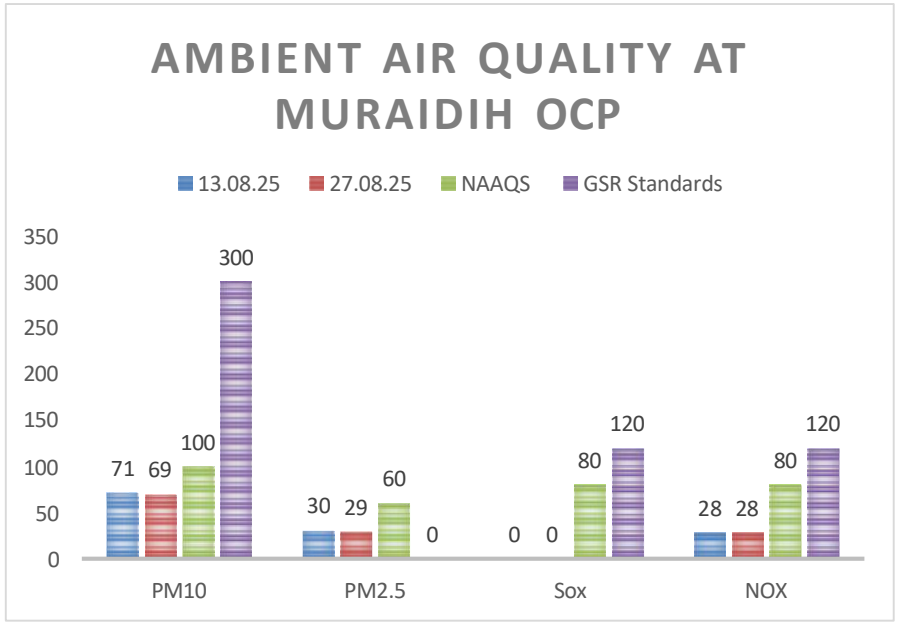
(Kumar Vaibhav)
Authorised Signatory

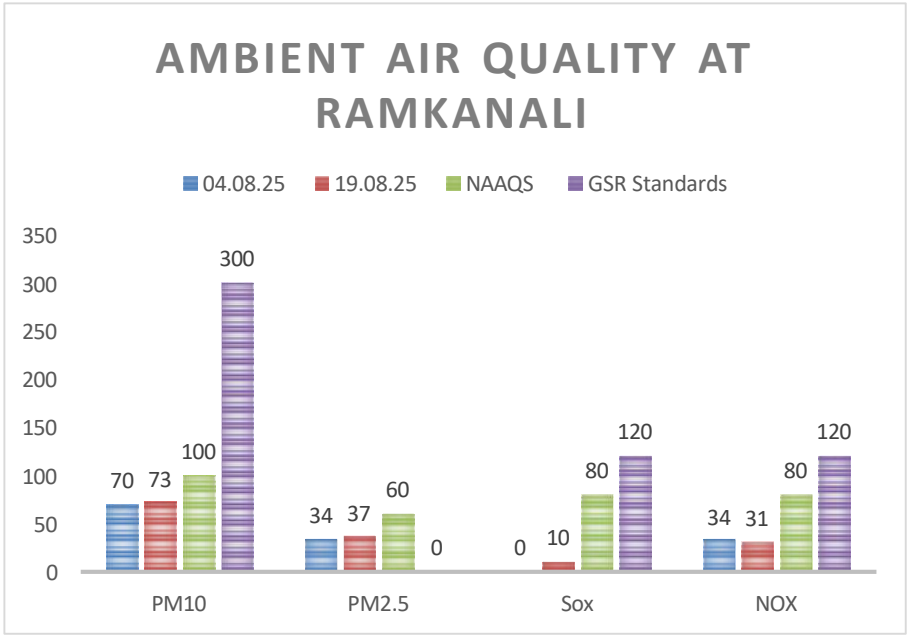
***Note**: The results above relate to the samples tested as received. This report cannot be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

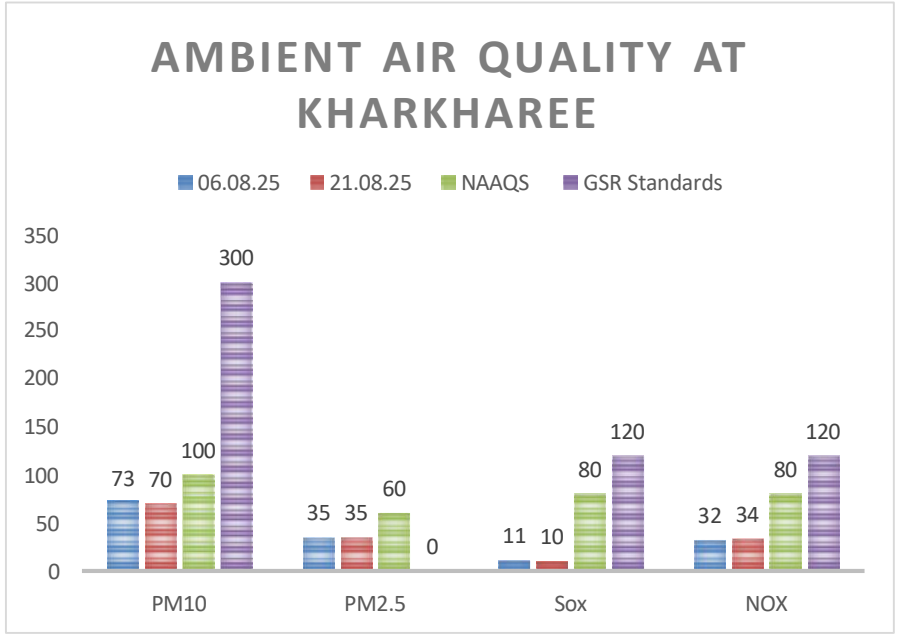
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AMBIENT AIR QUALITY AT BLOCK IV KOORIDIH
05.08.25
20.08.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
75 70 100 300
37 35 60 0
10 0 80 120
35 32 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT MURAIDIH OCP
13.08.25
27.08.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
71 69 100 300
30 29 60 0
0 0 80 120
28 28 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT RAMKANALI
04.08.25
19.08.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
70 73 100 300
34 37 60 0
0 10 80 120
34 31 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT KHARKHAREE
06.08.25
21.08.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
73 70 100 300
35 35 60 0
11 10 80 120
32 34 80 120
PM10
PM2.5
Sox
NOX

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) Mine Discharge of Govindpur (MW3)

A sampling point is fixed to assess the effluent quality of Mine discharge. This location is selected to monitor effluent discharge in to Khudia Nala and Bagdighi Nala.

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. The effluent samples were collected and analysed for four parameters on fortnightly basis at the Environmental Laboratory of CMPDI RI-II, Dhanbad.

3.3 Results & Interpretations

The results are given in tabular form along with the applicable standards. Results are compared with Schedule - VI, effluent prescribed by MoEF&CC. Results show that most of the parameters are within the permissible limits.

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
MINE EFFLUENT TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Mine Effluent samples

Month & Year	**08/2025**	**Cluster**	**Cluster III**	**ULR NO.**		**TC1432125000002016F**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.09.2025**
Project		**Sampling Ref. No.**	**REM/BCCL/2025/08**	**Sampling Method**	**IS 3025 (Part-1) CMPDI/RI-II/LPM 13**		
Sampling Stations	**(i)**	**Govindpur**	**Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent**			**Period of Analysis**	**04.08.2025 TO 30.08.2025**
			Date of Sampling	04.08.25	18.08.2025		

Sl. No.	Parameter	Method of Analysis	Observed Values		STANDARDS FOR COAL MINES (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)	LDL
			M1666	M1693		
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	44	42	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.75	7.79	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<4.0	<4.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	32	36	*250 (Max)*	4

***All units in mg/L unless specified otherwise. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*
***Grab sampling carried out for water samples.*

ANALYSED BY | (Gaurav Kant) ***REVIEWED BY*** | (Kumar Vaibhav) ***Authorised Signatory***

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

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NOISE LEVEL QUALITY MONITORING

4.1 Location of sampling sites

i) **Block-IV (N6)**

ii) **Nichitpur (N5)**

iii) **Govindpur Village (N7)**

i) Kharkharee (N21)

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter during day time & night time. Noise levels were measured for the complete day & night time, the Intergration time taken was one hour or 3600 seconds. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB (A).

4.2 Results & Interpretations

Ambient noise levels were recorded during day time & night time and the observed values were compared with standards prescribed by MoEF&CC. The results of Noise levels recorded during day & night time on fortnightly basis are presented in tabular form along with the applicable standard permissible limits. The observed values in terms of L_{EQ} are presented**.** The observed values at all the monitoring locations are found to be within permissible limits.

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
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TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

Month & Year	**08/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000002032F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.09.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/08**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Block IV**	**Date of Sampling**	05.08.25	20.08.25	**Zone Category of Station:**	**Core Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	47.3	46.2	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	50.9	50					
3		08:00 - 09:00	51.7	50.8					
4		09:00 – 10:00	54.8	54					
5		10:00 - 11:00	54.3	53.4					
6		11:00 - 12:00	55.5	55					
7		12:00 - 13:00	55.2	54					
8		13:00 - 14:00	55.4	55.9					
9		14:00 - 15:00	55.7	54.9					
10		15:00 - 16:00	58.2	56.7					
11		16:00 - 17:00	58.9	58.7					
12		17:00 - 18:00	59.7	59.5					
13		18:00 - 19:00	58.6	56.7					
14		19:00 - 20:00	58.2	57.6					
15		20:00 - 21:00	52.5	51.6					
16		21:00 - 22:00	51.4	50.3					
		Leq DAY	56.0	55.3					
1	Noise Level dB(A)Leq -Night	22:00-23:00	47	46.7	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	46.2	44.3					
3		00:00- 01:00	44.7	43.7					
4		01.00-02.00	40	40.3					
5		02.00-03.00	39.6	39.8					
6		03.00-04.00	42.5	41					
7		04.00-05.00	40.7	40.2					
8		05:00-06:00	41	41.9					
		Leq NIGHT	43.6	42.9					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
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Month & Year	**08/2025**	**Cluster**	**Cluster III**				**ULR No.**	**TC1432125000002032F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**						**Date of Issue**	**05.09.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/08**		**Sampling Method**		**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Muraidih OCP**	**Date of Sampling**	13.08.25	27.08.25	**Zone Category of Station:**	**Buffer Zone**	

Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A)) First Fortnight**	**Observed Values (in Leq dB(A)) Second Fortnight**	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards**	
								Zones	**Limits in dB**
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	40	39.9	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	40.1	41.8					
3		08:00 - 09:00	44.5	44					
4		09:00 – 10:00	45.5	46.1					
5		10:00 - 11:00	46.2	46.5					
6		11:00 - 12:00	48.3	48.1					
7		12:00 - 13:00	49.4	51					
8		13:00 - 14:00	45.2	45.9					
9		14:00 - 15:00	46.2	46.5					
10		15:00 - 16:00	48.3	49.4					
11		16:00 - 17:00	43.8	44					
12		17:00 - 18:00	40	40					
13		18:00 - 19:00	38.7	38.6					
14		19:00 - 20:00	39.1	39.1					
15		20:00 - 21:00	38.6	39.3					
16		21:00 - 22:00	38.4	38.7					
		Leq DAY	44.8	45.5					
1	Noise Level dB(A)Leq - Night	22:00-23:00	37.5	37.6	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	37.1	37.5					
3		00:00- 01:00	36.7	37.3					
4		01.00-02.00	36.6	36.9					
5		02.00-03.00	36.5	36.6					
6		03.00-04.00	37.4	37.2					
7		04.00-05.00	38.9	37.8					
8		05:00-06:00	38.9	38.9					
		Leq NIGHT	37.5	37.5					

**LDL indicates Lower Detection Limit*
***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

Month & Year	**08/2025**	**Cluster**	**Cluster III**				**ULR No.**	**TC1432125000002032F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**						**Date of Issue**	**05.09.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/08**		**Sampling Method**		**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Ramkanali**	**Date of Sampling**	04.08.25	19.08.25	**Zone Category of Station:**	**Buffer Zone**	

Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A)) First Fortnight**	**Observed Values (in Leq dB(A)) Second Fortnight**	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards**	
								Zones	**Limits in dB**
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	45.5	44.7	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	47.7	47.1					
3		08:00 - 09:00	50.1	49.7					
4		09:00 – 10:00	55.6	54.9					
5		10:00 - 11:00	56.9	55.9					
6		11:00 - 12:00	55.6	54.9					
7		12:00 - 13:00	58.2	59.5					
8		13:00 - 14:00	59.6	58.6					
9		14:00 - 15:00	53.4	53.4					
10		15:00 - 16:00	52.5	52.5					
11		16:00 - 17:00	52.2	52.2					
12		17:00 - 18:00	52.5	51.7					
13		18:00 - 19:00	51.7	50.9					
14		19:00 - 20:00	50.6	50.8					
15		20:00 - 21:00	50.6	50.3					
16		21:00 - 22:00	49.1	49.8					
		Leq DAY	54.2	53.9					
1	Noise Level dB(A)Leq -Night	22:00-23:00	47.3	46.7	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	47.2	46.5					
3		00:00- 01:00	44.5	44.6					
4		01.00-02.00	42.7	42.5					
5		02.00-03.00	42.2	42.2					
6		03.00-04.00	42	42					
7		04.00-05.00	43.9	43.6					
8		05:00-06:00	44.9	44.7					
		Leq NIGHT	44.8	44.5					

**LDL indicates Lower Detection Limit*
***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
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email: rdri2cmpdi@coalindia.in

Month & Year	**08/2025**	**Cluster**	**Cluster III**	**ULR No.**	**TC1432125000002032F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**05.09.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/08**	**Sampling Method**	**CMPDI/RI-II/LPM 13**
Sampling Stations	**i**	**Kharkharee**	**Date of Sampling**	06.08.25 / 21.08.25	**Zone Category of Station:** **Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	37.9	38.5	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	51.2	51.1					
3		08:00 - 09:00	60.9	61					
4		09:00 – 10:00	60.8	60.6					
5		10:00 - 11:00	57.6	56.6					
6		11:00 - 12:00	55.2	54.8					
7		12:00 - 13:00	53.1	53.9					
8		13:00 - 14:00	51.6	51					
9		14:00 - 15:00	49.7	49.1					
10		15:00 - 16:00	48.3	48.6					
11		16:00 - 17:00	48.6	49.2					
12		17:00 - 18:00	48.4	49					
13		18:00 - 19:00	46.2	46.2					
14		19:00 - 20:00	44.7	44.8					
15		20:00 - 21:00	42.9	43.1					
16		21:00 - 22:00	42.3	42.7					
		Leq DAY	54.2	54.1					
1	Noise Level dB(A)Leq -Night	22:00-23:00	41.6	39.7	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	39.1	39.6					
3		00:00- 01:00	39.2	39.6					
4		01.00-02.00	37.6	38.7					
5		02.00-03.00	37.3	34.5					
6		03.00-04.00	36.9	38.1					
7		04.00-05.00	36.7	35.7					
8		05:00-06:00	35.5	33.6					
		Leq NIGHT	38.4	38.0					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

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---- End of Report ----

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Ambient Air Quality Standards for Jharia Coal Field
As per the Environment (Protection) Amendment Rules, 2000 notified vide notification G.S.R. 742(E), dated 25.9.2000.

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
	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. Improvedwest 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 clause2.

** 24hourly/8hourlyvaluesshallbemet 92%ofthetimeinayear.However,8% of the time it may exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981), and in supersession of the notification No(s).S.O.384(E), dated 11th April 1994 and S.O.935(E), dated 14th NOVEMBER 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

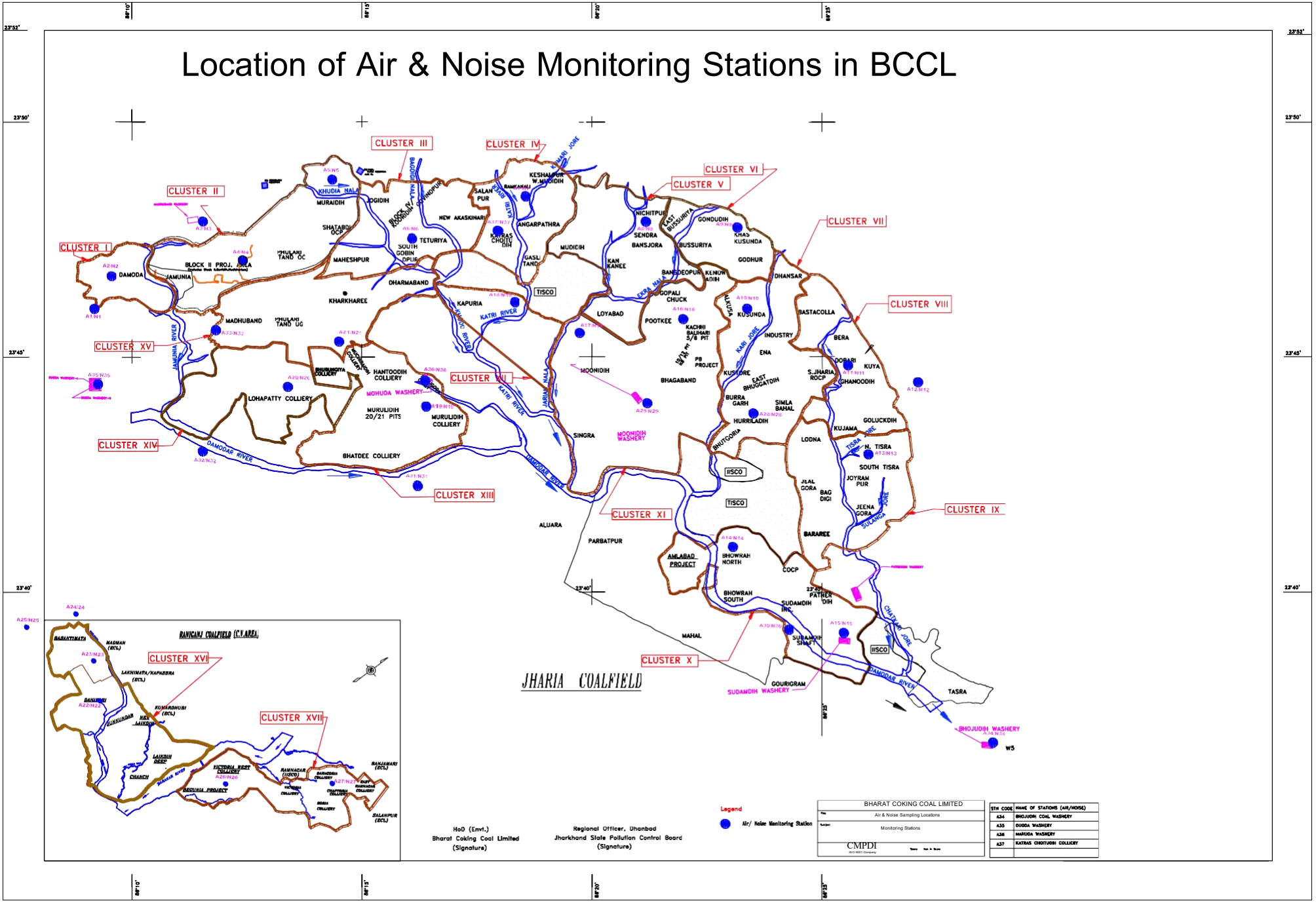
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogendioxide (NO_2), µg/m³	Annual * 24 Hours **	40 80	30 80	-Jacob &Hochheiser modified ($NaOH$-$NaAsO_2$) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM_{10}, µg/m³	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m³	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O_3) , µg/m³	8 Hours * 1 Hour **	100 180	100 180	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb) , µg/m³	Annual * 24 Hours **	0.50 1.0	0.50 1.0	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
Carbon Monoxide (CO), mg/m³	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m³	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C_6H_6), µg/m³	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m³	Annual *	01	01	-Solvent extraction followed byHPLC/GC analysis
Arsenic (As), ng/m³	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m³	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

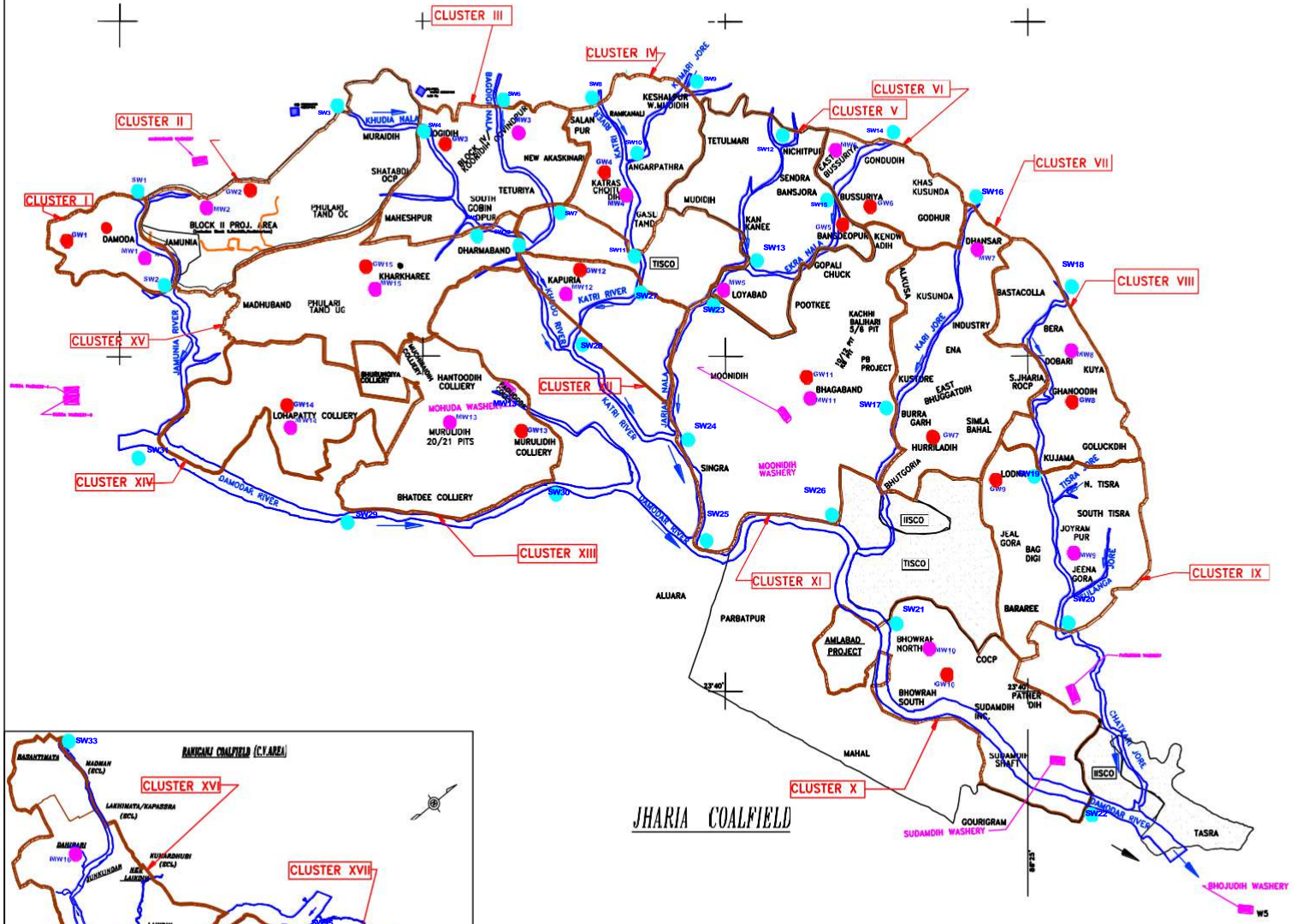
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they JUNE exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



INDEX

Cluste	Suface Wate (U/S, D/S)	Name of River/ Nala / Jore	Mine/ Effluent Water	Sampling Location	Ground Water	Sampling Location
I	SW1, SW2	Jamunia River	MW1	Damoda Area	GW1	Ghutway Village
II	SW3, SW4	Khudia Nala	MW2	Block II OCP	GW2	Joyrampur Village
III	SW4, SW5, SW6, SW7	Khudia Nala, Sagdigi Nala	MW3	Govindpur Colliery	GW3	Jogidih Village
IV	SW8, SW11, SW9, SW10	Katri River, Kumari Jore Jarian	MW4	Chotudih	GW4	Kankanee Village
V	SW12, SW13, SW15	Nala, Ekra Nala	MW5	Mudidih East	GW5	Nichitpur Bansjora
VI	SW14, SW15	Ekra Nala	MW6	Bassuria UGP	GW6	Borewell
VII	SW16, SW17	Kari Jore	MW7	Dhansar UGP	GW7	Lurlidih
VIII	SW18, SW19	Kashi Jore	MW8	Dobari UGP	GW8	Dhanodih
IX	SW19, SW20	Kashi Jore	MW9	Jeenagora	GW9	Lodna
X	SW21, SW22	Damodar River	MW10	Bhowrah North	GW10	Bhowrah South
XI	SW23, SW24, SW25, SW26	Jarian Nala, Damodar River	MW11	Bhagabandh UGP	GW11	Bhagabandh
XII	SW27, SW28	Katri River	MW12	Kapuria	GW12	Kapuria
XIII	SW29, SW30	Damodar River	MW13	Murulidih (20/21)	GW13	Murlidih
XIV	SW31, SW29	Damodar River	MW14	Lohapatti	GW14	Lohapatti
XV	SW5, SW32	Khudia Nala	MW15	Kharkharee UGP	GW15	Kharkharee
XVI	SW33, SW34	Khudia River	MW16	Dahibari OCP	GW16	Pallabari Village
XVII	SW35, SW36	Barakar River	MW17	Damagoria Colliery	GW17	Chaptoria

HoD (Envt.)
Bharat Coking Coal Limited
(Signature)

Regional Officer, Dhanbad
Jharkhand State Pollution Control Board
(Signature)

Legend
- Sampling Locations of Surface Water (Upstream/ Downstream)
- Sampling Locations of Mine Water
- Sampling Locations of Ground/ Drinking Water

BHARAT COKING COAL LIMITED

Customer	WATER SAMPLING LOCATIONS
Title	MONITORING STATIONS
Subject	CMPDI

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FOR COMPANY USE ONLY RESTRICTED
The information given in this report is not to be communicated either directly or indirectly to the press or to any person not holding an official position in the CIL /GOVERNMENT.

ENVIRONMENTAL MONITORING REPORT OF BHARAT COKING COAL LIMITED, CLUSTER – III

(FOR THE MONTH JULY, 2025)

E. C. no. J-11015/213/2010-IA.II (M) dated 06.02.2013.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

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4.	CHAPTER-IV	STANDARDS AND PLANS	20-21

EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the fauna and flora. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal Limited (BCCL), a Subsidiary company of Coal India Limited is operating Underground and Opencast Mines in Jharia Coalfield (JCF) is a part of Gondwana Coalfields located in Dhanbad district of Jharkhand, the JCF is bounded by $23^0$37' N to $23^0$52' N latitudes and $86^0$09' E to $86^0$30' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Jharia Coalfield (JCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEF&CC while granting environmental clearance of project, consent letter issued by the respective SPCB, and other statutory requirements.

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

The ambient air quality monitoring stations were selected to represent core, buffer zone area. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

2.2 Water sampling stations

The Water sampling stations were selected for mine sump water.

2.3 Noise level monitoring locations

Noise levels vary depending on the various activities in mining areas. The monitoring of noise level in different locations will be helpful to take appropriate mitigating measures. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_x). Respirable Dust Samplers (RDS) and Fine Dust Sampler ($PM_{2.5}$

sampler) were used for sampling of $PM_{10,}$ SO_2, & NO_x and Fine Dust Sampler ($PM_{2.5}$ sampler) were used for sampling of $PM_{2.5}$ at 24 hours interval once in a fortnight and the same for the gaseous pollutants. The samples were analysed in Environmental Laboratory of CMPDI, RI-II, Dhanbad.

3.2 Water quality

Water samples were collected as per standard practice. The Mine effluent samples were collected and analysed for four parameters on fortnightly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory of CMPDI, RI- II, Dhanbad.

3.3 Noise level monitoring

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB(A).

4.0 Results and interpretations

4.1 Air quality

It has been seen from the analysis results that the 24 hours average concentration parameters like $PM_{10,}$ $PM_{2.5}$, SO_2 and NO_x are mostly within the permissible limits in all sampling locations as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines and National Ambient Air Quality Standard -2009. Sometimes the concentration of PM_{10}& $PM_{2.5}$ exceeds the limits due to heavy public traffic, poor road condition, coke oven plants, burning of coal by surrounding habitants, brick making, municipal waste dumps and industries like Steel Plant, thermal Plants including their fly ash etc.

The following preventive and suppressive mitigative measures can be undertaken to contain the pollution level within prescribed level:-

- Wet drilling and controlled blasting should be practice.
- Explosive used should be optimised to restrict the dust generation.
- Transportation roads should be permanently asphalted free of ruts, potholes etc.
- Water should be sprayed on coal transportation road, service road more frequently and at regular interval.
- Dust from roads should be removed physically or mechanically.
- Greenbelts around industrial sites, service building area besides Avenue plantation along roads should be created.
- Coal dust should be suppressed by using fixed sprinklers.
- Regular maintenance of plant and machinery should be undertaken.

4.2 Water quality

The test results indicate that the major parameters compared with MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines, are within permissible limits.

4.3 Noise Level

During the noise level survey it has been observed that the noise level in the sampling locations is within the permissible limits prescribed as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines for Industrial Area and Noise pollution (Regulation and Control) Rules, 2000.

INTRODUCTION

Any industry and development activities including coal mining is bound to affect environmental attributes. There are positive as well as negative impacts of such operations. For controlling the adverse impacts a regular monitoring is essential. The environmental monitoring is being done as per the guide-lines stipulated by Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India.

The very purpose of environmental monitoring is to assess the quality of various attributes which affects the environment. As per quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.

The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akasshkinaree Mine and Block IV Kooridih Mixed Mine as per **E. C. no. J-11015/213/2010-IA.II**(M) dated 06.02.2013 and later all seven mines are amalgamated to single mine Named Cluster III with OC cum UG with Highway Mining method with no change in lease area and production capacity. The cluster – III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster- III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and Bagdighi Nala.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity of 2.769 MTPA (normative) and 3.6 MTPA peak capacity of coal production vide letter no **E. C. no. J-11015/213/2010-IA. II**(M) dated 06.02.2013 later with **E. C. no. J-11015/213/2010-IA. II**(M) dated 03.03.2025.

Ministry of Environment, Forest and Climate Change while granting environmental clearance has given one of the General conditions that " Four ambient air quality monitoring stations should be established in the core zone as well as in the buffer zone for PM_{10}, $PM_{2.5}$, SO_2, NOx monitoring. Location of the stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets, other conditions regarding water / effluent and noise level monitoring in consultation with the State Pollution Control Board."

In compliance of these conditions the Environmental Monitoring has been carried out & report prepared for submission to MoEF&CC & JSPCB and other statutory authorities.

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

(As per G.S.R. 742 (E) dt. 25th December, 2000)

2.1.1 Ambient Air Quality Sampling Locations

CORE ZONE Monitoring Location

i) Block IV Kooridih OCP (A6): Industrial Area

The location of the sampling station is at 23°47'54.00"N & 86°16'20.00"E. The sampler was placed at 1.5 m above the ground level near Safety office of Block IV OCP.

BUFFER ZONE Monitoring Location

i) Muraidih OCP (A5): Industrial Area

The sampler was placed at a height of 1.5 m from the ground level at Muraidih project office.

ii) Ramkanali Workshop (A7): Industrial area

The location of the sampling station is 23°48'34.00"N & 86°18'22.00"E. The sampler was placed at height of 1.5 m above the ground level at AARC agent Office, Ramkanali.

iii) Kharkharee(A21): **Industrial Area**

The location of the sampling station is 23°46'29.00"N & 86°14'37.08"E. The sampler was placed at a height of 1.5 m above the ground level at Kharkharee Colliery.

AMBIENT AIR QUALITY DATA

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

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Test Report for Ambient Air Samples

Month & Year	**7/2025**	**Cluster**	**Cluster III**	**ULR NO.**	**TC1432125000001946F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**21.08.2025**
Project	**Block-IV**	**Sample Ref. No.**	**REM/BCCL/2025/07**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	07.07.25	22.07.25	**Period of Analysis**	07.07.25 – 20.08.25	**Zone of Station:** **Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4006	**A4092**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	61	61	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	30	30	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	**33**	**35**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY (Gaurav Kant) ***REVIEWED BY*** (Amit Raj Mishra) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

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Test Report for Ambient Air Samples

Month & Year	**07/2025**	**Cluster**	**Cluster III**			**ULR No.**	**TC1432125000001946F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**21.08.2025**
Project	**Muraidih**		**Sample Ref. No.**	**REM/BCCL/2025/07**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	03.07.2025		18.07.2025	**Date of Sampling**	03.07.2025	20.08.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4043	**A4121**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	65	58	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	29	25	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	**32**	**28**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

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Ambient Air Quality Test Report

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Test Report for Ambient Air Samples

Month & Year	**07/2025**	**Cluster**	**Cluster III**	**ULR NO.**	**TC1432125000001946F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**21.08.2025**
Project	**Ramkanali Workshop**	**Sample Ref. No.**	**REM/BCCL/2025/07**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	14.07.25	29.07.25	**Period of Analysis**	14.07.25 – 20.08.25	**Zone of Station:** **Buffer Zone**

Sl. No.	Parameter	Method of Analysis	Observed Values (in µg/m³) A4021	Observed Values (in µg/m³) A4083	Range Of Testing	LDL	MoEF Standards Notification dated 25th September,2000 (GSR 742 E)	NAAQS, 2009
1	PM_{10}	IS -5182(Part 23):2006, R-2017	63	65	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	32	35	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	**31**	**34**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY (Gaurav Kant) ***REVIEWED BY*** (Amit Raj Mishra) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

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Ambient Air Quality Test Report

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Test Report for Ambient Air Samples

Month & Year	07/2025	**Cluster**	Cluster III	**ULR NO.**	TC1432125000001946F
Customer	Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)			**Date of Issue**	21.08.2025
Project	Kharkharee	**Sample Ref. No.**	REM/BCCL/2025/07	**Sampling Method**	CMPDI/RI-II/LPM 13 , (IS 5182)
Date of Sampling	04.07.2025	24.07.2025	**Period of Analysis**	04.07.2025 – 20.08.2025	**Zone of Station:** Buffer Zone

Sl. No.	Parameter	Method of Analysis	Observed Values (in µg/m³) A4005	Observed Values (in µg/m³) A4098	Range Of Testing	LDL	MoEF Standards Notification dated 25th September,2000 (GSR 742 E)	NAAQS, 2009
1	PM_{10}	IS -5182(Part 23):2006, R-2017	71	69	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	35	33	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	**35**	**32**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

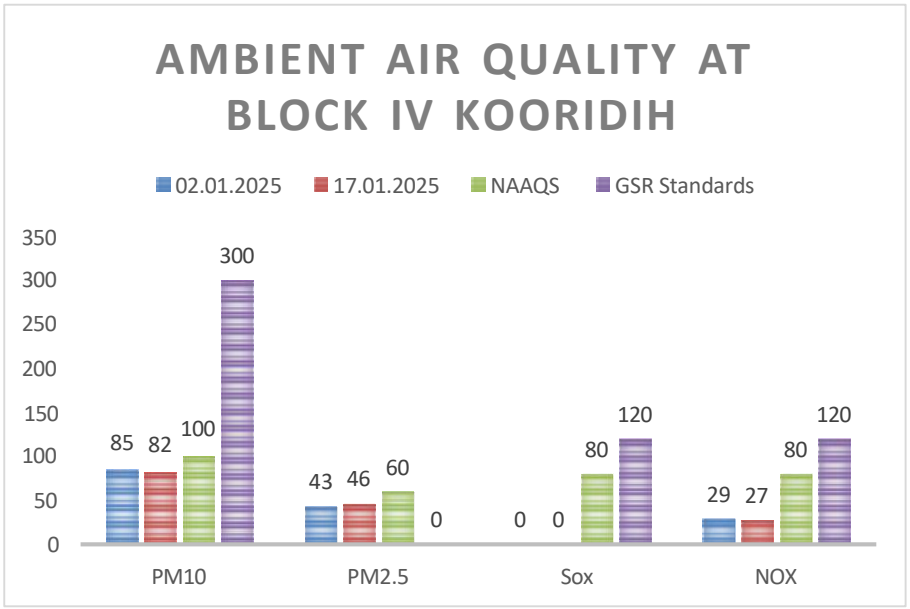
***All units are in µg/m3, 24 hourly Average, * LDL indicates Lower Detection Limit,*

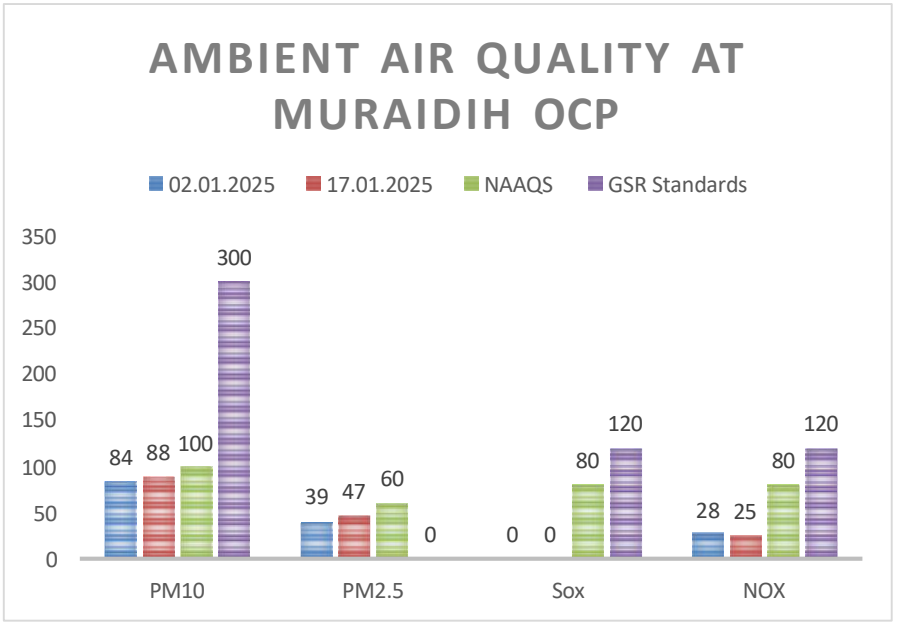
ANALYSED BY | (Gaurav Kant) ***REVIEWED BY*** | (Amit Raj Mishra) ***Authorised Signatory***

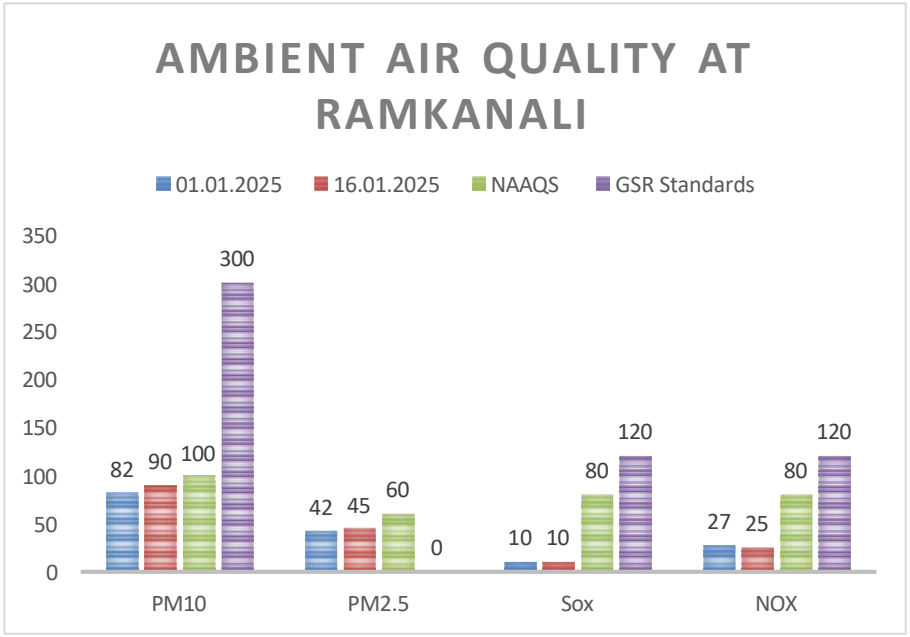
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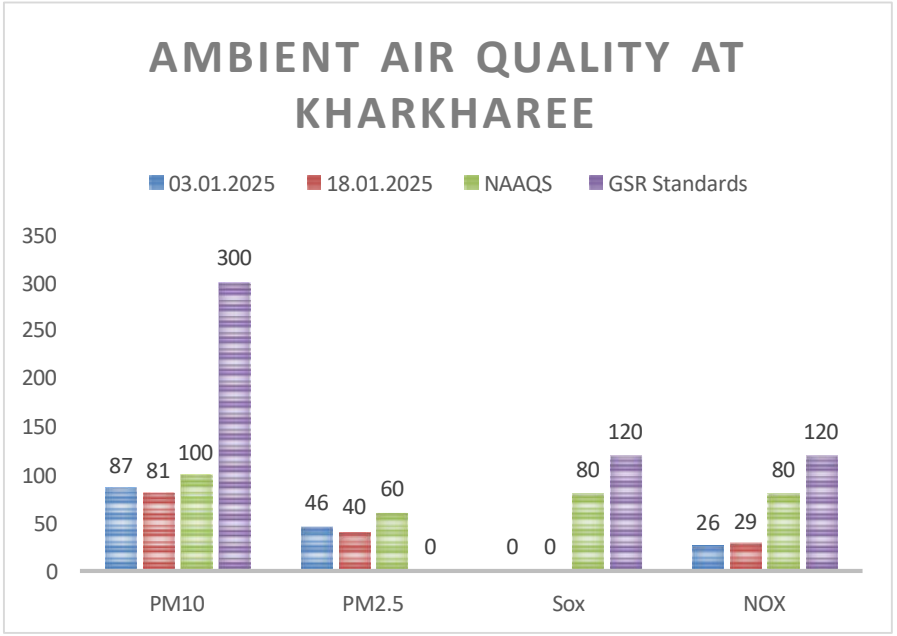
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AMBIENT AIR QUALITY AT BLOCK IV KOORIDIH
02.01.2025
17.01.2025
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
85 82 100 300
43 46 60 0
0 0 80 120
29 27 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT MURAIDIH OCP
02.01.2025
17.01.2025
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
84 88 100 300
39 47 60 0
0 0 80 120
28 25 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT RAMKANALI
01.01.2025
16.01.2025
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
82 90 100 300
42 45 60 0
10 10 80 120
27 25 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT KHARKHAREE
03.01.2025
18.01.2025
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
87 81 100 300
46 40 60 0
0 0 80 120
26 29 80 120
PM10
PM2.5
Sox
NOX

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) Mine Discharge of Govindpur (MW3)

A sampling point is fixed to assess the effluent quality of Mine discharge. This location is selected to monitor effluent discharge in to Khudia Nala and Bagdighi Nala.

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. The effluent samples were collected and analysed for four parameters on fortnightly basis at the Environmental Laboratory of CMPDI RI-II, Dhanbad.

3.3 Results & Interpretations

The results are given in tabular form along with the applicable standards. Results are compared with Schedule - VI, effluent prescribed by MoEF&CC. Results show that most of the parameters are within the permissible limits.

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
MINE EFFLUENT TEST REPORT

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Test Report for Mine Effluent samples

Month & Year	**07/2025**	**Cluster**	**Cluster III**	**ULR NO.**		**TC1432125000001964F**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**21.08.2025**
Project		**Sampling Ref. No.**	**REM/BCCL/2025/07**	**Sampling Method**	**IS 3025 (Part-1) CMPDI/RI-II/LPM 13**		
Sampling Stations	**(i)**	**Govindpur**	**Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent**			**Period of Analysis**	**01.07.2025 TO 31.07.2025**
			Date of Sampling	01.07.25	21.07.25		

Sl. No.	Parameter	Method of Analysis	Observed Values		STANDARDS FOR COAL MINES (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)	LDL
			M1617	**M1644**		
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	48	51	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.54	7.53	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<4.0	<4.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	44	40	*250 (Max)*	4

***All units in mg/L unless specified otherwise. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*
***Grab sampling carried out for water samples.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

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NOISE LEVEL QUALITY MONITORING

4.1 Location of sampling sites

i) **Block-IV (N6)**

ii) **Nichitpur (N5)**

iii) **Govindpur Village (N7)**

i) Kharkharee (N21)

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter during day time & night time. Noise levels were measured for the complete day & night time, the Intergration time taken was one hour or 3600 seconds. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB (A).

4.2 Results & Interpretations

Ambient noise levels were recorded during day time & night time and the observed values were compared with standards prescribed by MoEF&CC. The results of Noise levels recorded during day & night time on fortnightly basis are presented in tabular form along with the applicable standard permissible limits. The observed values in terms of L_{EQ} are presented**.** The observed values at all the monitoring locations are found to be within permissible limits.

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TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

Month & Year	**07/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000001980F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**21.08.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/07**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Block IV**	**Date of Sampling**	07.07.25	22.07.25	**Zone Category of Station:**	**Core Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	46.2	48.3	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	48.9	46.6					
3		08:00 - 09:00	48	47.1					
4		09:00 – 10:00	51.7	50.9					
5		10:00 - 11:00	55.7	57.7					
6		11:00 - 12:00	54.1	58					
7		12:00 - 13:00	62.9	62.2					
8		13:00 - 14:00	59.9	60.1					
9		14:00 - 15:00	64	65.6					
10		15:00 - 16:00	71	69.2					
11		16:00 - 17:00	69.5	70.2					
12		17:00 - 18:00	51.5	49.7					
13		18:00 - 19:00	51.5	49.7					
14		19:00 - 20:00	46.9	46.6					
15		20:00 - 21:00	46.6	46.6					
16		21:00 - 22:00	48.1	47.4					
		Leq DAY	62.5	62.3					
1	Noise Level dB(A)Leq -Night	22:00-23:00	43.8	43.3	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	42.4	42.7					
3		00:00- 01:00	41.8	42					
4		01.00-02.00	41.7	41.7					
5		02.00-03.00	41.4	41.4					
6		03.00-04.00	41.3	41.3					
7		04.00-05.00	41.2	41.5					
8		05:00-06:00	42.1	41.9					
		Leq NIGHT	42.0	42.0					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
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email: rdri2cmpdi@coalindia.in

Month & Year	**07/2025**	**Cluster**	**Cluster III**				**ULR No.**	**TC1432125000001980F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**						**Date of Issue**	**21.08.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/07**		**Sampling Method**		**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Muraidih OCP**	**Date of Sampling**	03.07.25	18.07.25	**Zone Category of Station:**	**Buffer Zone**	

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	47.5	46.9	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	47.2	47.4					
3		08:00 - 09:00	48.4	46.9					
4		09:00 – 10:00	50.4	51.5					
5		10:00 - 11:00	57.7	54.1					
6		11:00 - 12:00	55.7	56.6					
7		12:00 - 13:00	62.7	62.3					
8		13:00 - 14:00	60.1	58.2					
9		14:00 - 15:00	62.3	64.3					
10		15:00 - 16:00	58.9	60.2					
11		16:00 - 17:00	67.1	67.9					
12		17:00 - 18:00	50.3	51.2					
13		18:00 - 19:00	47.2	50.7					
14		19:00 - 20:00	48	48.3					
15		20:00 - 21:00	48.3	47.2					
16		21:00 - 22:00	46.9	47.5					
		Leq DAY	58.8	59.3					
1	Noise Level dB(A)Leq - Night	22:00-23:00	42.9	43.4	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	41.4	41.7					
3		00:00- 01:00	41.3	41.4					
4		01.00-02.00	41.2	43.9					
5		02.00-03.00	41.2	41.2					
6		03.00-04.00	39.5	41					
7		04.00-05.00	41	40					
8		05:00-06:00	41.7	41.5					
		Leq NIGHT	41.4	41.9					

**LDL indicates Lower Detection Limit*
***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

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TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

Month & Year	**07/2025**	**Cluster**	**Cluster III**				**ULR No.**	**TC1432125000001980F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**						**Date of Issue**	**21.08.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/07**		**Sampling Method**		**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Ramkanali**	**Date of Sampling**	14.07.25	29.07.25	**Zone Category of Station:**	**Buffer Zone**	

Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A))**	**Observed Values (in Leq dB(A))**	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards**	
			First Fortnight	**Second Fortnight**				**Zones**	**Limits in dB**
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	47.3	47.1	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	49.2	49					
3		08:00 - 09:00	47.5	47.4					
4		09:00 – 10:00	48.1	50					
5		10:00 - 11:00	52.8	58.8					
6		11:00 - 12:00	56	56.4					
7		12:00 - 13:00	61.5	62.8					
8		13:00 - 14:00	60.9	59.7					
9		14:00 - 15:00	62.2	63.3					
10		15:00 - 16:00	64	64					
11		16:00 - 17:00	70.7	70.5					
12		17:00 - 18:00	50	50.3					
13		18:00 - 19:00	50.6	49					
14		19:00 - 20:00	44.8	48.6					
15		20:00 - 21:00	47.4	46.9					
16		21:00 - 22:00	48.6	46.6					
		Leq DAY	60.9	61.1					
1	Noise Level dB(A)Leq -Night	22:00-23:00	43.9	42.5	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	42.7	42					
3		00:00- 01:00	42.9	41.7					
4		01.00-02.00	41.4	41.3					
5		02.00-03.00	41.3	40.2					
6		03.00-04.00	41.2	40.3					
7		04.00-05.00	41.8	40.7					
8		05:00-06:00	41.7	41.4					
		Leq NIGHT	42.2	41.3					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**07/2025**	**Cluster**	**Cluster III**	**ULR No.**	**TC1432125000001980F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**21.08.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/07**	**Sampling Method**	**CMPDI/RI-II/LPM 13**
Sampling Stations	**i**	**Kharkharee**	**Date of Sampling** 04.07.25	24.07.25	**Zone Category of Station:** **Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	46.9	46.2	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	47.2	47.7					
3		08:00 - 09:00	49.3	48.1					
4		09:00 – 10:00	51.6	52.6					
5		10:00 - 11:00	54.4	54.9					
6		11:00 - 12:00	55.6	53.5					
7		12:00 - 13:00	62.7	62.3					
8		13:00 - 14:00	63.5	61.2					
9		14:00 - 15:00	63.9	63.8					
10		15:00 - 16:00	58.9	59.2					
11		16:00 - 17:00	72.5	62.7					
12		17:00 - 18:00	60.5	58.5					
13		18:00 - 19:00	46.9	47.5					
14		19:00 - 20:00	47.1	46.9					
15		20:00 - 21:00	46.6	47.2					
16		21:00 - 22:00	49.8	47.5					
		Leq DAY	62.3	57.9					
1	Noise Level dB(A)Leq -Night	22:00-23:00	43.9	43.2	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	42.5	42					
3		00:00- 01:00	40.3	40.7					
4		01.00-02.00	38.7	39.8					
5		02.00-03.00	38.4	35.5					
6		03.00-04.00	37.9	39.2					
7		04.00-05.00	37.7	36.7					
8		05:00-06:00	36.5	34.6					
		Leq NIGHT	40.2	39.9					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY



(Amit Raj Mishra)
Authorised Signatory

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Ambient Air Quality Standards for Jharia Coal Field
As per the Environment (Protection) Amendment Rules, 2000 notified vide notification G.S.R. 742(E), dated 25.9.2000.

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
	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. Improvedwest 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 clause2.

** 24hourly/8hourlyvaluesshallbemet 92%ofthetimeinayear.However,8% of the time it may exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981), and in supersession of the notification No(s).S.O.384(E), dated 11th April 1994 and S.O.935(E), dated 14th NOVEMBER 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

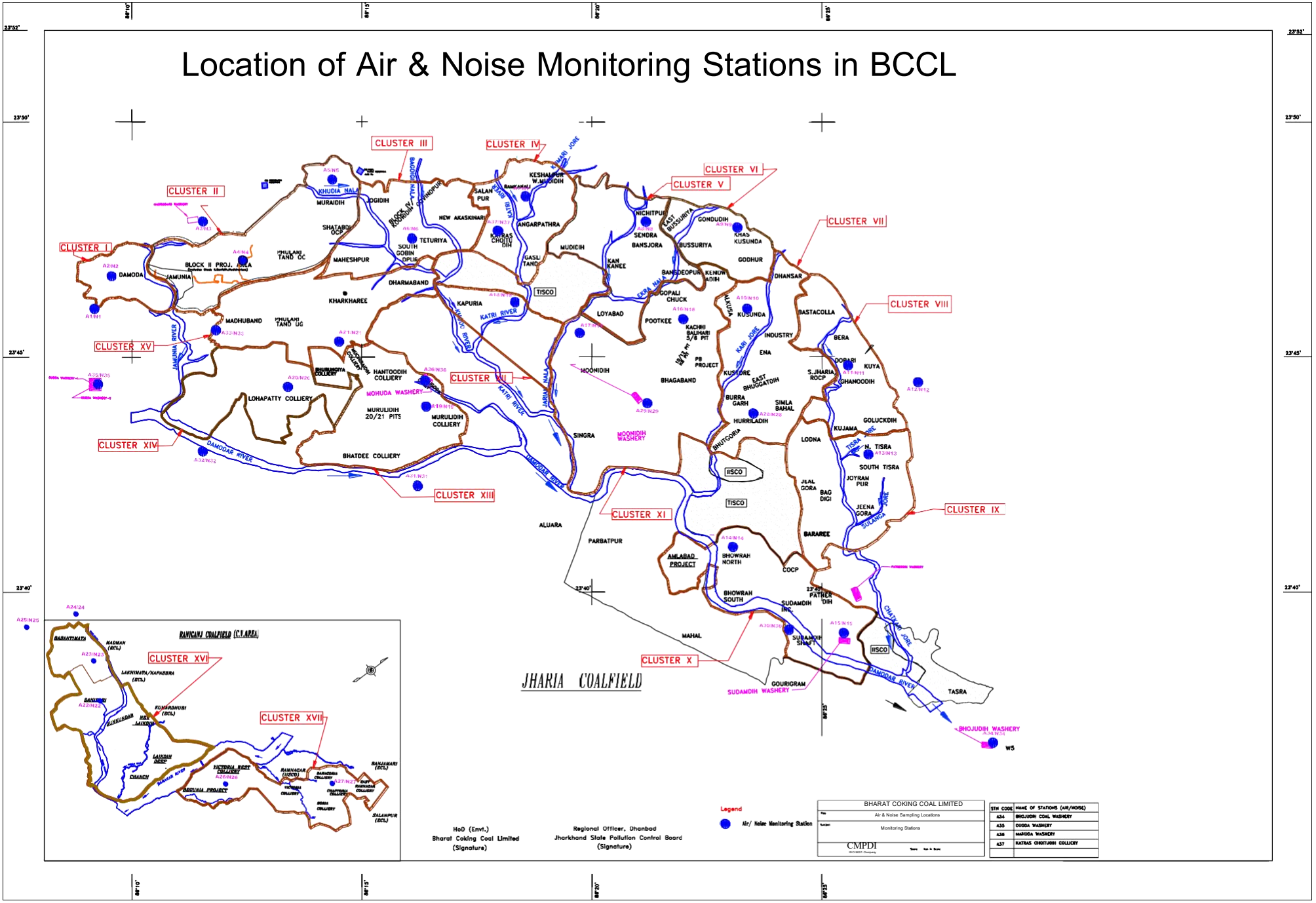
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogendioxide (NO_2), µg/m³	Annual * 24 Hours **	40 80	30 80	-Jacob &Hochheiser modified ($NaOH$-$NaAsO_2$) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM_{10}, µg/m³	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m³	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O_3) , µg/m³	8 Hours * 1 Hour **	100 180	100 180	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb) , µg/m³	Annual * 24 Hours **	0.50 1.0	0.50 1.0	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
Carbon Monoxide (CO), mg/m³	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m³	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C_6H_6), µg/m³	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m³	Annual *	01	01	-Solvent extraction followed byHPLC/GC analysis
Arsenic (As), ng/m³	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m³	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

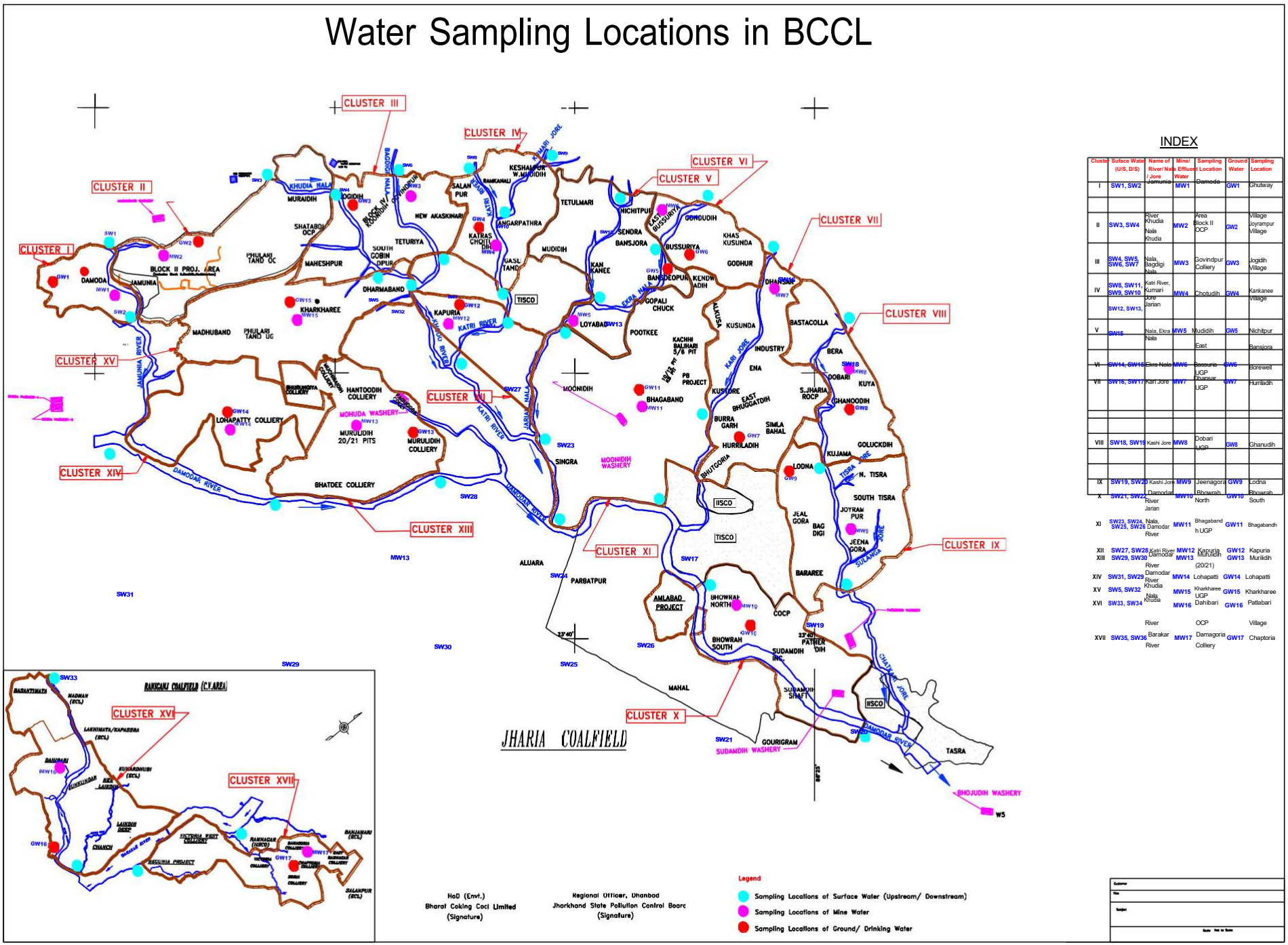
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they JUNE exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



INDEX

Cluster	Surface Water (U/S, D/S)	Name of River/ Nala / Jore	Mine/ Effluent Water	Sampling Location	Ground Water	Sampling Location
I	SW1, SW2	Damoda	MW1		GW1	Ghutway
II	SW3, SW4	River Khudia Nala Khudia	MW2	Area Block II OCP	GW2	Village Joyrampur Village
III	SW4, SW5, SW6, SW7	Nala, Bagdigi Nala	MW3	Govindpur Colliery	GW3	Jogidih Village
IV	SW8, SW11, SW9, SW10	Katri River, Kumari Jore Jarian	MW4	Chotudih	GW4	Kankanee Village
	SW12, SW13,					
V	SW15	Nala, Ekra Nala	MW5	Mudidih East	GW5	Nichitpur Bansjora
VI	SW14, SW16	Ekra Nala	MW6	Bassuria UGP Dhansar	GW6	Borewell
VII	SW16, SW17	Kari Jore	MW7	UGP	GW7	Hurriladih
VIII	SW18, SW19	Kashi Jore	MW8	Dobari UGP	GW8	Ghanudih
IX	SW19, SW20	Kashi Jore Damodar	MW9	Jeenagora Bhowrah	GW9	Lodna Bhowrah
X	SW21, SW22	River Jarian	MW10	North	GW10	South
XI	SW23, SW24, SW25, SW26	Nala, Damodar River	MW11	Bhagabandh UGP	GW11	Bhagabandh
XII	SW27, SW28, SW29, SW30	Katri River Damodar River Khudia	MW12 MW13	Kapuria Muruldih (20/21)	GW12 GW13	Kapuria Muruldih
XIV	SW31, SW29	Damodar River	MW14	Lohapatti	GW14	Lohapatti
XV	SW5, SW32	Nala Khudia	MW15	Kharkharee UGP	GW15	Kharkharee
XVI	SW33, SW34		MW16	Dahibari OCP	GW16	Patlabari Village
XVII	SW35, SW36	Barakar River	MW17	Damagoria Colliery	GW17	Chaptoria



BHARAT COKING COAL LIMITED

WATER SAMPLING LOCATIONS

MONITORING STATIONS

CMPDI

ISO 9001 Company

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ENVIRONMENTAL MONITORING REPORT OF BHARAT COKING COAL LIMITED, CLUSTER – III

(FOR THE MONTH JUNE, 2025)

E. C. no. J-11015/213/2010-IA.II (M) dated 06.02.2013.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

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EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the fauna and flora. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal Limited (BCCL), a Subsidiary company of Coal India Limited is operating Underground and Opencast Mines in Jharia Coalfield (JCF) is a part of Gondwana Coalfields located in Dhanbad district of Jharkhand, the JCF is bounded by $23^0$37' N to $23^0$52' N latitudes and $86^0$09' E to $86^0$30' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Jharia Coalfield (JCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEF&CC while granting environmental clearance of project, consent letter issued by the respective SPCB, and other statutory requirements.

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

The ambient air quality monitoring stations were selected to represent core, buffer zone area. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

2.2 Water sampling stations

The Water sampling stations were selected for mine sump water.

2.3 Noise level monitoring locations

Noise levels vary depending on the various activities in mining areas. The monitoring of noise level in different locations will be helpful to take appropriate mitigating measures. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_X). Respirable Dust Samplers (RDS) and Fine Dust Sampler ($PM_{2.5}$

sampler) were used for sampling of $PM_{10,}$ SO_2, & NO_x and Fine Dust Sampler ($PM_{2.5}$ sampler) were used for sampling of $PM_{2.5}$ at 24 hours interval once in a fortnight and the same for the gaseous pollutants. The samples were analysed in Environmental Laboratory of CMPDI, RI-II, Dhanbad.

3.2 Water quality

Water samples were collected as per standard practice. The Mine effluent samples were collected and analysed for four parameters on fortnightly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory of CMPDI, RI- II, Dhanbad.

3.3 Noise level monitoring

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB(A).

4.0 Results and interpretations

4.1 Air quality

It has been seen from the analysis results that the 24 hours average concentration parameters like $PM_{10,}$ $PM_{2.5}$, SO_2 and NO_x are mostly within the permissible limits in all sampling locations as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines and National Ambient Air Quality Standard -2009. Sometimes the concentration of PM_{10}& $PM_{2.5}$ exceeds the limits due to heavy public traffic, poor road condition, coke oven plants, burning of coal by surrounding habitants, brick making, municipal waste dumps and industries like Steel Plant, thermal Plants including their fly ash etc.

The following preventive and suppressive mitigative measures can be undertaken to contain the pollution level within prescribed level:-

- Wet drilling and controlled blasting should be practice.
- Explosive used should be optimised to restrict the dust generation.
- Transportation roads should be permanently asphalted free of ruts, potholes etc.
- Water should be sprayed on coal transportation road, service road more frequently and at regular interval.
- Dust from roads should be removed physically or mechanically.
- Greenbelts around industrial sites, service building area besides Avenue plantation along roads should be created.
- Coal dust should be suppressed by using fixed sprinklers.
- Regular maintenance of plant and machinery should be undertaken.

4.2 Water quality

The test results indicate that the major parameters compared with MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines, are within permissible limits.

4.3 Noise Level

During the noise level survey it has been observed that the noise level in the sampling locations is within the permissible limits prescribed as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines for Industrial Area and Noise pollution (Regulation and Control) Rules, 2000.

INTRODUCTION

Any industry and development activities including coal mining is bound to affect environmental attributes. There are positive as well as negative impacts of such operations. For controlling the adverse impacts a regular monitoring is essential. The environmental monitoring is being done as per the guide-lines stipulated by Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India.

The very purpose of environmental monitoring is to assess the quality of various attributes which affects the environment. As per quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.

The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akasshkinaree Mine and Block IV Kooridih Mixed Mine as per **E. C. no. J-11015/213/2010-IA.II**(M) dated 06.02.2013 and later all seven mines are amalgamated to single mine Named Cluster III with OC cum UG with Highway Mining method with no change in lease area and production capacity. The cluster – III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster-III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and Bagdighi Nala.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity of 2.769 MTPA (normative) and 3.6 MTPA peak capacity of coal production vide letter no **E. C. no. J-11015/213/2010-IA. II**(M) dated 06.02.2013 later with **E. C. no. J-11015/213/2010-IA. II**(M) dated 03.03.2025.

Ministry of Environment, Forest and Climate Change while granting environmental clearance has given one of the General conditions that " Four ambient air quality monitoring stations should be established in the core zone as well as in the buffer zone for PM_{10}, $PM_{2.5}$, SO_2, NOx monitoring. Location of the stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets, other conditions regarding water / effluent and noise level monitoring in consultation with the State Pollution Control Board."

In compliance of these conditions the Environmental Monitoring has been carried out & report prepared for submission to MoEF&CC & JSPCB and other statutory authorities.

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

(As per G.S.R. 742 (E) dt. 25th December, 2000)

2.1.1 Ambient Air Quality Sampling Locations

CORE ZONE Monitoring Location

i) Block IV Kooridih OCP (A6): Industrial Area

The location of the sampling station is at 23°47'54.00"N & 86°16'20.00"E. The sampler was placed at 1.5 m above the ground level near Safety office of Block IV OCP.

BUFFER ZONE Monitoring Location

i) Muraidih OCP (A5) : Industrial Area

The sampler was placed at a height of 1.5 m from the ground level at Muraidih project office.

ii) Ramkanali Workshop (A7) : Industrial area

The location of the sampling station is 23°48'34.00"N & 86°18'22.00"E. The sampler was placed at height of 1.5 m above the ground level at AARC agent Office, Ramkanali.

iii) Kharkharee(A21): **Industrial Area**

The location of the sampling station is 23°46'29.00"N & 86°14'37.08"E. The sampler was placed at a height of 1.5 m above the ground level at Kharkharee Colliery.

AMBIENT AIR QUALITY DATA

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
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Test Report for Ambient Air Samples

Month & Year	**6/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000001892F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**11.08.2025**
Project	**Block-IV**	**Sample Ref. No.**	**REM/BCCL/2025/06**		**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	02.06.25	17.06.25	**Period of Analysis**	02.06.2025	30.06.2025	**Zone of Station:**	**Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A3707	A3792				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	88	95	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	40	50	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	26	22	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
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Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**06/2025**	**Cluster**	**Cluster III**			**ULR No.**	**TC1432125000001892F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**11.08.2025**
Project	**Muraidih**		**Sample Ref. No.**	**REM/BCCL/2025/06**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	09.06.25		23.06.25	**Date of Sampling**	09.06.25	25.07.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A3693	A3771				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	75	92	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	40	50	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	31	29	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY (Gaurav Kant) ***REVIEWED BY*** (Amit Raj Mishra) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

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Ambient Air Quality Test Report

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TC-14321

Test Report for Ambient Air Samples

Month & Year	**06/2025**	**Cluster**	**Cluster III**	**ULR NO.**	**TC1432125000001892F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**11.08.2025**
Project	**Ramkanali Workshop**	**Sample Ref. No.**	**REM/BCCL/2025/06**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	04.06.25	16.06.25	**Period of Analysis**	04.06.2025 – 25.07.2025	**Zone of Station:** **Buffer Zone**

Sl. No.	Parameter	Method of Analysis	Observed Values (in µg/m³)		Range Of Testing	LDL	MoEF Standards Notification dated 25th September,2000 (GSR 742 E)	NAAQS, 2009
			A3713	A3796				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	92	94	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	48	52	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	32	27	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY | (Gaurav Kant) ***REVIEWED BY*** | (Amit Raj Mishra) ***Authorised Signatory***

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TC-14321

Test Report for Ambient Air Samples

Month & Year	**06/2025**	**Cluster**	**Cluster III**	**ULR NO.**	**TC1432125000001892F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**11.08.2025**
Project	**Kharkharee**	**Sample Ref. No.**	**REM/BCCL/2025/06**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	02.06.2025	18.06.2025	**Period of Analysis**	02.06.2025 – 25.07.2025	**Zone of Station:** **Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)** A3701	A3784	**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
1	PM_{10}	IS -5182(Part 23):2006, R-2017	87	92	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	47	48	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	11	10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	25	24	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

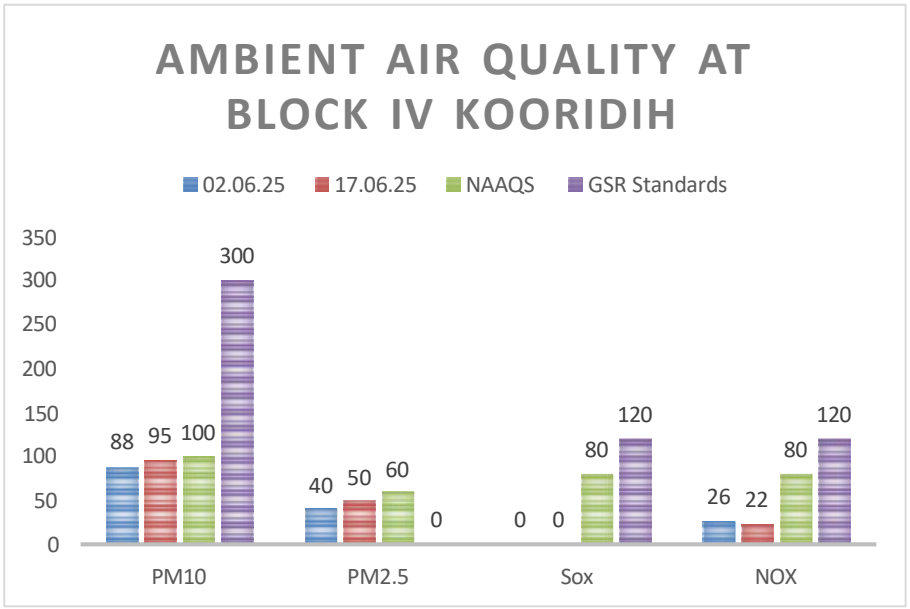
***All units are in µg/m3, 24 hourly Average, * LDL indicates Lower Detection Limit,*

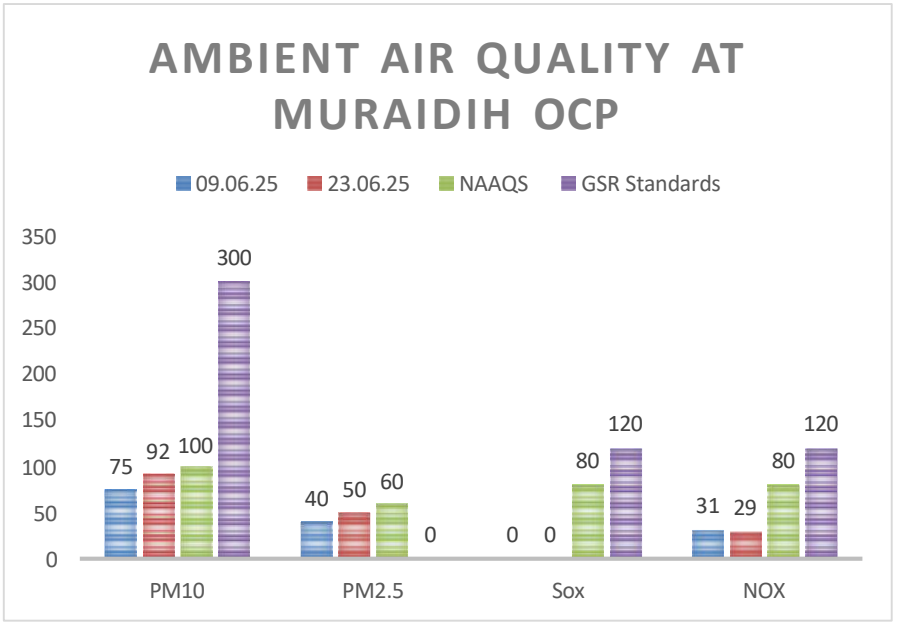
ANALYSED BY (Gaurav Kant) ***REVIEWED BY*** (Amit Raj Mishra) ***Authorised Signatory***

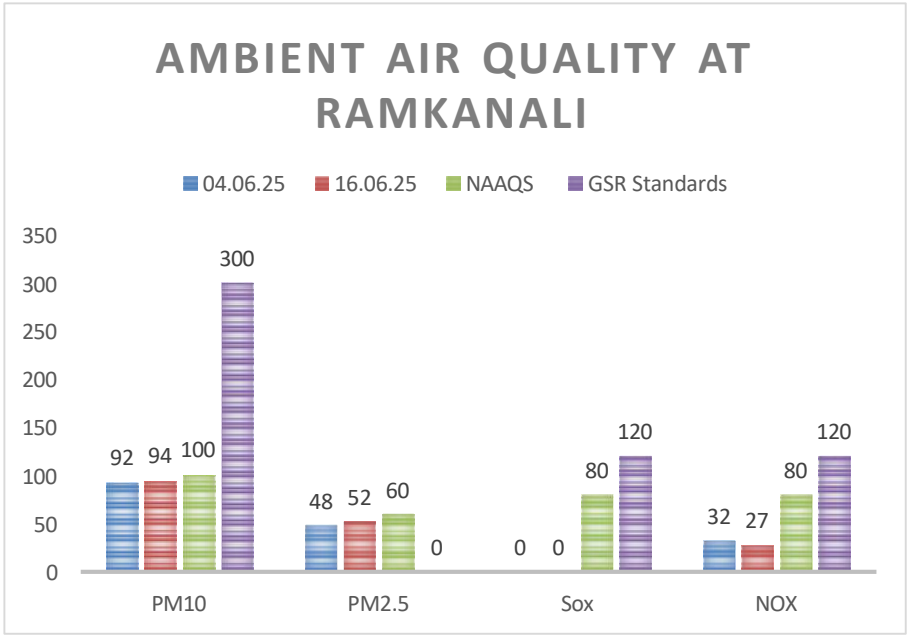
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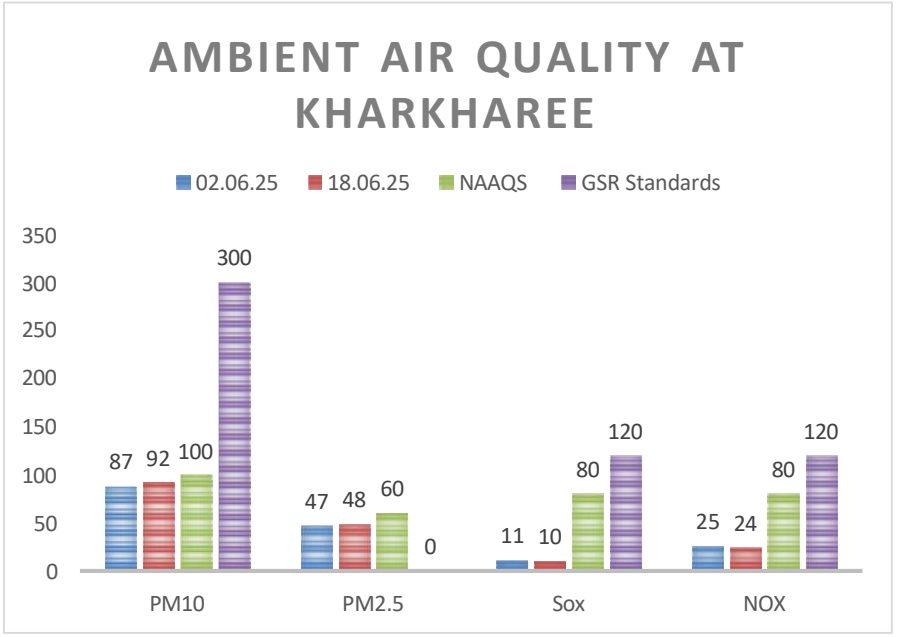
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AMBIENT AIR QUALITY AT BLOCK IV KOORIDIH
02.06.25
17.06.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
88 95 100 300
40 50 60 0
0 0 80 120
26 22 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT MURAIDIH OCP
09.06.25
23.06.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
75 92 100 300
40 50 60 0
0 0 80 120
31 29 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT RAMKANALI
04.06.25
16.06.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
92 94 100 300
48 52 60 0
0 0 80 120
32 27 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT KHARKHAREE
02.06.25
18.06.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
87 92 100 300
47 48 60 0
11 10 80 120
25 24 80 120
PM10
PM2.5
Sox
NOX

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) Mine Discharge of Govindpur (MW3)

A sampling point is fixed to assess the effluent quality of Mine discharge. This location is selected to monitor effluent discharge in to Khudia Nala and Bagdighi Nala.

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. The effluent samples were collected and analysed for four parameters on fortnightly basis at the Environmental Laboratory of CMPDI RI-II, Dhanbad.

3.3 Results & Interpretations

The results are given in tabular form along with the applicable standards. Results are compared with Schedule - VI, effluent prescribed by MoEF&CC. Results show that most of the parameters are within the permissible limits.

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
MINE EFFLUENT TEST REPORT

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Test Report for Mine Effluent samples

Month & Year	**06/2025**	**Cluster**	**Cluster III**	**ULR NO.**		TC1432125000001910F	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**11.08.2025**
Project		**Sampling Ref. No.**	**REM/BCCL/2025/06**	**Sampling Method**	**IS 3025 (Part-1) CMPDI/RI-II/LPM 13**		
Sampling Stations	**(i)**	**Govindpur**	**Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent**			**Period of Analysis**	**02.06.2025 TO 30.06.2025**
			Date of Sampling	**02.06.25**	**16.06.25**		

Sl. No.	Parameter	Method of Analysis	Observed Values		STANDARDS FOR COAL MINES (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)	LDL
			M1555	**M1582**		
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	48	42	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.81	7.79	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<4.0	<4.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	32	40	*250 (Max)*	4

***All units in mg/L unless specified otherwise. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*
***Grab sampling carried out for water samples.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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NOISE LEVEL QUALITY MONITORING

4.1 Location of sampling sites

i) **Block-IV (N6)**

ii) **Nichitpur (N5)**

iii) **Govindpur Village (N7)**

i) Kharkharee (N21)

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter during day time & night time. Noise levels were measured for the complete day & night time, the Intergration time taken was one hour or 3600 seconds. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB (A).

4.2 Results & Interpretations

Ambient noise levels were recorded during day time & night time and the observed values were compared with standards prescribed by MoEF&CC. The results of Noise levels recorded during day & night time on fortnightly basis are presented in tabular form along with the applicable standard permissible limits. The observed values in terms of L_{EQ} are presented**.** The observed values at all the monitoring locations are found to be within permissible limits.

TC-14321

cmpdi A Mini Ratna Company

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

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Month & Year	**06/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000001926F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**11.08.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/06**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Block IV**	**Date of Sampling**	02.06.25	17.06.25	**Zone Category of Station:**	**Core Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	56.4	55	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	60.7	59.6					
3		08:00 - 09:00	61.6	60.6					
4		09:00 – 10:00	65.2	64.4					
5		10:00 - 11:00	64.8	63.7					
6		11:00 - 12:00	66.1	65.5					
7		12:00 - 13:00	65.7	64.4					
8		13:00 - 14:00	66	66.7					
9		14:00 - 15:00	66.4	65.4					
10		15:00 - 16:00	69.5	67.6					
11		16:00 - 17:00	70.2	70					
12		17:00 - 18:00	71.1	70.9					
13		18:00 - 19:00	69.8	67.6					
14		19:00 - 20:00	69.4	68.6					
15		20:00 - 21:00	62.5	61.5					
16		21:00 - 22:00	55.3	53.7					
		Leq DAY	66.9	66.1					
1	Noise Level dB(A)Leq -Night	22:00-23:00	53	51.6	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	52.2	49.9					
3		00:00- 01:00	50.4	49.3					
4		01.00-02.00	45.1	45.4					
5		02.00-03.00	44.7	44.9					
6		03.00-04.00	47.9	46.3					
7		04.00-05.00	46	45.3					
8		05:00-06:00	46.3	47.4					
		Leq NIGHT	49.3	48.2					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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Month & Year	**06/2025**	**Cluster**	**Cluster III**				**ULR No.**	**TC1432125000001926F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**						**Date of Issue**	**11.08.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/06**		**Sampling Method**		**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Muraidih OCP**	**Date of Sampling**	09.06.25	23.06.25	**Zone Category of Station:**	**Buffer Zone**	

Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A)) First Fortnight**	**Observed Values (in Leq dB(A)) Second Fortnight**	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards**	
								Zones	**Limits in dB**
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	46.7	47.2	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	47.8	49.7					
3		08:00 - 09:00	53	52.4					
4		09:00 – 10:00	54.1	54.9					
5		10:00 - 11:00	55	55.5					
6		11:00 - 12:00	57.6	57.4					
7		12:00 - 13:00	58.7	59.7					
8		13:00 - 14:00	53.8	54.7					
9		14:00 - 15:00	55	55.5					
10		15:00 - 16:00	57.6	58.7					
11		16:00 - 17:00	52.1	51.1					
12		17:00 - 18:00	47.7	47.7					
13		18:00 - 19:00	46.2	46.1					
14		19:00 - 20:00	46.7	46.4					
15		20:00 - 21:00	46.1	46.2					
16		21:00 - 22:00	45.9	44.9					
		Leq DAY	53.7	54.2					
1	Noise Level dB(A)Leq - Night	22:00-23:00	44.2	43.7	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	43.8	41.9					
3		00:00- 01:00	43.4	41					
4		01.00-02.00	43.3	40.8					
5		02.00-03.00	42.9	40.7					
6		03.00-04.00	42.3	41.5					
7		04.00-05.00	44	43.3					
8		05:00-06:00	44	43.9					
		Leq NIGHT	43.5	42.3					

**LDL indicates Lower Detection Limit*
***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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Month & Year	**06/2025**	**Cluster**	**Cluster III**			**ULR No.**	**TC1432125000001926F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**11.08.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/06**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Ramkanali**	**Date of Sampling**	04.06.25	16.06.25	**Zone Category of Station:**	**Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	54.1	53.2	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	56.9	56.1					
3		08:00 - 09:00	59.7	59.2					
4		09:00 – 10:00	66.2	65.3					
5		10:00 - 11:00	67.8	66.7					
6		11:00 - 12:00	66.2	65.3					
7		12:00 - 13:00	69.5	70.9					
8		13:00 - 14:00	71	69.9					
9		14:00 - 15:00	63.7	63.7					
10		15:00 - 16:00	62.6	62.6					
11		16:00 - 17:00	62.1	62.1					
12		17:00 - 18:00	62.5	61.6					
13		18:00 - 19:00	61.6	60.7					
14		19:00 - 20:00	60.5	59.6					
15		20:00 - 21:00	60.5	55.3					
16		21:00 - 22:00	56.1	54.2					
		Leq DAY	64.9	64.5					
1	Noise Level dB(A)Leq -Night	22:00-23:00	53.4	52.7	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	53.3	52.5					
3		00:00- 01:00	50.2	50.3					
4		01.00-02.00	48.1	47.9					
5		02.00-03.00	47.6	47.6					
6		03.00-04.00	47.5	47.5					
7		04.00-05.00	49.5	49.2					
8		05:00-06:00	50.6	50.4					
		Leq NIGHT	50.6	50.2					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**06/2025**	**Cluster**	**Cluster III**			**ULR No.**	**TC1432125000001926F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**11.08.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/06**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Kharkharee**	**Date of Sampling**	02.06.25	18.06.25	**Zone Category of Station:**	**Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	45.1	46	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	61	60.9					
3		08:00 - 09:00	72.5	72.7					
4		09:00 – 10:00	72.4	72.1					
5		10:00 - 11:00	68.6	67.4					
6		11:00 - 12:00	65.7	65.2					
7		12:00 - 13:00	63.1	64.2					
8		13:00 - 14:00	61.5	60.8					
9		14:00 - 15:00	59.2	58.4					
10		15:00 - 16:00	57.6	57.9					
11		16:00 - 17:00	57.9	58.5					
12		17:00 - 18:00	57.7	58.2					
13		18:00 - 19:00	55	55					
14		19:00 - 20:00	53.2	53.3					
15		20:00 - 21:00	51.2	51.4					
16		21:00 - 22:00	50.5	50.9					
		Leq DAY	65.3	65.1					
1	Noise Level dB(A)Leq -Night	22:00-23:00	47.1	44.8	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	44.3	44.7					
3		00:00- 01:00	44.4	44.7					
4		01.00-02.00	42.6	43.8					
5		02.00-03.00	42.2	39					
6		03.00-04.00	41.7	43.1					
7		04.00-05.00	41.5	40.3					
8		05:00-06:00	40.1	38					
		Leq NIGHT	43.5	43.0					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

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Ambient Air Quality Standards for Jharia Coal Field
As per the Environment (Protection) Amendment Rules, 2000 notified vide notification G.S.R. 742(E), dated 25.9.2000.

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
	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. Improvedwest 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 clause2.

** 24hourly/8hourlyvaluesshallbemet 92%ofthetimeinayear.However,8% of the time it may exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981), and in supersession of the notification No(s).S.O.384(E), dated 11th April 1994 and S.O.935(E), dated 14th NOVEMBER 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

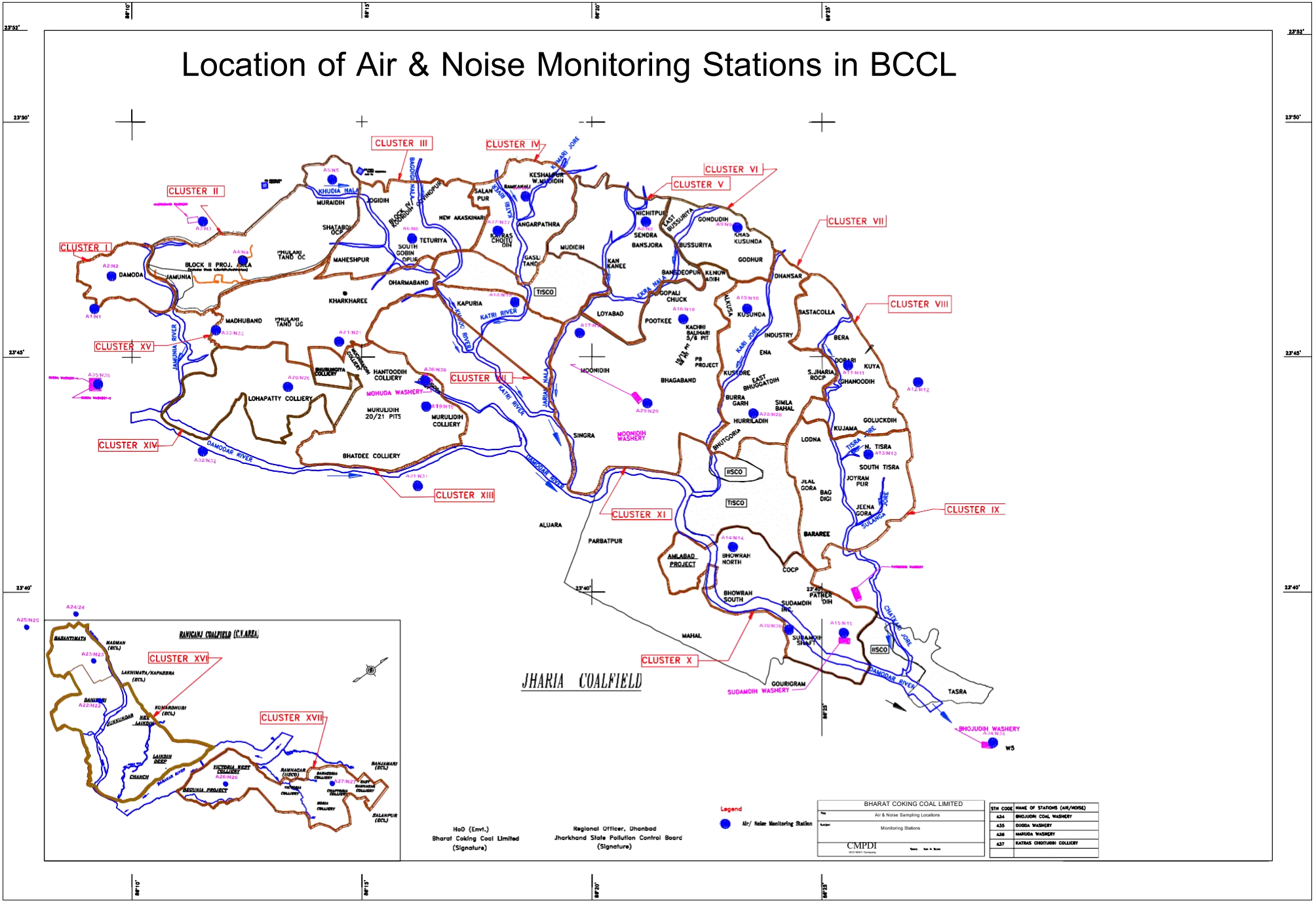
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogendioxide (NO_2), µg/m³	Annual * 24 Hours **	40 80	30 80	-Jacob &Hochheiser modified ($NaOH$-$NaAsO_2$) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM_{10}, µg/m³	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m³	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O_3) , µg/m³	8 Hours * 1 Hour **	100 180	100 180	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb) , µg/m³	Annual * 24 Hours **	0.50 1.0	0.50 1.0	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
Carbon Monoxide (CO), mg/m³	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m³	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C_6H_6), µg/m³	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m³	Annual *	01	01	-Solvent extraction followed byHPLC/GC analysis
Arsenic (As), ng/m³	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m³	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

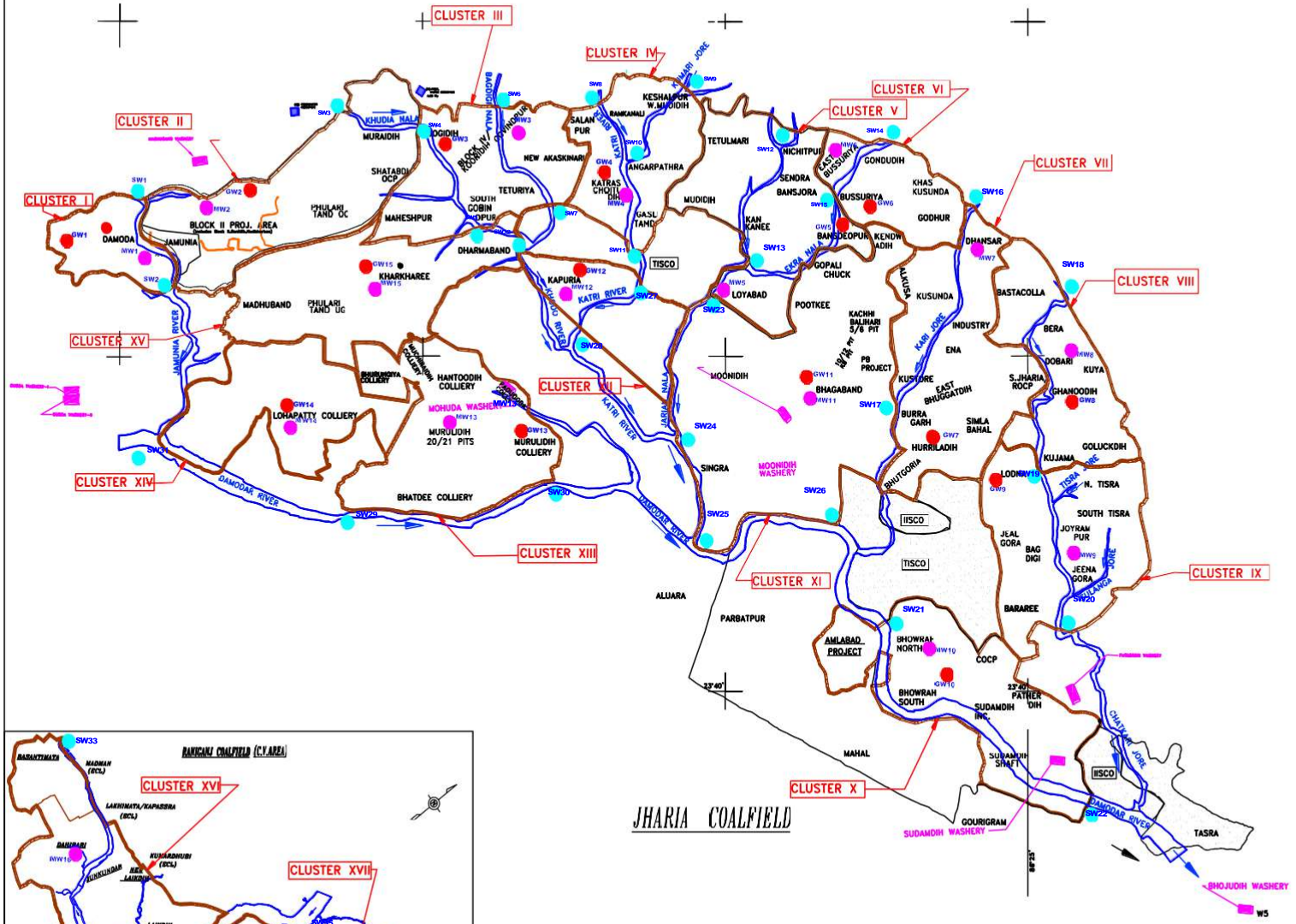
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they JUNE exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



INDEX

Cluste	Suface Wate (U/S, D/S)	Name of River/ Nala / Jore	Mine/ Effluent Water	Sampling Location	Ground Water	Sampling Location
I	SW1, SW2	Jamunia River	MW1	Damoda Area	GW1	Ghutway Village
II	SW3, SW4	Khudia Nala	MW2	Block II OCP	GW2	Joyrampur Village
III	SW4, SW5, SW6, SW7	Khudia Nala, Sagdigi Nala	MW3	Govindpur Colliery	GW3	Jogidih Village
IV	SW8, SW11, SW9, SW10	Katri River, Kumari Jore Jarian	MW4	Chotudih	GW4	Kankanee Village
V	SW12, SW13, SW15	Nala, Ekra Nala	MW5	Mudidih East	GW5	Nichitpur Bansjora
VI	SW14, SW15	Ekra Nala	MW6	Bassuria UGP	GW6	Borewell
VII	SW16, SW17	Kari Jore	MW7	Dhansar UGP	GW7	Lurlidih
VIII	SW18, SW19	Kashi Jore	MW8	Dobari UGP	GW8	Dhanodih
IX	SW19, SW20	Kashi Jore	MW9	Jeenagora	GW9	Lodna
X	SW21, SW22	Damodar River	MW10	Bhowrah North	GW10	Bhowrah South
XI	SW23, SW24, SW25, SW26	Jarian Nala, Damodar River	MW11	Bhagabandh UGP	GW11	Bhagabandh
XII	SW27, SW28	Katri River	MW12	Kapuria	GW12	Kapuria
XIII	SW29, SW30	Damodar River	MW13	Murulidih (20/21)	GW13	Murlidih
XIV	SW31, SW29	Damodar River	MW14	Lohapatti	GW14	Lohapatti
XV	SW5, SW32	Khudia Nala	MW15	Kharkharee UGP	GW15	Kharkharee
XVI	SW33, SW34	Khudia River	MW16	Dahibari OCP	GW16	Pallabari Village
XVII	SW35, SW36	Barakar River	MW17	Damagoria Colliery	GW17	Chaptoria

HoD (Envt.)
Bharat Coking Coal Limited
(Signature)

Regional Officer, Dhanbad
Jharkhand State Pollution Control Board
(Signature)

Legend
- Sampling Locations of Surface Water (Upstream/ Downstream)
- Sampling Locations of Mine Water
- Sampling Locations of Ground/ Drinking Water

BHARAT COKING COAL LIMITED

Customer	WATER SAMPLING LOCATIONS
Title	MONITORING STATIONS
Subject	CMPDI

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ENVIRONMENTAL MONITORING REPORT OF BHARAT COKING COAL LIMITED, CLUSTER – III

(FOR THE MONTH MAY, 2025)

E. C. no. J-11015/213/2010-IA.II (M) dated 06.02.2013.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

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3.	CHAPTER-III	RESULTS	7-19
4.	CHAPTER-IV	STANDARDS AND PLANS	20-21

EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the fauna and flora. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal Limited (BCCL), a Subsidiary company of Coal India Limited is operating Underground and Opencast Mines in Jharia Coalfield (JCF) is a part of Gondwana Coalfields located in Dhanbad district of Jharkhand, the JCF is bounded by $23^0$37' N to $23^0$52' N latitudes and $86^0$09' E to $86^0$30' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Jharia Coalfield (JCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEF&CC while granting environmental clearance of project, consent letter issued by the respective SPCB, and other statutory requirements.

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

The ambient air quality monitoring stations were selected to represent core, buffer zone area. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

2.2 Water sampling stations

The Water sampling stations were selected for mine sump water.

2.3 Noise level monitoring locations

Noise levels vary depending on the various activities in mining areas. The monitoring of noise level in different locations will be helpful to take appropriate mitigating measures. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_x). Respirable Dust Samplers (RDS) and Fine Dust Sampler ($PM_{2.5}$

sampler) were used for sampling of $PM_{10,}$ SO_2, & NO_x and Fine Dust Sampler ($PM_{2.5}$ sampler) were used for sampling of $PM_{2.5}$ at 24 hours interval once in a fortnight and the same for the gaseous pollutants. The samples were analysed in Environmental Laboratory of CMPDI, RI-II, Dhanbad.

3.2 Water quality

Water samples were collected as per standard practice. The Mine effluent samples were collected and analysed for four parameters on fortnightly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory of CMPDI, RI- II, Dhanbad.

3.3 Noise level monitoring

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB(A).

4.0 Results and interpretations

4.1 Air quality

It has been seen from the analysis results that the 24 hours average concentration parameters like $PM_{10,}$ $PM_{2.5}$, SO_2 and NO_x are mostly within the permissible limits in all sampling locations as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines and National Ambient Air Quality Standard -2009. Sometimes the concentration of PM_{10}& $PM_{2.5}$ exceeds the limits due to heavy public traffic, poor road condition, coke oven plants, burning of coal by surrounding habitants, brick making, municipal waste dumps and industries like Steel Plant, thermal Plants including their fly ash etc.

The following preventive and suppressive mitigative measures can be undertaken to contain the pollution level within prescribed level:-

- Wet drilling and controlled blasting should be practice.
- Explosive used should be optimised to restrict the dust generation.
- Transportation roads should be permanently asphalted free of ruts, potholes etc.
- Water should be sprayed on coal transportation road, service road more frequently and at regular interval.
- Dust from roads should be removed physically or mechanically.
- Greenbelts around industrial sites, service building area besides Avenue plantation along roads should be created.
- Coal dust should be suppressed by using fixed sprinklers.
- Regular maintenance of plant and machinery should be undertaken.

4.2 Water quality

The test results indicate that the major parameters compared with MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines, are within permissible limits.

4.3 Noise Level

During the noise level survey it has been observed that the noise level in the sampling locations is within the permissible limits prescribed as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines for Industrial Area and Noise pollution (Regulation and Control) Rules, 2000.

INTRODUCTION

Any industry and development activities including coal mining is bound to affect environmental attributes. There are positive as well as negative impacts of such operations. For controlling the adverse impacts a regular monitoring is essential. The environmental monitoring is being done as per the guide-lines stipulated by Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India.

The very purpose of environmental monitoring is to assess the quality of various attributes which affects the environment. As per quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.

The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akasshkinaree Mine and Block IV Kooridih Mixed Mine as per **E. C. no. J-11015/213/2010-IA.II**(M) dated 06.02.2013 and later all seven mines are amalgamated to single mine Named Cluster III with OC cum UG with Highway Mining method with no change in lease area and production capacity. The cluster – III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster-III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and Bagdighi Nala.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity of 2.769 MTPA (normative) and 3.6 MTPA peak capacity of coal production vide letter no **E. C. no. J-11015/213/2010-IA. II**(M) dated 06.02.2013 later with **E. C. no. J-11015/213/2010-IA. II**(M) dated 03.03.2025.

Ministry of Environment, Forest and Climate Change while granting environmental clearance has given one of the General conditions that " Four ambient air quality monitoring stations should be established in the core zone as well as in the buffer zone for PM_{10}, $PM_{2.5}$, SO_2, NOx monitoring. Location of the stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets, other conditions regarding water / effluent and noise level monitoring in consultation with the State Pollution Control Board."

In compliance of these conditions the Environmental Monitoring has been carried out & report prepared for submission to MoEF&CC & JSPCB and other statutory authorities.

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

(As per G.S.R. 742 (E) dt. 25th December, 2000)

2.1.1 Ambient Air Quality Sampling Locations

CORE ZONE Monitoring Location

i) Block IV Kooridih OCP (A6): Industrial Area

The location of the sampling station is at 23°47'54.00"N & 86°16'20.00"E. The sampler was placed at 1.5 m above the ground level near Safety office of Block IV OCP.

BUFFER ZONE Monitoring Location

i) Muraidih OCP (A5) : Industrial Area

The sampler was placed at a height of 1.5 m from the ground level at Muraidih project office.

ii) Ramkanali Workshop (A7) : Industrial area

The location of the sampling station is 23°48'34.00"N & 86°18'22.00"E. The sampler was placed at height of 1.5 m above the ground level at AARC agent Office, Ramkanali.

iii) Kharkharee(A21): **Industrial Area**

The location of the sampling station is 23°46'29.00"N & 86°14'37.08"E. The sampler was placed at a height of 1.5 m above the ground level at Kharkharee Colliery.

AMBIENT AIR QUALITY DATA

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
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email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**05/2025**	**Cluster**	**Cluster III**	**ULR NO.**	**TC1432125000001838F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**24.06.2025**
Project	**Block-IV**	**Sample Ref. No.**	**REM/BCCL/2025/05**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	13.05.25	29.05.25	**Period of Analysis**	13.05.25 – 20.06.2025	**Zone of Station:** **Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)** A3906	A3991	**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
1	PM_{10}	IS -5182(Part 23):2006, R-2017	88	97	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	48	58	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	**31**	**33**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*
***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

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Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
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TC-14321

Test Report for Ambient Air Samples

Month & Year	**05/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000001838F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**24.06.2025**
Project	**Ramkanali Workshop**		**Sample Ref. No.**	**REM/BCCL/2025/05**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	15.05.25		30.05.25	**Period of Analysis**	15.05.25 – 20.06.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)** A3921	A4000	**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
1	PM_{10}	IS -5182(Part 23):2006, R-2017	106	118	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	56	63	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	28	32	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*
***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

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Test Report for Ambient Air Samples

Month & Year	**05/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000001838F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**24.06.2025**
Project	**Kharkharee**	**Sample Ref. No.**	**REM/BCCL/2025/05**		**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	12.05.25	26.05.25	**Period of Analysis**	12.05.25	20.06.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			1st FN A3896	**2nd FN** A3971				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	96	97	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	52	55	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	**30**	**33**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

***All units are in µg/m3, 24 hourly Average, * LDL indicates Lower Detection Limit,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

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Test Report for Ambient Air Samples

Month & Year	**05/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000001838F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**24.06.2025**
Project	**Muraidih 20/21**	**Sample Ref. No.**		**Sampling Method**		**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	02.05.25	16.05.25	**Period of Analysis**	02.05.25	20.06.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			1st FN A3849	**2nd FN** A3927				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	96	90	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	49	48	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	**30**	**32**	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

***All units are in µg/m3, 24 hourly Average, * LDL indicates Lower Detection Limit,*

ANALYSED BY

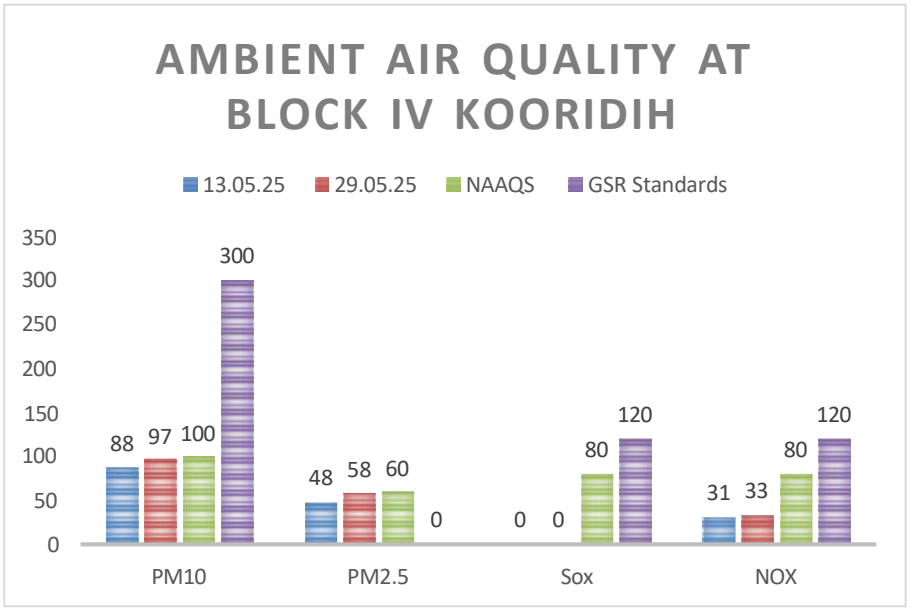
(Gaurav Kant)
REVIEWED BY

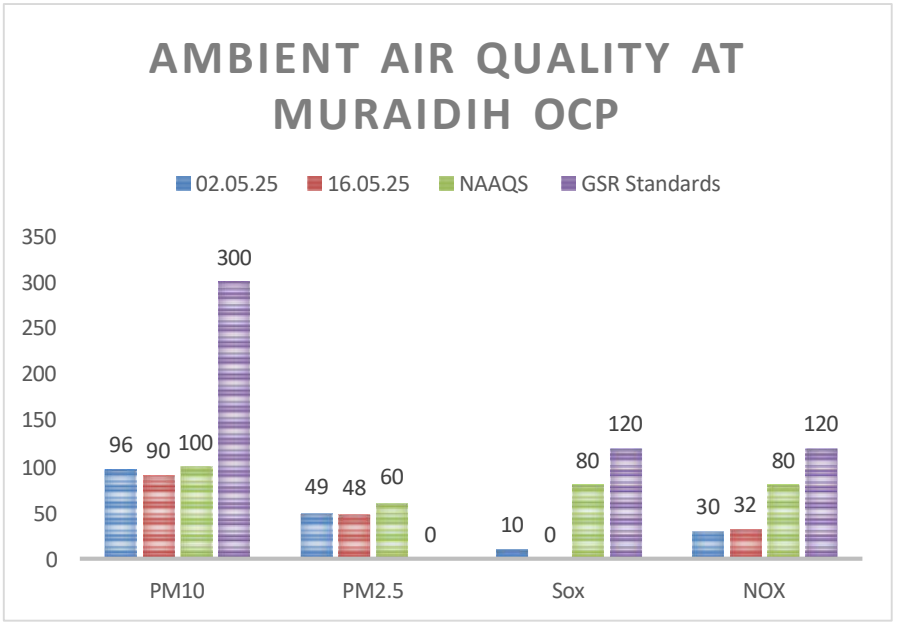
(Amit Raj Mishra)
Authorised Signatory

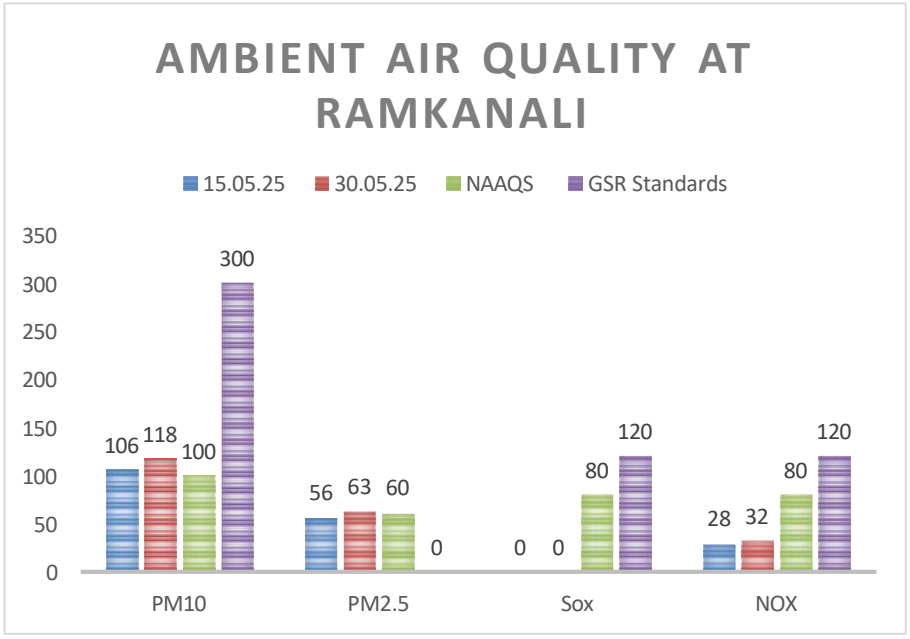
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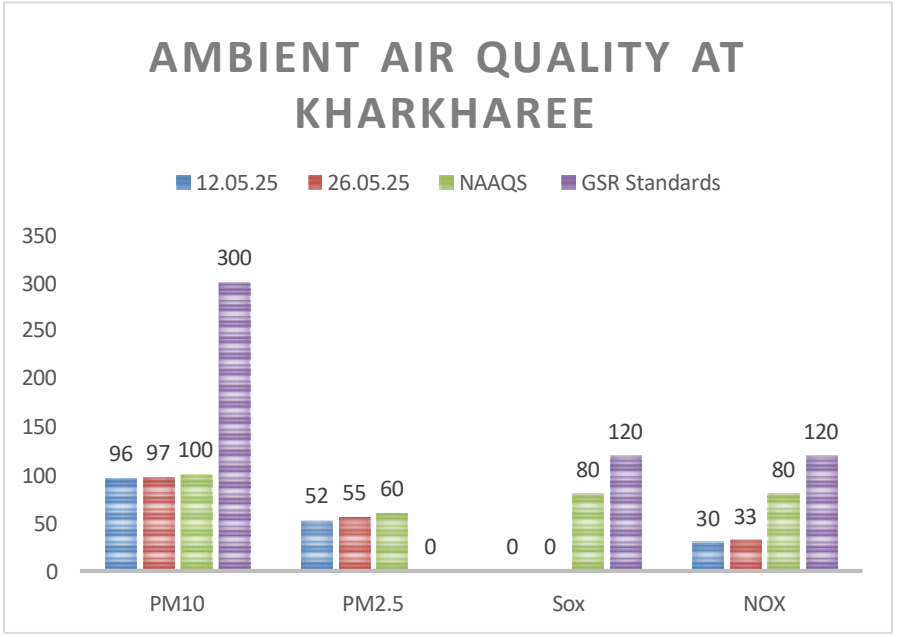
---- End of Report ----

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AMBIENT AIR QUALITY AT BLOCK IV KOORIDIH
13.05.25
29.05.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
88 97 100 300
48 58 60 0
0 0 80 120
31 33 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT MURAIDIH OCP
02.05.25
16.05.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
96 90 100 300
49 48 60 0
10 0 80 120
30 32 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT RAMKANALI
15.05.25
30.05.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
106 118 100 300
56 63 60 0
0 0 80 120
28 32 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT KHARKHAREE
12.05.25
26.05.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
96 97 100 300
52 55 60 0
0 0 80 120
30 33 80 120
PM10
PM2.5
Sox
NOX

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) Mine Discharge of Govindpur (MW3)

A sampling point is fixed to assess the effluent quality of Mine discharge. This location is selected to monitor effluent discharge in to Khudia Nala and Bagdighi Nala.

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. The effluent samples were collected and analysed for four parameters on fortnightly basis at the Environmental Laboratory of CMPDI RI-II, Dhanbad.

3.3 Results & Interpretations

The results are given in tabular form along with the applicable standards. Results are compared with Schedule - VI, effluent prescribed by MoEF&CC. Results show that most of the parameters are within the permissible limits.

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
MINE EFFLUENT TEST REPORT

CMPDIL, RI-II
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DHANBAD. -826005
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Test Report for Mine Effluent samples

Month & Year	**05/2025**	**Cluster**	**Cluster III**	**ULR NO.**	**TC1432125000001856F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**24.06.2025**
Project		**Sampling Ref. No.**	**REM/BCCL/2025/05**	**Sampling Method**	**IS 3025 (Part-1) CMPDI/RI-II/LPM 13**
Sampling Stations	**(i)**	**Govindpur**	**Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent**	**Period of Analysis**	**05.05.2025 TO 31.05.2025**
			Date of Sampling	05.05.25	20.05.25

Sl. No.	Parameter	Method of Analysis	Observed Values		STANDARDS FOR COAL MINES (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)	LDL
			M1507	M1534		
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	44	46	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	8.01	8	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<4.0	<4.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	32	36	*250 (Max)*	4

***All units in mg/L unless specified otherwise. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*
***Grab sampling carried out for water samples.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report cannot be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

NOISE LEVEL QUALITY MONITORING

4.1 Location of sampling sites

i) **Block-IV (N6)**

ii) **Nichitpur (N5)**

iii) **Govindpur Village (N7)**

i) Kharkharee (N21)

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter during day time & night time. Noise levels were measured for the complete day & night time, the Intergration time taken was one hour or 3600 seconds. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB (A).

4.2 Results & Interpretations

Ambient noise levels were recorded during day time & night time and the observed values were compared with standards prescribed by MoEF&CC. The results of Noise levels recorded during day & night time on fortnightly basis are presented in tabular form along with the applicable standard permissible limits. The observed values in terms of L_{EQ} are presented**.** The observed values at all the monitoring locations are found to be within permissible limits.

TC-14321

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A Mini Ratna Company

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
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email: rdri2cmpdi@coalindia.in

Month & Year	**05/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000001872F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**24.06.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/05**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Block IV**	**Date of Sampling**	13.05.25	29.05.25	**Zone Category of Station:**	**Core Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	54.6	53.3	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	58.8	57.7					
3		08:00 - 09:00	60	58.7					
4		09:00 – 10:00	63.2	62.3					
5		10:00 - 11:00	62.7	61.7					
6		11:00 - 12:00	64	63.5					
7		12:00 - 13:00	63.6	62.3					
8		13:00 - 14:00	63.9	64.6					
9		14:00 - 15:00	64.3	63.4					
10		15:00 - 16:00	67.2	65.5					
11		16:00 - 17:00	68	67.8					
12		17:00 - 18:00	68.9	68.7					
13		18:00 - 19:00	67.6	65.5					
14		19:00 - 20:00	67.1	66.5					
15		20:00 - 21:00	60.5	59.6					
16		21:00 - 22:00	53.6	52.1					
		Leq DAY	64.7	64.0					
1	Noise Level dB(A)Leq -Night	22:00-23:00	49.2	47.9	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	48.5	46.4					
3		00:00- 01:00	46.7	45.8					
4		01.00-02.00	41.9	42.2					
5		02.00-03.00	41.5	41.7					
6		03.00-04.00	44.4	42.9					
7		04.00-05.00	42.6	42.1					
8		05:00-06:00	42.9	43.9					
		Leq NIGHT	45.7	44.7					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
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Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**05/2025**	**Cluster**	**Cluster III**			**ULR No.**	**TC1432125000001872F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**24.06.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/05**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Muraidih OCP**	**Date of Sampling**	02.05.25	16.05.25	**Zone Category of Station:**	**Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	45.1	45.7	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	46.3	48.2					
3		08:00 - 09:00	51.3	50.8					
4		09:00 – 10:00	52.5	53.2					
5		10:00 - 11:00	53.3	53.7					
6		11:00 - 12:00	56	55.6					
7		12:00 - 13:00	56.8	57.8					
8		13:00 - 14:00	52.2	53					
9		14:00 - 15:00	53.3	53.7					
10		15:00 - 16:00	55.8	57					
11		16:00 - 17:00	50.5	49.4					
12		17:00 - 18:00	46.2	46.2					
13		18:00 - 19:00	44.7	44.6					
14		19:00 - 20:00	45.1	44.9					
15		20:00 - 21:00	44.6	44.7					
16		21:00 - 22:00	44.4	43.5					
		Leq DAY	52.0	52.4					
1	Noise Level dB(A)Leq - Night	22:00-23:00	40.9	40.4	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	40.5	38.8					
3		00:00- 01:00	40.2	38.1					
4		01.00-02.00	40.1	37.9					
5		02.00-03.00	39.7	37.8					
6		03.00-04.00	39.2	38.4					
7		04.00-05.00	40.7	40.1					
8		05:00-06:00	40.7	40.6					
		Leq NIGHT	40.3	39.2					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

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email: rdri2cmpdi@coalindia.in

Month & Year	**05/2025**	**Cluster**	**Cluster III**	**ULR No.**	**TC1432125000001872F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**24.06.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/05**	**Sampling Method**	**CMPDI/RI-II/LPM 13**
Sampling Stations	**i**	**Ramkanali**	**Date of Sampling**	15.05.25 – 30.05.25	**Zone Category of Station:** **Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	52.5	51.5	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	55.1	54.3					
3		08:00 - 09:00	57.8	57.4					
4		09:00 – 10:00	63	63.3					
5		10:00 - 11:00	65.7	64.6					
6		11:00 - 12:00	64.1	63.3					
7		12:00 - 13:00	67.2	68.7					
8		13:00 - 14:00	68.8	67.7					
9		14:00 - 15:00	61.7	61.7					
10		15:00 - 16:00	60.6	60.6					
11		16:00 - 17:00	60.2	60.2					
12		17:00 - 18:00	60.5	59.7					
13		18:00 - 19:00	59.7	58.8					
14		19:00 - 20:00	58.5	57.7					
15		20:00 - 21:00	58.5	53.6					
16		21:00 - 22:00	54.3	52.6					
		Leq DAY	62.7	62.4					
1	Noise Level dB(A)Leq - Night	22:00-23:00	49.6	48.9	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	49.5	48.7					
3		00:00- 01:00	46.5	46.6					
4		01.00-02.00	44.6	44.4					
5		02.00-03.00	44.2	44.2					
6		03.00-04.00	44	44					
7		04.00-05.00	46	45.7					
8		05:00-06:00	46.9	46.7					
		Leq NIGHT	46.9	46.5					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

Month & Year	**05/2025**	**Cluster**	**Cluster III**				**ULR No.**	**TC1432125000001872F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**						**Date of Issue**	**24.06.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/05**		**Sampling Method**		**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Kharkharee**	**Date of Sampling**	12.05.25	26.05.25	**Zone Category of Station:**	**Buffer Zone**	

Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A)) First Fortnight**	**Observed Values (in Leq dB(A)) Second Fortnight**	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards**	
								Zones	**Limits in dB**
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	43.7	44.5	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	59.1	59					
3		08:00 - 09:00	70.2	70.4					
4		09:00 – 10:00	70.1	69.8					
5		10:00 - 11:00	66.5	65.4					
6		11:00 - 12:00	63.6	63.2					
7		12:00 - 13:00	61.2	62.2					
8		13:00 - 14:00	59.6	58.9					
9		14:00 - 15:00	57.4	56.7					
10		15:00 - 16:00	55.8	56.1					
11		16:00 - 17:00	56.1	56.8					
12		17:00 - 18:00	55.9	56.5					
13		18:00 - 19:00	53.3	53.3					
14		19:00 - 20:00	51.5	51.6					
15		20:00 - 21:00	49.5	49.7					
16		21:00 - 22:00	48.9	49.3					
		Leq DAY	63.1	63.0					
1	Noise Level dB(A)Leq - Night	22:00-23:00	43.6	41.6	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	41	41.5					
3		00:00- 01:00	41.1	41.5					
4		01.00-02.00	39.4	40.5					
5		02.00-03.00	39.1	36.2					
6		03.00-04.00	38.6	39.9					
7		04.00-05.00	38.4	37.4					
8		05:00-06:00	37.2	35.2					
		Leq NIGHT	40.2	39.8					

**LDL indicates Lower Detection Limit*
***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

Page -1 of 1

Ambient Air Quality Standards for Jharia Coal Field
As per the Environment (Protection) Amendment Rules, 2000 notified vide notification G.S.R. 742(E), dated 25.9.2000.

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
	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. Improvedwest 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 clause2.

** 24hourly/8hourlyvaluesshallbemet 92%ofthetimeinayear.However,8% of the time it may exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981), and in supersession of the notification No(s).S.O.384(E), dated 11th April 1994 and S.O.935(E), dated 14th NOVEMBER 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

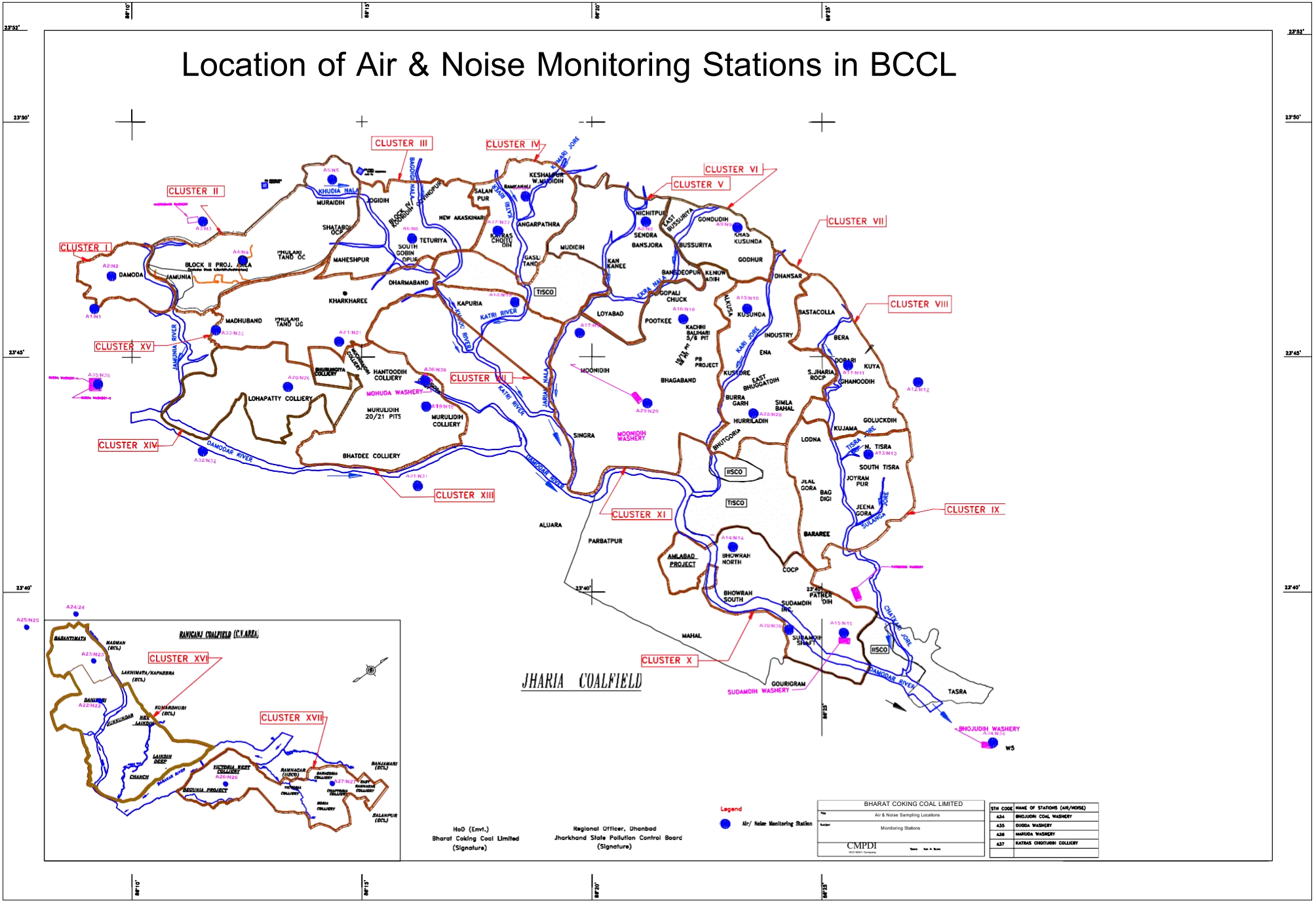
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogendioxide (NO_2), µg/m³	Annual * 24 Hours **	40 80	30 80	-Jacob &Hochheiser modified ($NaOH$-$NaAsO_2$) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM_{10}, µg/m³	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m³	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O_3) , µg/m³	8 Hours * 1 Hour **	100 180	100 180	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb) , µg/m³	Annual * 24 Hours **	0.50 1.0	0.50 1.0	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
Carbon Monoxide (CO), mg/m³	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m³	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C_6H_6), µg/m³	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m³	Annual *	01	01	-Solvent extraction followed byHPLC/GC analysis
Arsenic (As), ng/m³	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m³	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

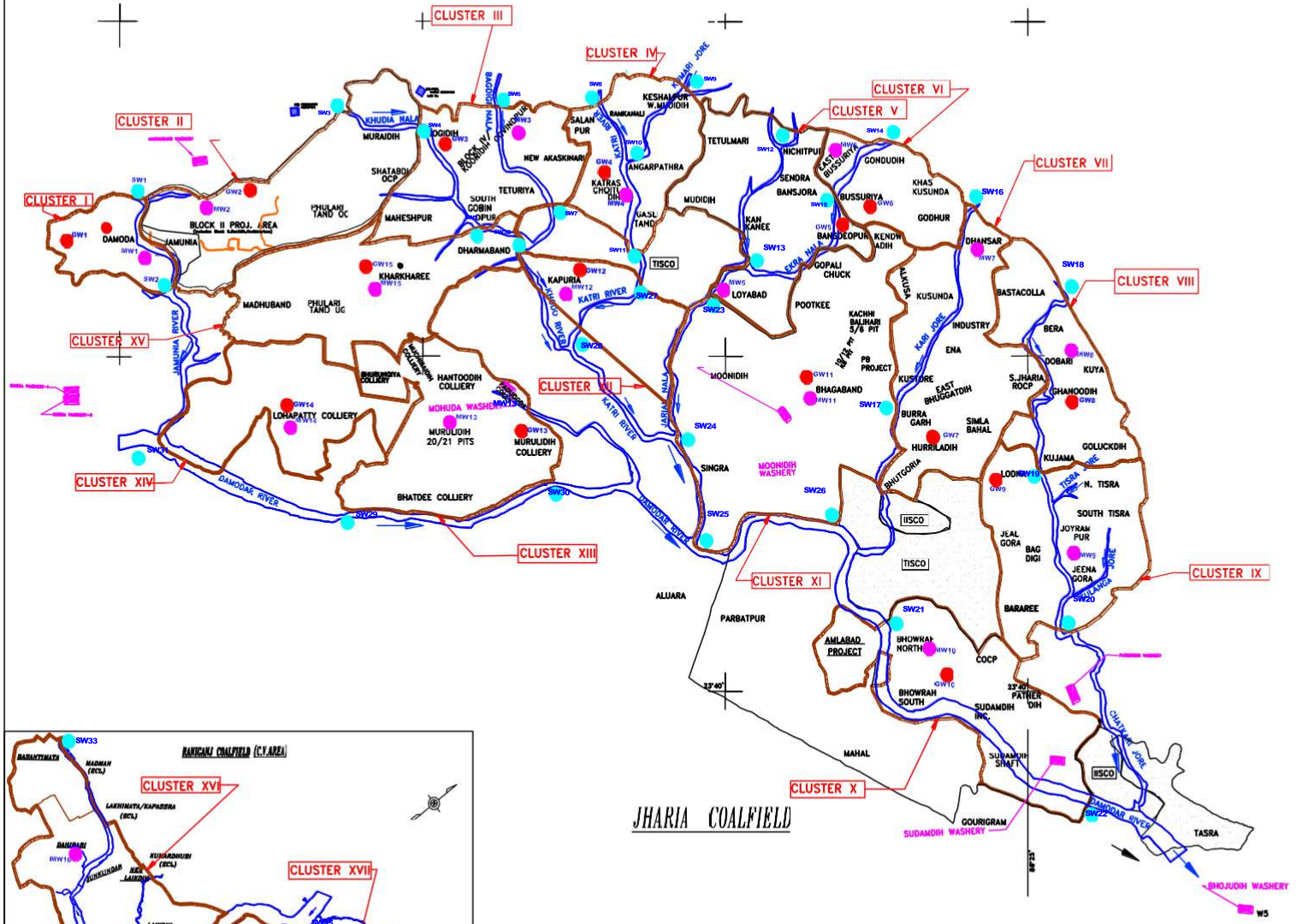
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they JUNE exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



INDEX

Cluste	Suface Wate (U/S, D/S)	Name of River/ Nala / Jore	Mine/ Effluent Water	Sampling Location	Ground Water	Sampling Location
I	SW1, SW2	Jamunia River	MW1	Damoda Area	GW1	Ghutway Village
II	SW3, SW4	Khudia Nala	MW2	Block II OCP	GW2	Joyrampur Village
III	SW4, SW5, SW6, SW7	Khudia Nala, Sagdigi Nala	MW3	Govindpur Colliery	GW3	Jogidih Village
IV	SW8, SW11, SW9, SW10	Katri River, Kumari Jore Jarian	MW4	Chotudih	GW4	Kankanee Village
V	SW12, SW13, SW15	Nala, Ekra Nala	MW5	Mudidih East	GW5	Nichitpur Bansjora
VI	SW14, SW15	Ekra Nala	MW6	Bassuria UGP	GW6	Borewell
VII	SW16, SW17	Kari Jore	MW7	Dhansar UGP	GW7	Lurlidih
VIII	SW18, SW19	Kashi Jore	MW8	Dobari UGP	GW8	Dhanodih
IX	SW19, SW20	Kashi Jore	MW9	Jeenagora	GW9	Lodna
X	SW21, SW22	Damodar River	MW10	Bhowrah North	GW10	Bhowrah South
XI	SW23, SW24, SW25, SW26	Jarian Nala, Damodar River	MW11	Bhagabandh UGP	GW11	Bhagabandh
XII	SW27, SW28	Katri River	MW12	Kapuria	GW12	Kapuria
XIII	SW29, SW30	Damodar River	MW13	Murulidih (20/21)	GW13	Murlidih
XIV	SW31, SW29	Damodar River	MW14	Lohapatti	GW14	Lohapatti
XV	SW5, SW32	Khudia Nala	MW15	Kharkharee UGP	GW15	Kharkharee
XVI	SW33, SW34	Khudia River	MW16	Dahibari OCP	GW16	Pallabari Village
XVII	SW35, SW36	Barakar River	MW17	Damagoria Colliery	GW17	Chaptoria

HoD (Envt.)
Bharat Coking Coal Limited
(Signature)

Regional Officer, Dhanbad
Jharkhand State Pollution Control Board
(Signature)

Legend
- Sampling Locations of Surface Water (Upstream/ Downstream)
- Sampling Locations of Mine Water
- Sampling Locations of Ground/ Drinking Water

BHARAT COKING COAL LIMITED

Customer	WATER SAMPLING LOCATIONS
Title	MONITORING STATIONS
Subject	CMPDI

L

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ENVIRONMENTAL MONITORING REPORT OF BHARAT COKING COAL LIMITED, CLUSTER – III

(FOR THE MONTH APRIL, 2025)

E. C. no. J-11015/213/2010-IA.II (M) dated 06.02.2013.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

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3.	CHAPTER-III	RESULTS	7-19
4.	CHAPTER-IV	STANDARDS AND PLANS	20-21

EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the fauna and flora. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal Limited (BCCL), a Subsidiary company of Coal India Limited is operating Underground and Opencast Mines in Jharia Coalfield (JCF) is a part of Gondwana Coalfields located in Dhanbad district of Jharkhand, the JCF is bounded by $23^0$37' N to $23^0$52' N latitudes and $86^0$09' E to $86^0$30' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Jharia Coalfield (JCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEF&CC while granting environmental clearance of project, consent letter issued by the respective SPCB, and other statutory requirements.

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

The ambient air quality monitoring stations were selected to represent core, buffer zone area. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

2.2 Water sampling stations

The Water sampling stations were selected for mine sump water.

2.3 Noise level monitoring locations

Noise levels vary depending on the various activities in mining areas. The monitoring of noise level in different locations will be helpful to take appropriate mitigating measures. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_x). Respirable Dust Samplers (RDS) and Fine Dust Sampler ($PM_{2.5}$

sampler) were used for sampling of $PM_{10,}$ SO_2, & NO_x and Fine Dust Sampler ($PM_{2.5}$ sampler) were used for sampling of $PM_{2.5}$ at 24 hours interval once in a fortnight and the same for the gaseous pollutants. The samples were analysed in Environmental Laboratory of CMPDI, RI-II, Dhanbad.

3.2 Water quality

Water samples were collected as per standard practice. The Mine effluent samples were collected and analysed for four parameters on fortnightly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory of CMPDI, RI- II, Dhanbad.

3.3 Noise level monitoring

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB(A).

4.0 Results and interpretations

4.1 Air quality

It has been seen from the analysis results that the 24 hours average concentration parameters like $PM_{10,}$ $PM_{2.5}$, SO_2 and NO_x are mostly within the permissible limits in all sampling locations as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines and National Ambient Air Quality Standard -2009. Sometimes the concentration of PM_{10}& $PM_{2.5}$ exceeds the limits due to heavy public traffic, poor road condition, coke oven plants, burning of coal by surrounding habitants, brick making, municipal waste dumps and industries like Steel Plant, thermal Plants including their fly ash etc.

The following preventive and suppressive mitigative measures can be undertaken to contain the pollution level within prescribed level:-

- Wet drilling and controlled blasting should be practice.
- Explosive used should be optimised to restrict the dust generation.
- Transportation roads should be permanently asphalted free of ruts, potholes etc.
- Water should be sprayed on coal transportation road, service road more frequently and at regular interval.
- Dust from roads should be removed physically or mechanically.
- Greenbelts around industrial sites, service building area besides Avenue plantation along roads should be created.
- Coal dust should be suppressed by using fixed sprinklers.
- Regular maintenance of plant and machinery should be undertaken.

4.2 Water quality

The test results indicate that the major parameters compared with MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines, are within permissible limits.

4.3 Noise Level

During the noise level survey it has been observed that the noise level in the sampling locations is within the permissible limits prescribed as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines for Industrial Area and Noise pollution (Regulation and Control) Rules, 2000.

INTRODUCTION

Any industry and development activities including coal mining is bound to affect environmental attributes. There are positive as well as negative impacts of such operations. For controlling the adverse impacts a regular monitoring is essential. The environmental monitoring is being done as per the guide-lines stipulated by Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India.

The very purpose of environmental monitoring is to assess the quality of various attributes which affects the environment. As per quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.

The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akasshkinaree Mine and Block IV Kooridih Mixed Mine as per **E. C. no. J-11015/213/2010-IA.II**(M) dated 06.02.2013 and later all seven mines are amalgamated to single mine Named Cluster III with OC cum UG with Highway Mining method with no change in lease area and production capacity. The cluster – III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster-III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and Bagdighi Nala.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity of 2.769 MTPA (normative) and 3.6 MTPA peak capacity of coal production vide letter no **E. C. no. J-11015/213/2010-IA. II**(M) dated 06.02.2013 later with **E. C. no. J-11015/213/2010-IA. II**(M) dated 03.03.2025.

Ministry of Environment, Forest and Climate Change while granting environmental clearance has given one of the General conditions that " Four ambient air quality monitoring stations should be established in the core zone as well as in the buffer zone for PM_{10}, $PM_{2.5}$, SO_2, NOx monitoring. Location of the stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets, other conditions regarding water / effluent and noise level monitoring in consultation with the State Pollution Control Board."

In compliance of these conditions the Environmental Monitoring has been carried out & report prepared for submission to MoEF&CC & JSPCB and other statutory authorities.

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

(As per G.S.R. 742 (E) dt. 25th December, 2000)

2.1.1 Ambient Air Quality Sampling Locations

CORE ZONE Monitoring Location

i) Block IV Kooridih OCP (A6): Industrial Area

The location of the sampling station is at 23°47'54.00"N & 86°16'20.00"E. The sampler was placed at 1.5 m above the ground level near Safety office of Block IV OCP.

BUFFER ZONE Monitoring Location

i) Muraidih OCP (A5) : Industrial Area

The sampler was placed at a height of 1.5 m from the ground level at Muraidih project office.

ii) Ramkanali Workshop (A7) : Industrial area

The location of the sampling station is 23°48'34.00"N & 86°18'22.00"E. The sampler was placed at height of 1.5 m above the ground level at AARC agent Office, Ramkanali.

iii) Kharkharee(A21): **Industrial Area**

The location of the sampling station is 23°46'29.00"N & 86°14'37.08"E. The sampler was placed at a height of 1.5 m above the ground level at Kharkharee Colliery.

AMBIENT AIR QUALITY DATA

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
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DHANBAD. -826005
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Test Report for Ambient Air Samples

Month & Year	**04/2025**	**Cluster**	**Cluster III**	**ULR NO.**	**TC1432125000001786F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.05.2025**
Project	**Block-IV**	**Sample Ref. No.**	**REM/BCCL/2025/04**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	03.04.25	19.04.25	**Period of Analysis**	03.04.25 – 25.05.2025	**Zone of Station:** **Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			1st FN A3707	**2nd FN A3792**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	104	118	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	57	63	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	31	29	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*
***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

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TC-14321

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Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

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Test Report for Ambient Air Samples

Month & Year	**04/2025**	**Cluster**	**Cluster III**	**ULR NO.**	**TC1432125000001786F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.05.2025**
Project	**Ramkanali Workshop**	**Sample Ref. No.**	**REM/BCCL/2025/04**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	04.04.25	21.04.25	**Period of Analysis**	04.04.25 – 25.05.2025	**Zone of Station:** **Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			1st FN A3713	**2nd FN A3796**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	111	96	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	65	56	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	29	31	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*
***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

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Test Report for Ambient Air Samples

Month & Year	**04/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000001786F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**30.05.2025**
Project	**Kharkharee**	**Sample Ref. No.**	**REM/BCCL/2025/04**		**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	02.04.25	18.04.25	**Period of Analysis**	02.04.25	25.05.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			1st FN A3701	**2nd FN A3784**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	104	99	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	58	56	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	10	11	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	30	28	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

***All units are in µg/m3, 24 hourly Average, * LDL indicates Lower Detection Limit,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

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Test Report for Ambient Air Samples

Month & Year	**04/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000001786F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**30.05.2025**
Project	**Muraidih 20/21**	**Sample Ref. No.**	**REM/BCCL/2025/04**		**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	10.04.2025	25.04.2025	**Period of Analysis**	01.04.2025	25.05.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			1st FN A3745	**2nd FN A3823**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	106	94	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	50	50	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	29	30	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

***All units are in µg/m3, 24 hourly Average, * LDL indicates Lower Detection Limit,*

ANALYSED BY

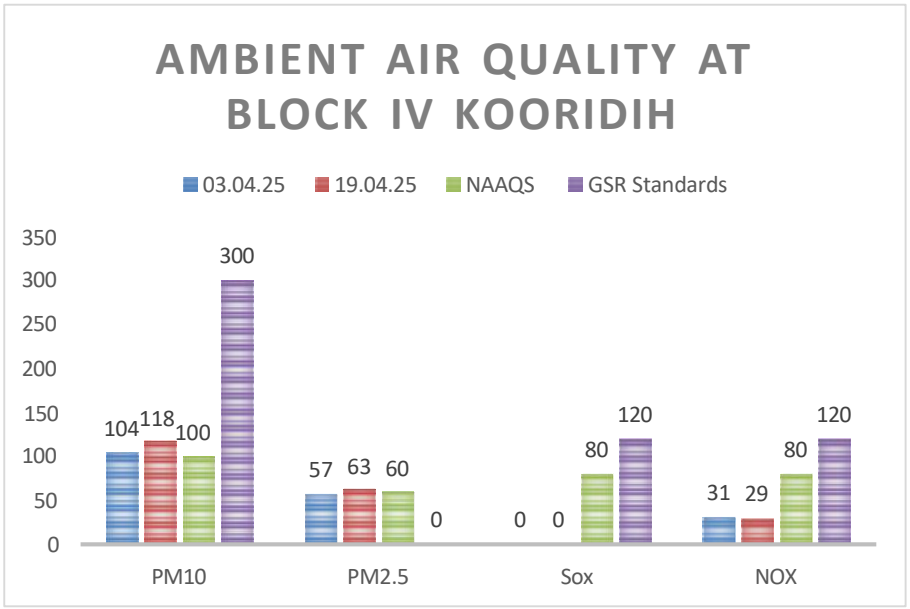
(Gaurav Kant)
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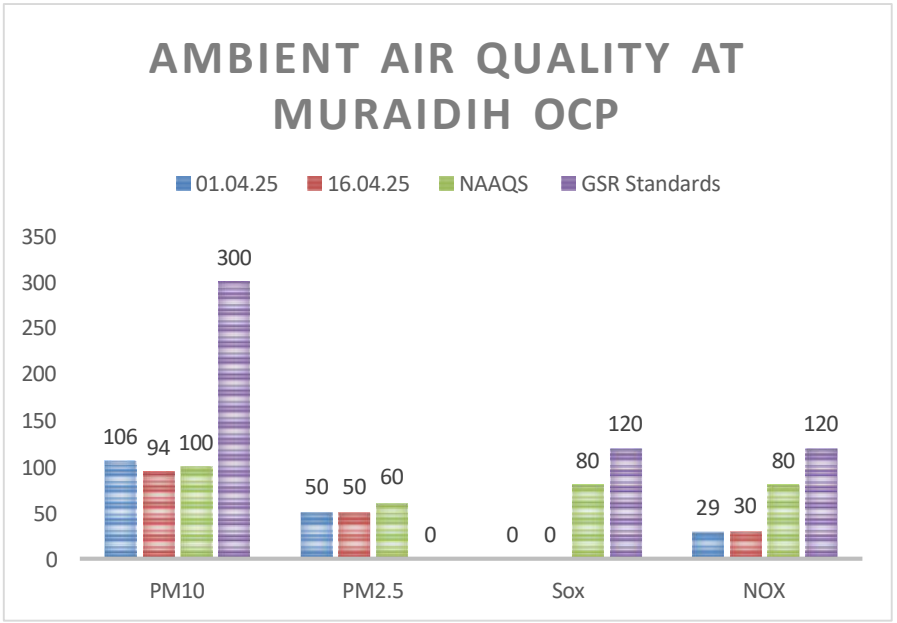
(Amit Raj Mishra)
Authorised Signatory

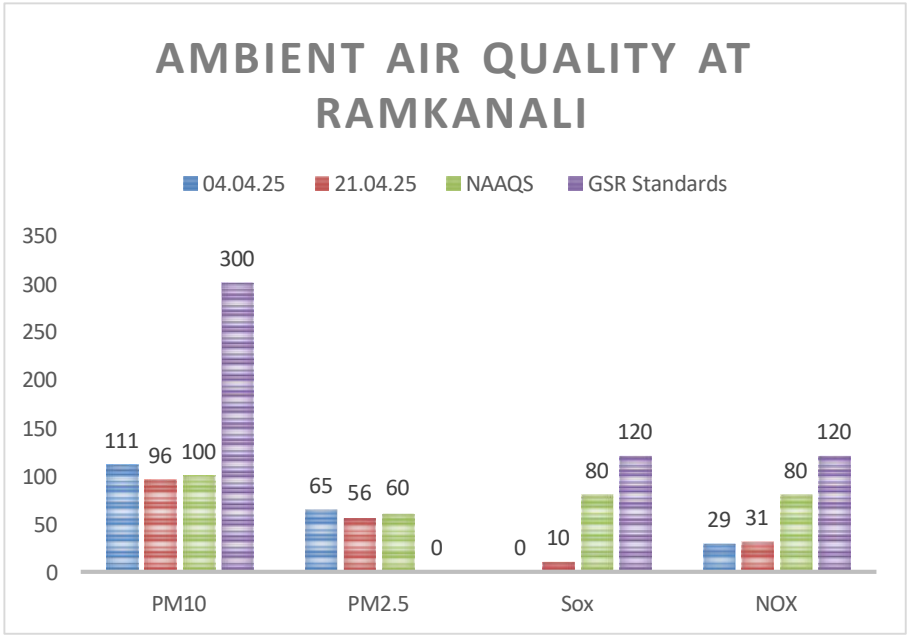
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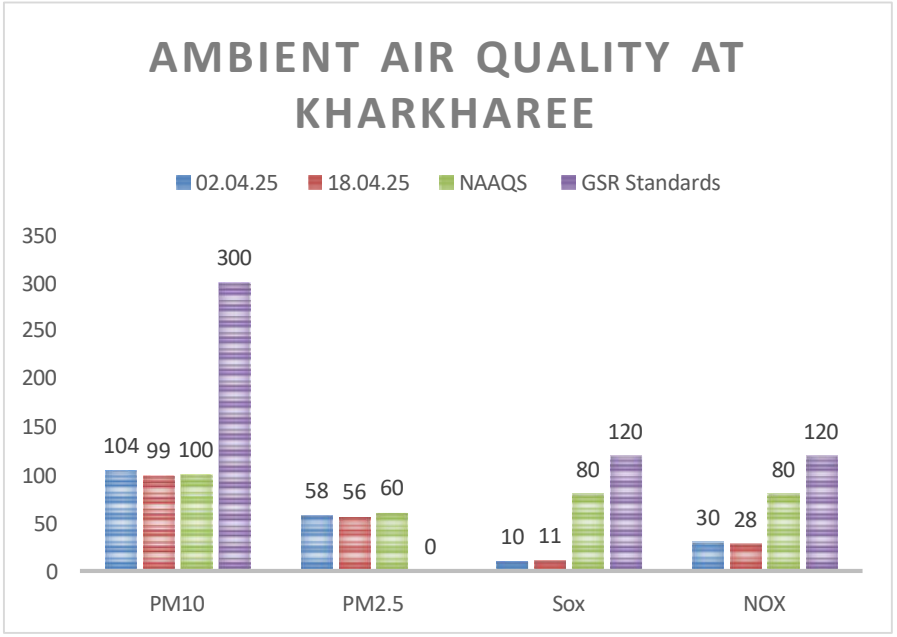
---- End of Report ----

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AMBIENT AIR QUALITY AT BLOCK IV KOORIDIH
03.04.25
19.04.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
104 118 100 300
57 63 60 0
0 0 80 120
31 29 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT MURAIDIH OCP
01.04.25
16.04.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
106 94 100 300
50 50 60 0
0 0 80 120
29 30 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT RAMKANALI
04.04.25
21.04.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
111 96 100 300
65 56 60 0
0 10 80 120
29 31 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT KHARKHAREE
02.04.25
18.04.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
104 99 100 300
58 56 60 0
10 11 80 120
30 28 80 120
PM10
PM2.5
Sox
NOX

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) Mine Discharge of Govindpur (MW3)

A sampling point is fixed to assess the effluent quality of Mine discharge. This location is selected to monitor effluent discharge in to Khudia Nala and Bagdighi Nala.

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. The effluent samples were collected and analysed for four parameters on fortnightly basis at the Environmental Laboratory of CMPDI RI-II, Dhanbad.

3.3 Results & Interpretations

The results are given in tabular form along with the applicable standards. Results are compared with Schedule - VI, effluent prescribed by MoEF&CC. Results show that most of the parameters are within the permissible limits.

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
MINE EFFLUENT TEST REPORT

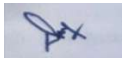
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email: rdri2cmpdi@coalindia.in

Test Report for Mine Effluent samples

Month & Year	**04/2025**	**Cluster**	**Cluster III**	**ULR NO.**	**TC1432125000001804F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**30.05.2025**
Project		**Sampling Ref. No.**	**REM/BCCL/2025/04**	**Sampling Method**	**IS 3025 (Part-1) CMPDI/RI-II/LPM 13**
Sampling Stations	**(i)**	**Govindpur**	**Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent**	**Period of Analysis**	**07.04.2025 TO 30.04.2025**
			Date of Sampling	07.04.2025	21.04.2025

Sl. No.	Parameter	Method of Analysis	Observed Values M1459	Observed Values M1472	STANDARDS FOR COAL MINES (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)	LDL
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	39	41	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.41	7.43	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<4.0	<4.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	36	44	*250 (Max)*	4

***All units in mg/L unless specified otherwise. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*
***Grab sampling carried out for water samples.*



ANALYSED BY



(Kumar Vaibhav)
REVIEWED BY



(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report cannot be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

NOISE LEVEL QUALITY MONITORING

4.1 Location of sampling sites

i) **Block-IV (N6)**

ii) **Nichitpur (N5)**

iii) **Govindpur Village (N7)**

i) Kharkharee (N21)

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter during day time & night time. Noise levels were measured for the complete day & night time, the Intergration time taken was one hour or 3600 seconds. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB (A).

4.2 Results & Interpretations

Ambient noise levels were recorded during day time & night time and the observed values were compared with standards prescribed by MoEF&CC. The results of Noise levels recorded during day & night time on fortnightly basis are presented in tabular form along with the applicable standard permissible limits. The observed values in terms of L_{EQ} are presented**.** The observed values at all the monitoring locations are found to be within permissible limits.

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TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

Month & Year	**04/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000001820F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**30.05.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/04**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Block IV**	**Date of Sampling**	03.04.25	19.04.25	**Zone Category of Station:**	**Core Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	52.6	51.4	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	56.6	55.6					
3		08:00 - 09:00	57.5	56.5					
4		09:00 – 10:00	60.9	60.1					
5		10:00 - 11:00	60.4	59.4					
6		11:00 - 12:00	61.7	61.1					
7		12:00 - 13:00	61.3	60.1					
8		13:00 - 14:00	61.6	62.2					
9		14:00 - 15:00	61.9	61					
10		15:00 - 16:00	64.7	63.1					
11		16:00 - 17:00	65.6	65.4					
12		17:00 - 18:00	66.4	66.2					
13		18:00 - 19:00	65.1	63.1					
14		19:00 - 20:00	64.6	64					
15		20:00 - 21:00	58.3	57.4					
16		21:00 - 22:00	57.2	55.9					
		Leq DAY	62.4	61.6					
1	Noise Level dB(A)Leq -Night	22:00-23:00	53.3	53	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	52.5	50.3					
3		00:00- 01:00	50.7	49.7					
4		01.00-02.00	45.4	45.7					
5		02.00-03.00	45	45.2					
6		03.00-04.00	48.2	46.5					
7		04.00-05.00	46.2	45.6					
8		05:00-06:00	46.5	47.6					
		Leq NIGHT	49.6	48.8					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
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Month & Year	**04/2025**	**Cluster**	**Cluster III**			**ULR No.**	**TC1432125000001820F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**30.05.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/04**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Muraidih OCP**	**Date of Sampling**	01.04.25	16.04.25	**Zone Category of Station:**	**Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	44.5	44.4	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	44.6	46.4					
3		08:00 - 09:00	49.4	48.8					
4		09:00 – 10:00	50.6	51.2					
5		10:00 - 11:00	51.3	51.6					
6		11:00 - 12:00	53.7	53.5					
7		12:00 - 13:00	54.8	55.7					
8		13:00 - 14:00	50.3	51					
9		14:00 - 15:00	51.3	51.6					
10		15:00 - 16:00	53.7	54.8					
11		16:00 - 17:00	48.6	48.8					
12		17:00 - 18:00	44.5	44.5					
13		18:00 - 19:00	43	42.9					
14		19:00 - 20:00	43.4	43.4					
15		20:00 - 21:00	42.9	43.6					
16		21:00 - 22:00	42.7	43					
		Leq DAY	50.0	50.5					
1	Noise Level dB(A)Leq - Night	22:00-23:00	42.3	42.4	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	41.9	42.3					
3		00:00- 01:00	41.4	42.1					
4		01.00-02.00	41.3	41.7					
5		02.00-03.00	41.2	41.3					
6		03.00-04.00	42.2	42					
7		04.00-05.00	43.8	42.6					
8		05:00-06:00	43.8	43.8					
		Leq NIGHT	42.4	42.3					

**LDL indicates Lower Detection Limit*
***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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---- End of Report ----

TC-14321

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Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
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Month & Year	**04/2025**	**Cluster**	**Cluster III**			**ULR No.**	**TC1432125000001820F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**30.05.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/04**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Ramkanali**	**Date of Sampling**	04.04.25	21.04.25	**Zone Category of Station:**	**Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	50.6	49.6	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	53.1	52.3					
3		08:00 - 09:00	55.7	55.2					
4		09:00 – 10:00	61.8	60.9					
5		10:00 - 11:00	63.2	62.2					
6		11:00 - 12:00	61.8	60.9					
7		12:00 - 13:00	64.7	66.1					
8		13:00 - 14:00	66.2	65.2					
9		14:00 - 15:00	59.4	59.4					
10		15:00 - 16:00	58.4	58.4					
11		16:00 - 17:00	57.9	57.9					
12		17:00 - 18:00	58.3	57.4					
13		18:00 - 19:00	57.4	56.6					
14		19:00 - 20:00	56.3	56.5					
15		20:00 - 21:00	56.3	55.9					
16		21:00 - 22:00	54.5	55.4					
		Leq DAY	60.4	60.1					
1	Noise Level dB(A)Leq - Night	22:00-23:00	53.3	52.6	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	53.2	52.4					
3		00:00- 01:00	50.1	50.2					
4		01.00-02.00	48	47.8					
5		02.00-03.00	47.5	47.5					
6		03.00-04.00	47.3	47.3					
7		04.00-05.00	49.5	49.2					
8		05:00-06:00	50.5	50.3					
		Leq NIGHT	50.5	50.1					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

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CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

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TC-14321

Month & Year	**04/2025**	**Cluster**	**Cluster III**				**ULR No.**	**TC143212500001820F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**						**Date of Issue**	**30.05.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/04**		**Sampling Method**		**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Kharkharee**	**Date of Sampling**	02.04.25	18.04.25	**Zone Category of Station:**	**Buffer Zone**	

Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A)) First Fortnight**	**Observed Values (in Leq dB(A)) Second Fortnight**	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards**	
								Zones	**Limits in dB**
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	42.1	42.8	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	56.9	56.8					
3		08:00 - 09:00	67.6	67.8					
4		09:00 – 10:00	67.5	67.3					
5		10:00 - 11:00	64	62.9					
6		11:00 - 12:00	61.3	60.8					
7		12:00 - 13:00	59	59.9					
8		13:00 - 14:00	57.3	56.7					
9		14:00 - 15:00	55.2	54.5					
10		15:00 - 16:00	53.7	54					
11		16:00 - 17:00	54	54.6					
12		17:00 - 18:00	53.8	54.4					
13		18:00 - 19:00	51.3	51.3					
14		19:00 - 20:00	49.6	49.8					
15		20:00 - 21:00	47.7	47.9					
16		21:00 - 22:00	47.1	47.5					
		Leq DAY	60.6	60.5					
1	Noise Level dB(A)Leq - Night	22:00-23:00	46.9	44.8	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	44.1	44.6					
3		00:00- 01:00	44.2	44.6					
4		01.00-02.00	42.4	43.6					
5		02.00-03.00	42.1	38.9					
6		03.00-04.00	41.6	42.9					
7		04.00-05.00	41.4	40.2					
8		05:00-06:00	40	37.9					
		Leq NIGHT	43.3	42.9					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY



(Amit Raj Mishra)
Authorised Signatory

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---- End of Report ----

Page -1 of 1

Ambient Air Quality Standards for Jharia Coal Field
As per the Environment (Protection) Amendment Rules, 2000 notified vide notification G.S.R. 742(E), dated 25.9.2000.

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
	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. Improvedwest 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 clause2.

** 24hourly/8hourlyvaluesshallbemet 92%ofthetimeinayear.However,8% of the time it may exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981), and in supersession of the notification No(s).S.O.384(E), dated 11th April 1994 and S.O.935(E), dated 14th NOVEMBER 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

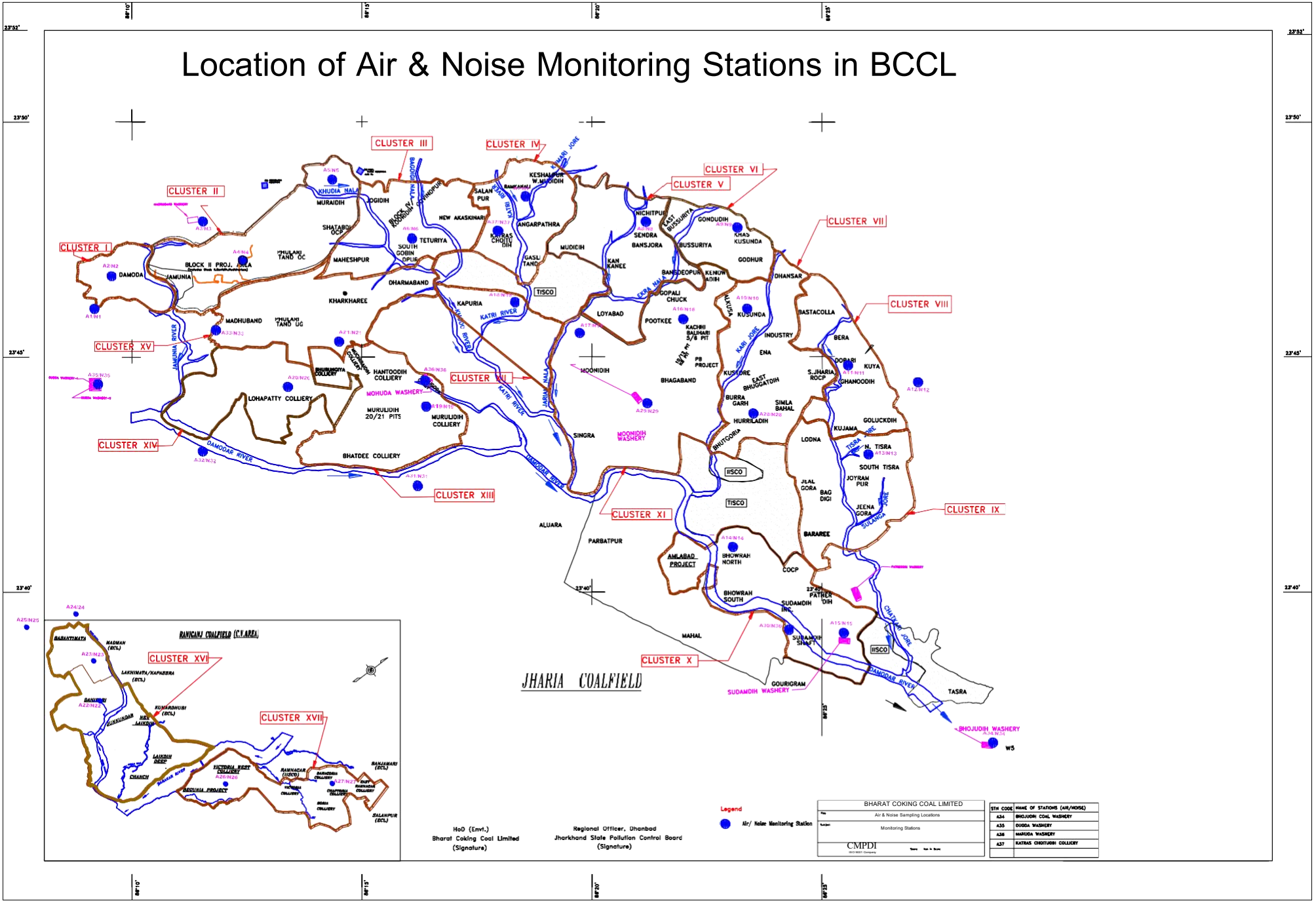
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogendioxide (NO_2), µg/m³	Annual * 24 Hours **	40 80	30 80	-Jacob &Hochheiser modified ($NaOH$-$NaAsO_2$) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM_{10}, µg/m³	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m³	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O_3) , µg/m³	8 Hours * 1 Hour **	100 180	100 180	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb) , µg/m³	Annual * 24 Hours **	0.50 1.0	0.50 1.0	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
Carbon Monoxide (CO), mg/m³	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m³	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C_6H_6), µg/m³	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m³	Annual *	01	01	-Solvent extraction followed byHPLC/GC analysis
Arsenic (As), ng/m³	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m³	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

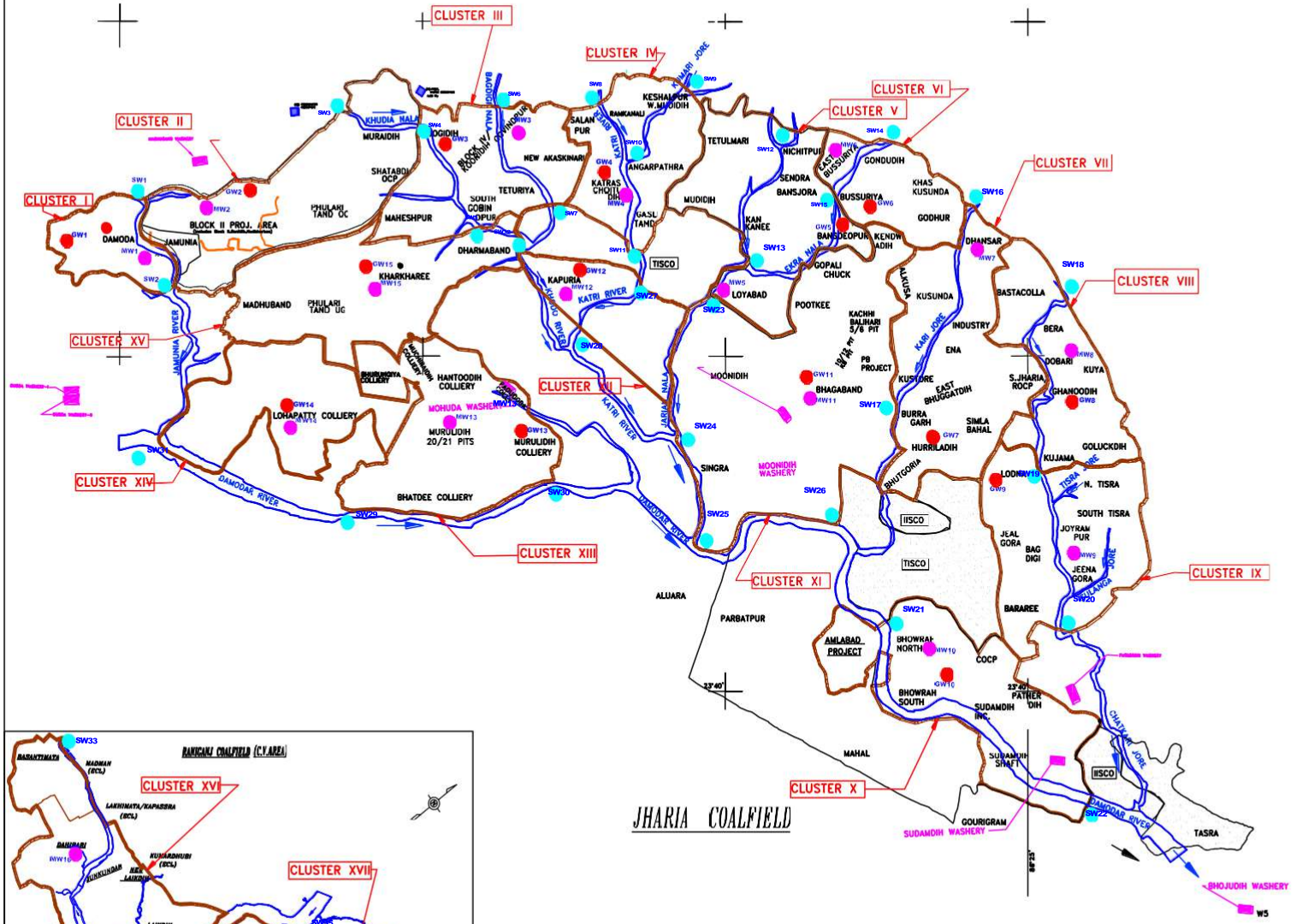
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they JUNE exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



INDEX

Cluste	Suface Wate (U/S, D/S)	Name of River/ Nala / Jore	Mine/ Effluent Water	Sampling Location	Ground Water	Sampling Location
I	SW1, SW2	Jamunia River	MW1	Damoda Area	GW1	Ghutway Village
II	SW3, SW4	Khudia Nala	MW2	Block II OCP	GW2	Joyrampur Village
III	SW4, SW5, SW6, SW7	Khudia Nala, Sagdigi Nala	MW3	Govindpur Colliery	GW3	Jogidih Village
IV	SW8, SW11, SW9, SW10	Katri River, Kumari Jore Jarian	MW4	Chotudih	GW4	Kankanee Village
V	SW12, SW13, SW15	Nala, Ekra Nala	MW5	Mudidih East	GW5	Nichitpur Bansjora
VI	SW14, SW15	Ekra Nala	MW6	Bassuria UGP	GW6	Borewell
VII	SW16, SW17	Kari Jore	MW7	Dhansar UGP	GW7	Lurlidih
VIII	SW18, SW19	Kashi Jore	MW8	Dobari UGP	GW8	Dhanodih
IX	SW19, SW20	Kashi Jore	MW9	Jeenagora	GW9	Lodna
X	SW21, SW22	Damodar River	MW10	Bhowrah North	GW10	Bhowrah South
XI	SW23, SW24, SW25, SW26	Jarian Nala, Damodar River	MW11	Bhagabandh UGP	GW11	Bhagabandh
XII	SW27, SW28	Katri River	MW12	Kapuria	GW12	Kapuria
XIII	SW29, SW30	Damodar River	MW13	Murulidih (20/21)	GW13	Murlidih
XIV	SW31, SW29	Damodar River	MW14	Lohapatti	GW14	Lohapatti
XV	SW5, SW32	Khudia Nala	MW15	Kharkharee UGP	GW15	Kharkharee
XVI	SW33, SW34	Khudia River	MW16	Dahibari OCP	GW16	Pallabari Village
XVII	SW35, SW36	Barakar River	MW17	Damagoria Colliery	GW17	Chaptoria

HoD (Envt.)
Bharat Coking Coal Limited
(Signature)

Regional Officer, Dhanbad
Jharkhand State Pollution Control Board
(Signature)

Legend
- Sampling Locations of Surface Water (Upstream/ Downstream)
- Sampling Locations of Mine Water
- Sampling Locations of Ground/ Drinking Water

BHARAT COKING COAL LIMITED

Customer	WATER SAMPLING LOCATIONS
Title	MONITORING STATIONS
Subject	CMPDI



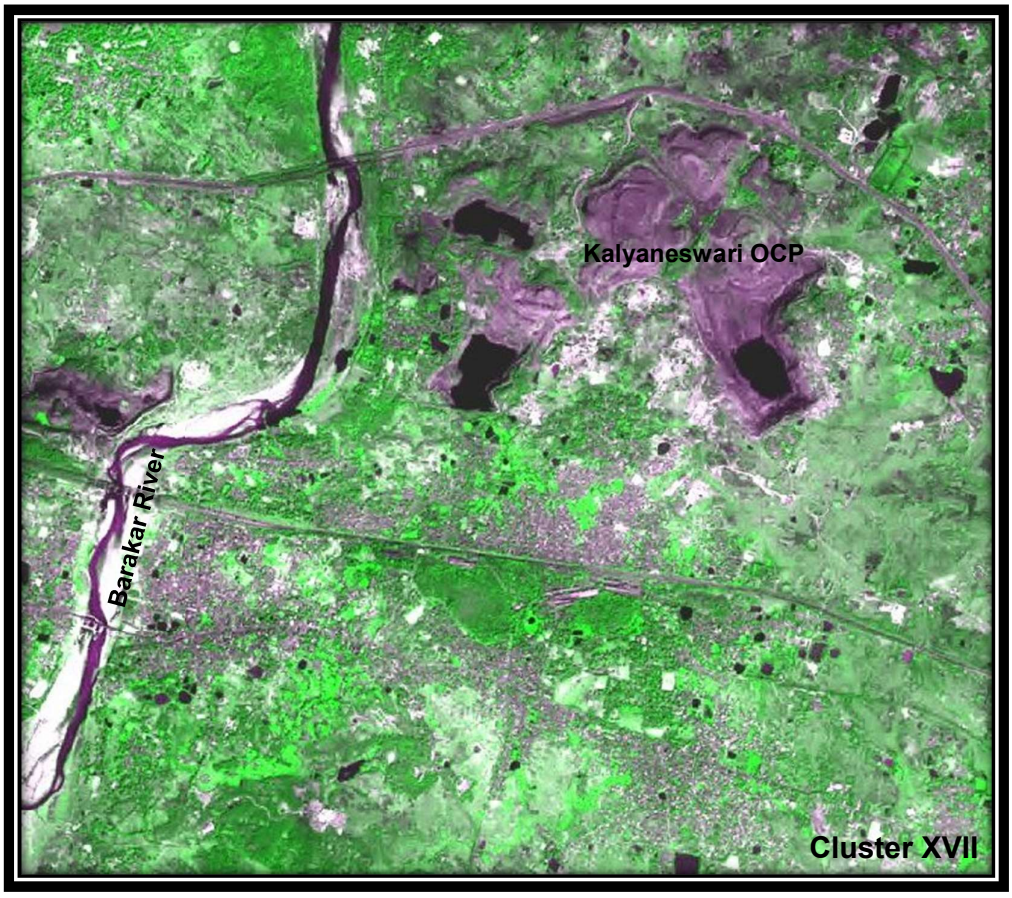

GPS Map Camera
Katras, Jharkhand, भारत
Q7XF+Q33, Main Rd Barora, Katras, Jharkhand 828125, भारत
Lat 23.800154°
Long 86.272343°
27/05/24 08:23 AM GMT +02:00
Google



Embankment along water body

भारत कोकिंग कोल लिमिटेड के ५ मिलियन घन मीटर (कोल+अधिभार) से कम उत्पादन क्षमतावाले ०५ क्लस्टर (खुली + भूमिगत खदानों के समूह) का भूमि पुनरुद्धार हेतु वर्ष २०२३ के उपग्रह डाटा के आधार पर निगरानी का प्रतिवेदन

Land Reclamation/ Restoration Monitoring of five Clusters of (Opencast + Underground) Coal Mines of Bharat Coking Coal Limited based on Satellite Data of the Year 2023



Submitted to

Bharat Coking Coal Limited

भारत कोकिंग कोल लिमिटेड के ५ मिलियन घन मीटर (कोल+अधिभार) से कम उत्पादन क्षमतावाले ०५ क्लस्टर (खुली + भूमिगत खदानों के समूह) का भूमि पुनरुद्धार हेतु वर्ष २०२३ के उपग्रह डाटा के आधार पर निगरानी का प्रतिवेदन

Land Reclamation/ Restoration Monitoring of five Clusters of (Opencast + Underground) Coal Mines of Bharat Coking Coal Limited based on Satellite Data of the Year 2023

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कार्यकारी सारांश

१.० परियोजना भारत कोकिंग कोल लिमिटेड के ५ मिलियन घन मीटर (कोल + अधिभार) से कम उत्पादन क्षमतावाले ०५ क्लस्टर अर्थात (भूमिगत + खुली) खदानों के समूह के पुनरुद्धार हेतु वर्ष २०२३ के उपग्रह डाटा पर आधारित तीन साल के अन्तराल पर नियमित निगरानी।

२.० उद्देश्य भूमि पुनरुद्धार (लैंड रिक्लेमेशन) का उद्देश्य कुल पट्टाक्षेत्र में बैकफील, वृक्षारोपण, सामाजिक वानिकी, सक्रिय खनन क्षेत्र, जल निकाय (वाटर ड्रेनेज) बंजर भूमि, कृषि भूमि और जंगल के विभिन्न प्रकार के वितरण प्रणाली के क्षेत्र का आकलन करने के लिए है। यह अध्ययन उपरोक्त सभी क्लस्टरों के भूमि पुनरुद्धार (लैंड रिक्लेमेशन) का निगरानी के प्रगति का आकलन करने में मदद करेगा तथा इसके अतिरिक्त पर्यावरण संरक्षण के लिए आवश्यक उपचारात्मक उपायों को क्रियान्वित करने में भी सहायता करेगा।

३.० मुख्य निष्कर्ष

- वर्ष २०२३-२४ में भूमि पुनरुद्धार (लैंड रिक्लेमेशन) हेतु चयन किये गए कुल ०५ क्लस्टरों का कुल पट्टाक्षेत्र अथवा माइन लीज होल्ड एरिया ७९००.९१ हेक्टेयर है, जिसमें १४३७.९९ हेक्टेयर उत्खनन क्षेत्र के अंतर्गत है तथा इस उत्खनन क्षेत्र में से १९.६८ हेक्टेयर (१.३७%) क्षेत्र में जैविक पुनरुद्धार (बैकफील पर बृक्ष।रोपण) किया गया है तथा ६९३.४८ हेक्टेयर (४८.२३%) क्षेत्र में तकनीकी पुनरुद्धार (बैकफीलिंग) का कार्य प्रगति पर है और शेष ७२४.८३ हेक्टेयर (५०.४१%) क्षेत्र सक्रिय खनन के अन्तर्गत है। क्लस्टरवार भूमि पुनरुद्धार (लैंड रिक्लेमेशन) के निगरानी का वर्णन विस्तार रूप से तालिका संख्या ०१ में दर्शाया गया है ।

- वर्ष २०२३ के उपग्रह डाटा के विश्लेषण से यह देखा गया है कि तकनीकी पुनरुद्धार (बैकफ़िलिंग) के तहत क्षेत्र ६५७.४९ हेक्टेयर (वर्ष २०२०) से बढ़कर ६९३.४८ हेक्टेयर (वर्ष २०२३) हो गया है जो वर्ष २०२० के संबंध में ३५.९९ हेक्टेयर की वृद्धि दर्शाता है।

- जैविक पुनरुद्धार (बैकफील पर बृक्ष।रोपण) के तहत क्षेत्र २७.८१ हेक्टेयर (वर्ष २०२०) से घटकर १९.६८ हेक्टेयर (वर्ष २०२३) हो गया है जो वर्ष २०२० के संबंध में ८.१३ हेक्टेयर की कमी दर्शाता है।

- अधिभार पर किए गए वृक्षारोपण के तहत क्षेत्र ११३.७२ हेक्टेयर (वर्ष २०२०) से घटकर ९२.७७ हेक्टेयर (वर्ष २०२३) हो गया है जो वर्ष २०२० के संबंध में २०.९५ हेक्टेयर की कमी दर्शाता है।

- सामाजिक वानिकी के अंतर्गत वृक्षारोपण के तहत क्षेत्र ५०४.२३ हेक्टेयर (वर्ष २०२०) से बढ़कर ५१७.१० हेक्टेयर (वर्ष २०२३) हो गया है जो वर्ष २०२० के संबंध में १२.८७ हेक्टेयर की वृद्धि दर्शाता है।

- सक्रिय खनन के अंतर्गत क्षेत्र ६१५.४४ हेक्टेयर (वर्ष २०२०) से बढ़कर ७२४.८३ हेक्टेयर (वर्ष २०२३) हो गया है जो वर्ष २०२० के संबंध में १०९.३९ हेक्टेयर की वृद्धि दर्शाता है।

- कुल उत्खनन क्षेत्र १३००.७४ हेक्टेयर (वर्ष २०२०) से बढ़कर १४३७.९९ हेक्टेयर (वर्ष २०२३) हो गया है जो वर्ष २०२० के संबंध में १३७.२५ हेक्टेयर की वृद्धि दर्शाता है।

- कुल वृक्षारोपण अथवा हरित आवरण के तहत कुल क्षेत्र ६४५.७६ हेक्टेयर (वर्ष २०२०) से घटकर ६२९.५५ हेक्टेयर (वर्ष २०२३) हो गया है जो वर्ष २०२० के संबंध में १६.२१ हेक्टेयर की कमी दर्शाता है।

- निगरानी के लिए बनाई गई तालिका-१ में उल्लिखित बिसीसीएल की विभिन्न क्लस्टरों में वर्ष २०२३ के लिए भूमि पुनरुद्धार की स्थिति की तुलना वर्ष २०२० से करने पर, विश्लेषण से यह स्पष्ट है कि भूमि पुनरुद्धार के तहत क्षेत्र ६८५.३० हेक्टेयर (वर्ष २०२०) से बढ़कर ७१३.१६ हेक्टेयर (वर्ष २०२३) हो गया है।

- इस रिपोर्ट और निष्कर्षों को आगे की निगरानी और सुधार संबंधी गतिविधियों के लिए आधार माना जाएगा।

Executive Summary

1. **Project** — Land reclamation/ restoration monitoring of five clusters of (Opencast + Underground) coal mines of Bharat Coking Coal Ltd. (BCCL), based on satellite data on every three-year basis.

2. **Objective** — Objective of land reclamation/ restoration monitoring is to assess the area of backfilled, plantation, social forestry, active mining area, water bodies, distribution of wasteland, agricultural land and forest in the leasehold area of the project. This will help in assessing the progressive status of mined land reclamation and to take up remedial measures, if any, required for environmental protection.

3. **Salient Findings**

- Out of the total mine leasehold area of 7900.91 Ha. of the 05 clusters producing less than 5mcm (Coal+OB) annually considered for monitoring during the year 2023-24; total excavated area is 1437.99 Ha. out of which 19.68 Ha. area (1.37%) has been planted on backfill (Biological Reclamation) and 693.48 Ha. area (48.23%) is under backfilling (Technical Reclamation) and 724.83 Ha. area (50.41%) under active mining. Cluster wise details of land reclamation of the above Clusters is given in Table-1.

- It has been observed from the analysis of Satellite Data of the year 2023 that area under technical reclamation (backfilling) has increased from 657.49 Ha. (Yr.2020) to 693.48 Ha. (Yr.2023) which indicates an increase of 35.99 Ha. with respect to the year 2020.

- Area under biological reclamation has decreased from 27.81 Ha. (Yr.2020) to 19.68 Ha. (Yr.2023) which indicates a decrease of 8.13 Ha. with respect to the year 2020.

- Plantation on OB dump has decreased from 113.72 Ha. (Yr.2020) to 92.77 Ha. (Yr.2023) which indicates a decrease of 20.95 Ha. with respect to the year 2020.

- Plantation under social forestry has increased from 504.23 Ha. (Yr.2020) to 517.10 Ha. (Yr.2023) which indicates an increase of 12.87 Ha. with respect to the year 2020.

- Area under active mining has increased from 615.44 Ha. (Yr.2020) to 724.83 Ha. (Yr.2023) which indicates an increase of 109.39 Ha. with respect to the year 2020.

- Total excavated area has increased from 1300.74 Ha. (Yr.2020) to 1437.99 Ha. (Yr.2023) which indicates an increase of 137.25 Ha. with respect to the year 2020.

- Total area under plantation (green cover) has decreased from 645.76 Ha. (Yr.2020) to 629.55 Ha. (Yr.2023) which indicates a decrease of 16.21 Ha. with respect to the year 2020.

- On comparing the status of land reclamation for the year 2023 with respect to the year 2020 in different Clusters of BCCL mentioned in Table 1, undertaken for monitoring, it is evident from the analysis that area under land reclamation has increased from 685.30 Ha. (Yr.2020) to 713.16 Ha. (Yr.2023).

- This report and the findings will be considered as basis for further monitoring and reclamation related activities.

Table 1

Land Reclamation Status in five Clusters (Underground + Opencast Mines) of BCCL based on Satellite Data of the Year 2023

(Area in Hectare)

Sl. No.	Cluster No.	Total Leasehold Area		Technical Reclamation		Plantation						Area under Active Mining		Total Excavated Area		Total Area under Plantation (% Green Cover Generated in Leasehold)		Total Area under Reclamation	
						Biological		Other Plantations											
				Area under Backfilling		Plantation on Excavated / Backfilled Area		Plantation on External OB Dumps		Social Forestry, Avanue Plantation Etc.									
1	*2*	*3*		*4*		*5*		*6*		*7*		*8*		*9 (=4+5+8)*		*10 (=5+6+7)*		*11(=4+5)*	
		2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023
1	Cluster III	1552.53	1420.61	60.37	68.71	3.89	4.96	21.11	28.67	162.33	141.36	104.79	84.88	169.05	158.55	187.33	174.99	64.26	73.67
				35.71%	43.34%	2.30%	3.13%					61.99%	53.54%			12.07%	12.32%	38.01%	46.46%
2	Cluster V	1724.52	1957.08	187.59	193.60	7.19	7.41	23.85	19.84	105.29	158.45	103.52	182.86	298.30	383.87	136.33	185.70	194.78	201.01
				62.89%	50.43%	2.41%	1.93%					34.70%	47.64%			7.91%	9.49%	65.30%	52.36%
3	Cluster VIII	1331.95	1183.92	206.91	198.08	9.93	4.08	21.97	16.86	24.70	22.63	124.49	151.45	341.33	353.61	56.60	43.57	216.84	202.16
				60.62%	56.02%	2.91%	1.15%					36.47%	42.83%			4.25%	3.68%	63.53%	57.17%
4	Cluster IX	1967.22	1942.12	77.53	108.00	6.80	3.23	41.79	22.40	168.58	151.33	217.24	240.24	301.57	351.47	217.17	176.96	84.33	111.23
				25.71%	30.73%	2.25%	0.92%					72.04%	68.35%			11.04%	9.11%	27.96%	31.65%
5	Cluster XVII	1412.00	1397.18	125.09	125.09	0.00	0.00	5.00	5.00	43.33	43.33	65.40	65.40	190.49	190.49	48.33	48.33	125.09	125.09
				65.67%	65.67%	0.00%	0.00%					34.33%	34.33%			3.42%	3.46%	65.67%	65.67%
	TOTAL	**7988.22**	**7900.91**	**657.49**	**693.48**	**27.81**	**19.68**	**113.72**	**92.77**	**504.23**	**517.10**	**615.44**	**724.83**	**1300.74**	**1437.99**	**645.76**	**629.55**	**685.30**	**713.16**
				50.55%	**48.23%**	**2.14%**	**1.37%**					**47.31%**	**50.41%**			**8.08%**	**7.97%**	**52.69%**	**49.59%**

(% is calculated with respect to Excavated Area as applicable)

Note: In reference of the above Table, different parameters are classified as follows:

1. Area under Biological Reclamation includes Areas under Plantation done on Backfilled Area Only.
2. Area under Technical Reclamation includes Area under Barren Backfilling only.
3. Area under Active Mining Includes Coal Quarry, Advance Quarry Site and Quarry filled with water etc., if any.
4. Social Forestry and Plantation on External OB Dumps are not included in Biological Reclamation and are put under separate categories as shown in the above Table.
5. (%) calculated in the above Table is in respect to Total Excavated Area except for "Total Area under Plantation" where % is in terms of "Leasehold Area".
6. Leasehold Boundaries of the above 5 clusters are updated as per EC.

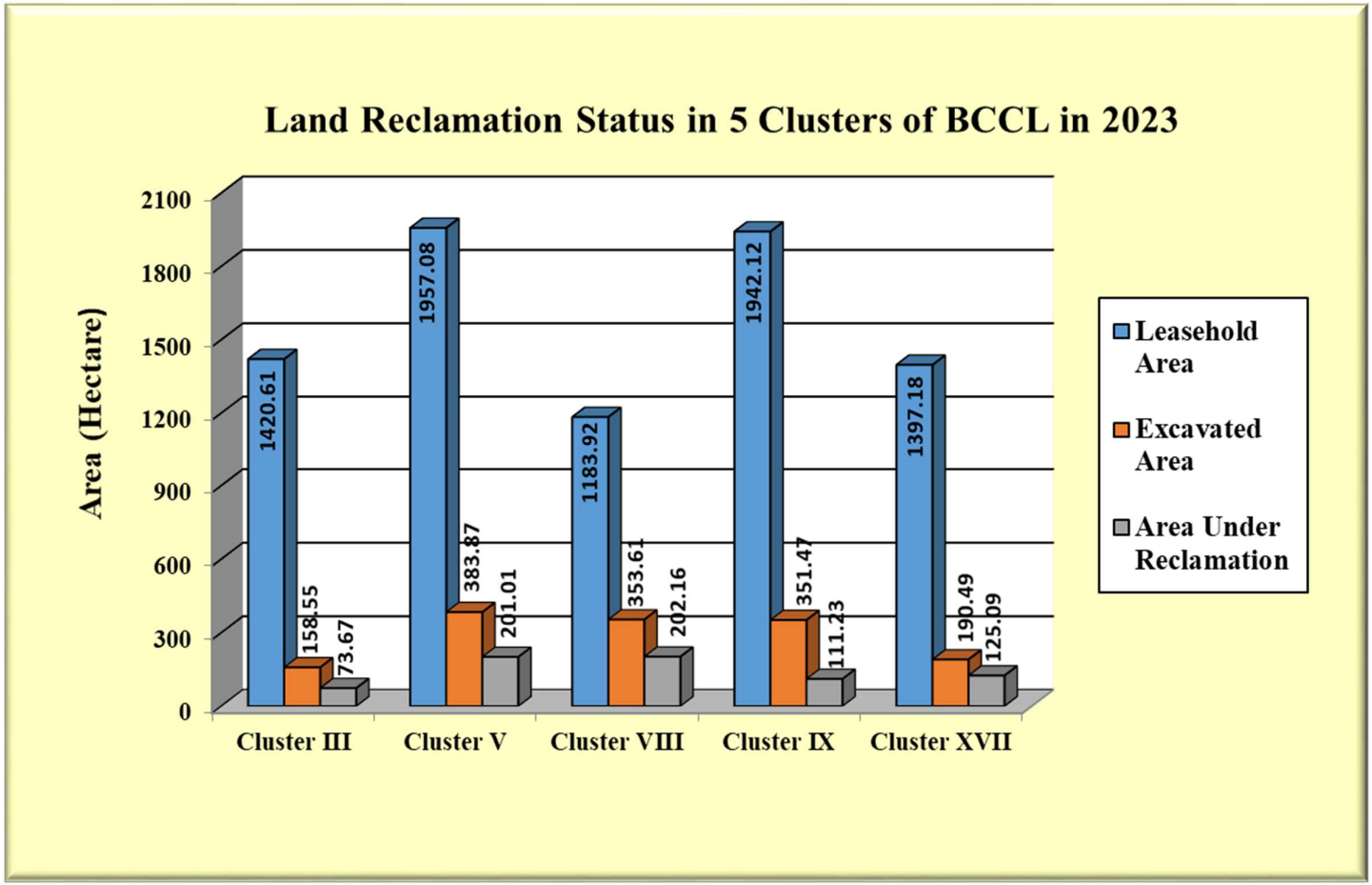


Fig. 1: Cluster wise Land Reclamation Status in five Clusters - 2023 (BCCL)

1.0 Background

1.1 Land is the most important natural resource which embodies soil, water, flora, fauna and total ecosystem. All human activities are based on the land which is the scarcest natural resource in our country. Mining is a site specific industry and it could not be shifted anywhere else from the location where mineral occurs. It is a fact that surface mining activities do affect the land environment due to ground breaking. Therefore, there is an urgent need to reclaim and restore the mined out land for its productive use for sustainable development of mining. This will not only mitigate environmental degradation, but would also help in creating a more congenial environment for land acquisition by coal companies in future.

1.2 Keeping above in view, Coal India Ltd. (CIL) issued a work order vide letter no. CIL/WBP/ENV/2017/DP/8391 dated 22.06.2017 to Central Mine Planning & Design Institute (CMPDI), Ranchi, for monitoring of clusters with coal mines (both underground and open cast projects) having less than 5 million m^3 per annum capacity (Coal +OB) at an interval of three years based on remote sensing satellite data for sustainable development of mining. Earlier, CMPDI used to carry out land reclamation monitoring for individual projects of less than 5 million capacities, but from 2017 the same was carried out cluster wise for mines of BCCL. For operational reasons and convenience, underground and opencast mines (often with multiple overlapping seams), have now been clustered together. Further, a revised work order was issued vide letter no. CIL/ENVT/2022-23/W.O/10899 dated 06.07.2022 from Coal India Limited for the period 2022-23 to 2023-24. According to this work order, 76 OC projects having more than 5 million cu. m (coal +OB) per annum capacity shall be monitored every year and also land reclamation monitoring of 47 OCPs having less than 5 million cu. m (coal +OB) per annum capacity, totaling 123 OC mines will be monitored in

2023-24 covering all the subsidiaries of Coal India Ltd. The result of land reclamation status of all such mines are hosted on the website of CIL, (www.coalindia.in), CMPDI (www.cmpdi.co.in) and the concerned coal companies in public domain. Detailed report is submitted to Coal India and respective subsidiaries.

1.3 Land reclamation monitoring of all clusters of coal mining projects would also comply the statutory requirements of Ministry of Environment, Forest & Climate Change (**MoEF & CC**). Such monitoring would not only facilitate in taking timely mitigation measures against environmental degradation, but would also enable coal companies to utilize the reclaimed land for larger socio-economic benefits in a planned way.

1.4 Present report is embodying the finding of the study based on satellite data of the year 2023 carried out for five clusters of mines comprising both underground and opencast projects of Bharat Coking Coal Ltd.

2.0 Objective

Objective of the land reclamation/restoration monitoring is to assess the area under backfilling, plantation, OB dumps, social forestry, active mining area, settlements, water bodies, distribution of wasteland, agricultural land and forest land in the leasehold area of the project. This is an important step taken up for assessing the progressive status of mined land reclamation and for taking up remedial measures, if any, required for environmental protection.

3.0 Methodology

There are number of steps involved between raw satellite data procurement and preparation of final map. National Remote Sensing Centre (NRSC) Hyderabad, being the nodal agency for satellite data supply in India, provides only raw digital satellite data, which needs further digital image processing for extracting the information and map preparation before uploading the same in the website. Methodology for land reclamation monitoring is given in fig 2. Following steps are involved in land reclamation/ restoration monitoring:

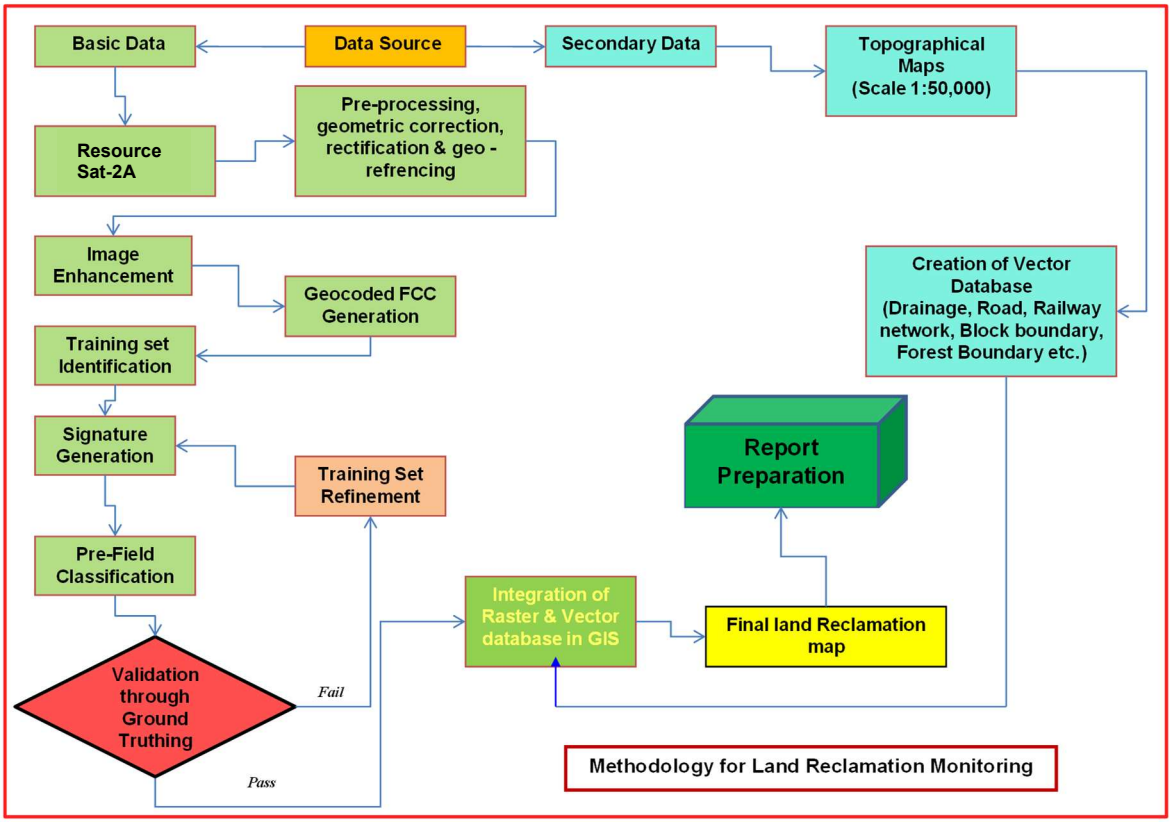


Fig. 2: Methodology of Land Reclamation Monitoring

3.1 Data Procurement: After browsing the data quality and date of pass on internet, supply order for data is placed to NRSC. Secondary data like leasehold boundary, toposheet are procured for creation of vector database.

3.2 **Satellite Data Processing:** Satellite data are processed using ERDAS IMAGINE digital image processing s/w. Methodology involves the following major steps:

- **Rectification & Geo-referencing:** Inaccuracies in digital imagery may occur due to 'systematic errors' attributed to earth curvature and rotation as well as 'non-systematic errors' attributed to satellite receiving station itself. Raw digital images may contain geometric distortions, which make them unusable as maps. Therefore, geo-referencing is required for correction of image data using ground control points (GCP) to make it compatible with the new series WGS-84 compatible SoI toposheet.

- **Image enhancement:**

  To improve the interpretability of the raw data, image enhancement is necessary. Local operations modify the value of each pixel based on brightness value of neighbouring pixels using ERDAS IMAGINE 2022 s/w. and enhance the image quality for interpretation.

- **Training set selection**

  Training set requires to be selected, so that software can classify the image data accurately. The image data are analysed based on the interpretation keys. These keys are evolved from certain fundamental image-elements such as tone/colour, size, shape, texture, pattern, location, association and shadow. Based on the image-elements and other geo-technical elements like land form, drainage pattern and physiography; training sets were selected/identified for each land use/cover class. Field survey was carried out by taking selective traverses in order to collect the ground information (or reference data) so that training sets are selected accurately in the image. This was intended to serve as an aid for classification.

- **Classification and Accuracy assessment**

  Image classification is carried out using the maximum likelihood algorithm. The classification proceeds through the following steps: (a) calculation of statistics [i.e. signature generation] for the identified training areas, and (b) the decision boundary of maximum probability based on the mean vector, variance, covariance and correlation matrix of the pixels. After evaluating the statistical parameters of the training sets, reliability test of training sets is conducted by measuring the statistical separation between the classes that resulted from computing divergence matrix. The overall accuracy of the classification was finally assessed with reference to ground truth data.

- **Area calculation**

  The area of each land use class in the leasehold is determined using ERDAS IMAGINE v. 2022 s/w.

- **Overlay of Vector data base**

  Vector data base is created based on secondary data. Vector layer like drainage, railway line, leasehold boundary, forest boundary etc. are superimposed on the image as vector layer in the Arc GIS database.

- **Pre-field map preparation**

  Pre-field map is prepared for validation of the classification result.

3.3 Ground Truthing:

Selective ground verification of the land use classes is carried out in the field and necessary corrections if required, are incorporated before map finalization.

3.4 Land reclamation database on GIS:

Land reclamation database is created on GIS platform to identify the temporal changes identified from satellite data of different cut - of dates. The database boundary shape files (.shp), kml files and the maps thus prepared confirm to the WGS-84 datum and UTM projected co-ordinate system.

4.0 Land Reclamation Status in Bharat Coking Coal Ltd.

4.1 Following 5 clusters of mines comprising both opencast and underground projects of Bharat Coking Coal Ltd. have been taken up for land reclamation monitoring during the year 2023-24:

- **Cluster III** (Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akashkinaree Mine, Block-IV/Kooridih Mixed Mine)
- **Cluster V** (Nichitpur OCP, Tetulmari OCP & UG section, Mudidih OCP & UG section, Sendra Bansjora OCP & UG section, Kankanee OCP & UG section, Bansdeopur OCP & UG section, Loyabad UG)
- **Cluster VIII** (Bastacolla Colliery OC & UG, Bera Colliery OC & UG, Dobari Colliery UG, Ghanoodih Colliery OC, Kuya Colliery OC & UG, Goluckdih OC, Kujama Colliery OC)
- **Cluster IX** (Lodna UG, Bagdigi UG, Joyrampur UG, Bararee UG, Jealgora UG, NTST Expn. OCP)
- **Cluster XVII** (Begunia UG, Victoria West UG, Kalyaneswari OCP)

4.2 Cluster wise Land Reclamation status of above mentioned clusters in BCCL is given in Table 1 and also shown graphically in Fig 1. Area statistics of different land use classes present in the mine leasehold of the above clusters for the year 2023 are shown in Table 2. Land use maps derived from the satellite data are shown in Plate 1 - 5. Different land use classes based on satellite data are depicted in bar charts in Fig. 3 - 7.

4.3 Study reveals that out of total mine leasehold area of 7900.91 ha. of the 5 clusters of mines (Opencast + Underground) of BCCL mentioned above taken for this study in 2023-24, total excavated area is 1437.99 ha. out of which 19.68 ha. (1.37%) has been planted (*Biologically Reclaimed*), 693.48

ha. (48.23%) is under backfilling (*Technically Reclaimed*) and balance 724.83 ha. (50.41%) is under active mining.

4.4 The leasehold boundaries of the above mentioned 5 clusters are updated as per EC.

4.5 It is seen that technical reclamation in the above 5 Clusters has increased from 657.49 ha. (Year 2020) to 693.48 ha. (Year 2023).

4.6 Study indicates that Cluster III and Cluster V of BCCL considered for this study in the year 2023-24 indicate increasing trend in Biological Reclamation (plantation on backfill) with respect to the year 2020. Area under plantation on backfill has increased from 3.89 ha. (Year 2020) to 4.96 ha. (Year 2023) in Cluster III and from 7.19 ha. (Year 2020) to 7.41 ha. (Year 2023) in Cluster V respectively. Whereas in Cluster VIII plantation on backfill has decreased from 9.93 ha. (Year 2020) to 4.08 ha. (Year 2023) due to rehandling of backfill. In Cluster IX, biological reclamation has decreased from 6.80 ha. (Year 2020) to 3.23 ha. (Year 2023) due to the effect of underground fire. In Cluster XVII biological reclamation has not been started yet.

4.7 On comparing the status of plantation on OB dumps for the year 2023 with respect to the year 2020 in the above Cluster of mines of BCCL, it is evident from the analysis that area under plantation on OB dumps has increased from 21.11 ha. (Year 2020) to 28.67 ha. (Year 2023) in Cluster III. This increase in span of three years is due to the sincere effort made by BCCL towards environmental protection in these Clusters. Plantation on OB has decreased from 23.85 ha. (Year 2020) to 19.84 ha. (Year 2023) in Cluster V. In Cluster VIII it has decreased from 21.97 ha. (Year 2020) to 16.86 ha. (Year 2023) and in Cluster IX, it has decreased from 41.79 ha. (Year 2020) to 22.40 ha. (Year 2023) due to rehandling of OB dumps. But in the above

Clusters where plantation on OB dumps has decreased, new plantations on OB dumps and their slopes has been started by BCCL but their height and canopy cover are not enough to be captured in satellite imagery. In Cluster XVII there is no change or plantation on OB dumps is static during the last three-year duration.

4.8 It is seen that total plantation under social forestry has increased from 504.23 ha. (Year 2020) to 517.10 ha. (Year 2023). Plantation under social forestry has decreased from 162.33 ha. (Year 2020) to 141.36 ha. (Year 2023) in Cluster III. In Cluster VIII it has decreased from 24.70 ha. (Year 2020) to 22.63 ha. (Year 2023) and in Cluster IX it has decreased from 168.58 ha. (Year 2020) to 151.33 ha. (Year 2023). This decrease of 20.97 ha. area in Cluster III, 2.07 ha. in Cluster VIII and 17.25 ha. in Cluster IX is due to change in shape and area of these clusters. In Cluster V plantation under social forestry has increased from 105.29 ha. (Year 2020) to 158.45 ha. (Year 2023). Ongoing projects like road side plantations and river side plantations in this cluster is under progress. In Cluster XVII there is no change or plantation under social forestry is static during the last three-year duration.

4.9 In Cluster III, it is seen that total excavated area has decreased from 169.05 ha. (Year 2020) to 158.55 ha. (Year 2023). This decrease of 10.50 ha. area is due to reduction in area under mining which has happened due to change in shape and area of this cluster. The Cluster boundary is updated as per EC.

4.10 After analyzing the satellite data of the year 2020 vs 2023, it reveals that area under total plantation (Green cover) carried out on backfilled area, OB dumps as well as under social forestry in the above clusters of BCCL has decreased from 645.76 ha. (8.08%) to 629.55 ha. (7.97%) in span of last

three years. The reason for this reduction in area under green cover has been described separately earlier in point no. 4.6, 4.7 and 4.8.

4.11 On comparing the status of land reclamation for the year 2023 with respect to the year 2020 it is evident from the analysis that total area under land reclamation has increased from 685.30 ha. (Year 2020) to 713.16 ha. (Year 2023). This increase of 27.86 ha. area under land reclamation is due to increase in reclamation activities in Cluster III, Cluster V & Cluster IX. In Cluster VIII, it is seen that total area under reclamation has decreased from 216.84 ha. (Year 2020) to 202.16 ha. (Year 2023). This decrease of 14.68 ha. area is due to reduction in area under backfilling which is due to change in shape and reduction of leasehold area of this cluster. The cluster boundary is updated as per EC.

4.12 The area under total plantation (Green Cover) is maximum in Cluster III (12.32%) followed by Cluster V with (9.49%), Cluster IX with (9.11%), Cluster VIII with (3.68%) and Cluster XVII with (3.46%).

4.13 Out of the 5 Clusters in BCCL considered for satellite data based land reclamation monitoring in 2023-24, Cluster XVII tops with 65.67% reclamation followed by Cluster VIII with 57.17%, Cluster V with 52.36%, Cluster III with 46.46% and Cluster IX with 31.65%.

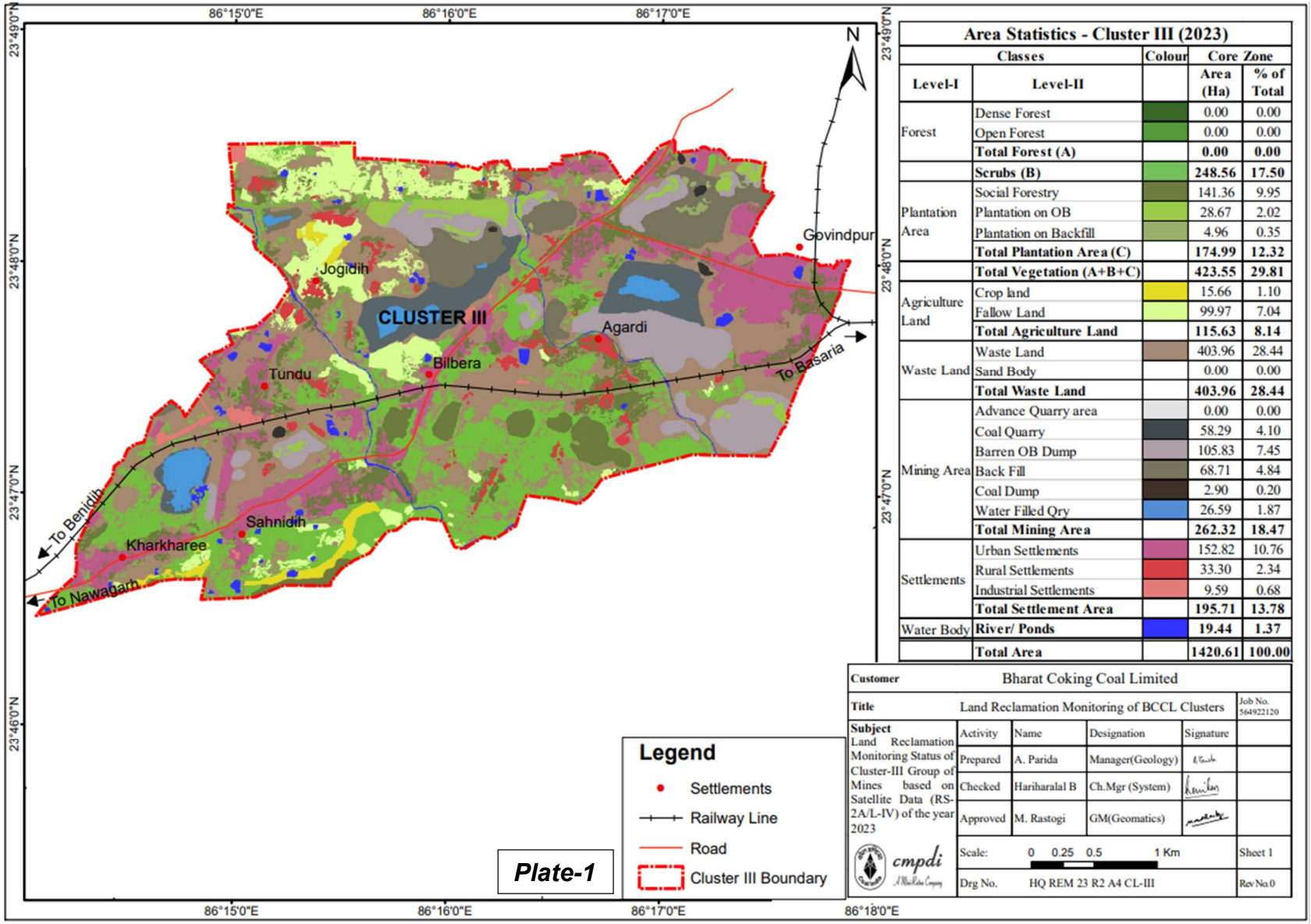
Table 2

Cluster wise Area Statistics of Land Use/ Cover classes in five Clusters of (OC+UG) mines of BCCL based on Satellite Data of the year 2023

Status of Land Reclamation in 5 Clusters of (UG+OC) mines of Bharat Coking Coal Ltd. based on Satellite data of the Year 2023

(Area in Hectare)

		CLUSTER III		CLUSTER V		CLUSTER VIII		CLUSTER IX		CLUSTER XVII		TOTAL	
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
FOREST'S	Dense Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Open Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total Forest (A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCRUBS	**Scrubs (B)**	248.56	17.50	306.59	15.67	127.95	10.81	297.34	15.31	178.23	12.76	1158.67	14.67
PLANTATION	Social Forestry/Avenue Plantation	141.36	9.95	158.45	8.10	22.63	1.91	151.33	7.79	43.33	3.10	517.10	6.54
	Plantation on OB Dump	28.67	2.02	19.84	1.01	16.86	1.42	22.40	1.15	5.00	0.36	92.77	1.17
	Plantation on Backfill (Biological Reclamation)	4.96	0.35	7.41	0.38	4.08	0.34	3.23	0.17	0.00	0.00	19.68	0.25
	Total Plantation (C)	174.99	12.32	185.70	9.49	43.57	3.68	176.96	9.11	48.33	3.46	629.55	7.97
	Total Vegetation (A+B+C)	**423.55**	**29.81**	**492.29**	**25.15**	**171.52**	**14.49**	**474.30**	**24.42**	**226.56**	**16.22**	**1788.22**	**22.63**
	Coal Dump	2.90	0.20	1.71	0.09	2.53	0.21	4.89	0.25	0.00	0.00	12.03	0.15
ACTIVE MINING	Coal Quarry	58.29	4.10	177.60	9.07	130.42	11.02	239.35	12.32	53.28	3.81	658.94	8.34
	Advance Quarry Site	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Quarry Filled With Water	26.59	1.87	5.26	0.27	21.03	1.78	0.89	0.05	12.12	0.87	65.89	0.83
	Total Area under *Active Mining*	**84.88**	**5.97**	**182.86**	**9.34**	**151.45**	**12.79**	**240.24**	**12.37**	**65.40**	**4.68**	**724.83**	**9.17**
	Barren OB Dump	105.83	7.45	181.11	9.25	170.51	14.40	224.00	11.53	44.48	3.18	725.93	9.19
RECLAIMED	Area Under Backfilling (Technical Reclamation)	68.71	4.84	193.60	9.89	198.08	16.73	108.00	5.56	125.09	8.95	693.48	8.78
	Total Area under Mine Operation	**262.32**	**18.47**	**559.28**	**28.58**	**522.57**	**44.14**	**577.13**	**29.72**	**234.97**	**16.82**	**2156.27**	**27.29**
WASTELAND	Waste Lands	403.96	28.44	499.52	25.52	216.17	18.26	573.10	29.51	104.82	7.50	1797.57	22.75
	Fly Ash Pond / Sand Body	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.73	0.48	6.73	0.09
	Total Wasteland	**403.96**	**28.44**	**499.52**	**25.52**	**216.17**	**18.26**	**573.10**	**29.51**	**111.55**	**7.98**	**1804.30**	**22.84**
WATERBODIES	Reservoir, Nallah, Ponds	19.44	1.37	13.99	0.71	10.48	0.89	19.20	0.99	35.39	2.53	98.50	1.25
	Total Waterbodies	**19.44**	**1.37**	**13.99**	**0.71**	**10.48**	**0.89**	**19.20**	**0.99**	**35.39**	**2.53**	**98.50**	**1.25**
AGRICULTURE	Crop Lands	15.66	1.10	8.75	0.45	14.00	1.18	1.78	0.09	69.23	4.95	109.42	1.38
	Fallow Lands	99.97	7.04	105.02	5.37	67.72	5.72	32.14	1.65	464.00	33.21	768.85	9.73
	Total Agriculture	**115.63**	**8.14**	**113.77**	**5.81**	**81.72**	**6.90**	**33.92**	**1.75**	**533.23**	**38.16**	**878.27**	**11.12**
SETTLEMENTS	Urban Settlement	152.82	10.76	254.37	13.00	124.74	10.54	197.76	10.18	213.57	15.29	943.26	11.94
	Rural Settlement	33.30	2.34	13.29	0.68	49.23	4.16	57.10	2.94	31.25	2.24	184.17	2.33
	Industrial Settlement	9.59	0.68	10.57	0.54	7.49	0.63	9.61	0.49	10.66	0.76	47.92	0.61
	Total Settlements	**195.71**	**13.78**	**278.23**	**14.22**	**181.46**	**15.33**	**264.47**	**13.62**	**255.48**	**18.29**	**1175.35**	**14.88**
	Grand Total	**1420.61**	**100.00**	**1957.08**	**100.00**	**1183.92**	**100.00**	**1942.12**	**100.00**	**1397.18**	**100.00**	**7900.91**	**100.00**



Area Statistics - Cluster III (2023)

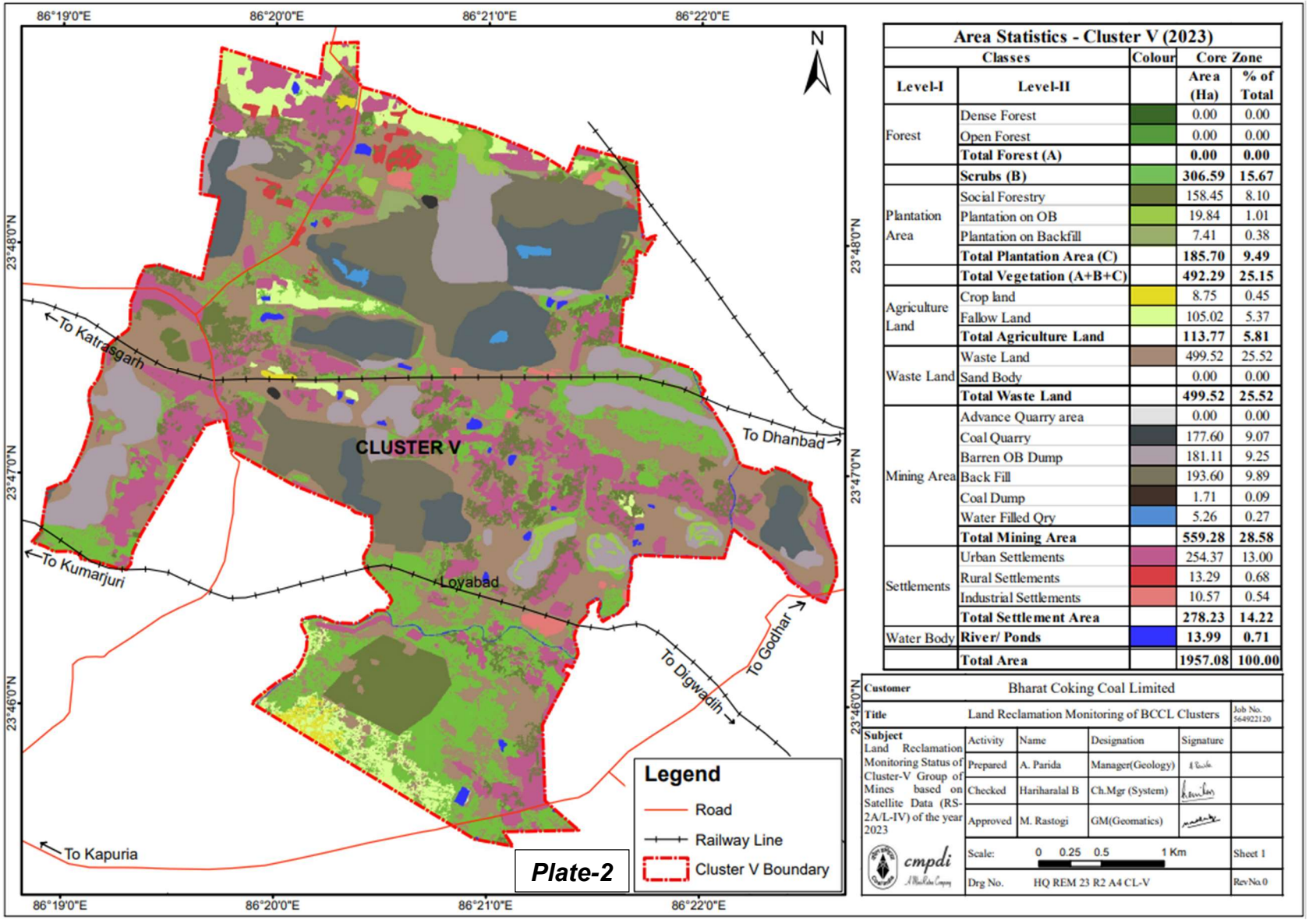
Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**248.56**	**17.50**
Plantation Area	Social Forestry		141.36	9.95
	Plantation on OB		28.67	2.02
	Plantation on Backfill		4.96	0.35
	Total Plantation Area (C)		**174.99**	**12.32**
	Total Vegetation (A+B+C)		**423.55**	**29.81**
Agriculture Land	Crop land		15.66	1.10
	Fallow Land		99.97	7.04
	Total Agriculture Land		**115.63**	**8.14**
Waste Land	Waste Land		403.96	28.44
	Sand Body		0.00	0.00
	Total Waste Land		**403.96**	**28.44**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		58.29	4.10
	Barren OB Dump		105.83	7.45
	Back Fill		68.71	4.84
	Coal Dump		2.90	0.20
	Water Filled Qry		26.59	1.87
	Total Mining Area		**262.32**	**18.47**
Settlements	Urban Settlements		152.82	10.76
	Rural Settlements		33.30	2.34
	Industrial Settlements		9.59	0.68
	Total Settlement Area		**195.71**	**13.78**
Water Body	**River/ Ponds**		**19.44**	**1.37**
	Total Area		**1420.61**	**100.00**

Legend

- Settlements
- Railway Line
- Road
- Cluster III Boundary

Plate-1

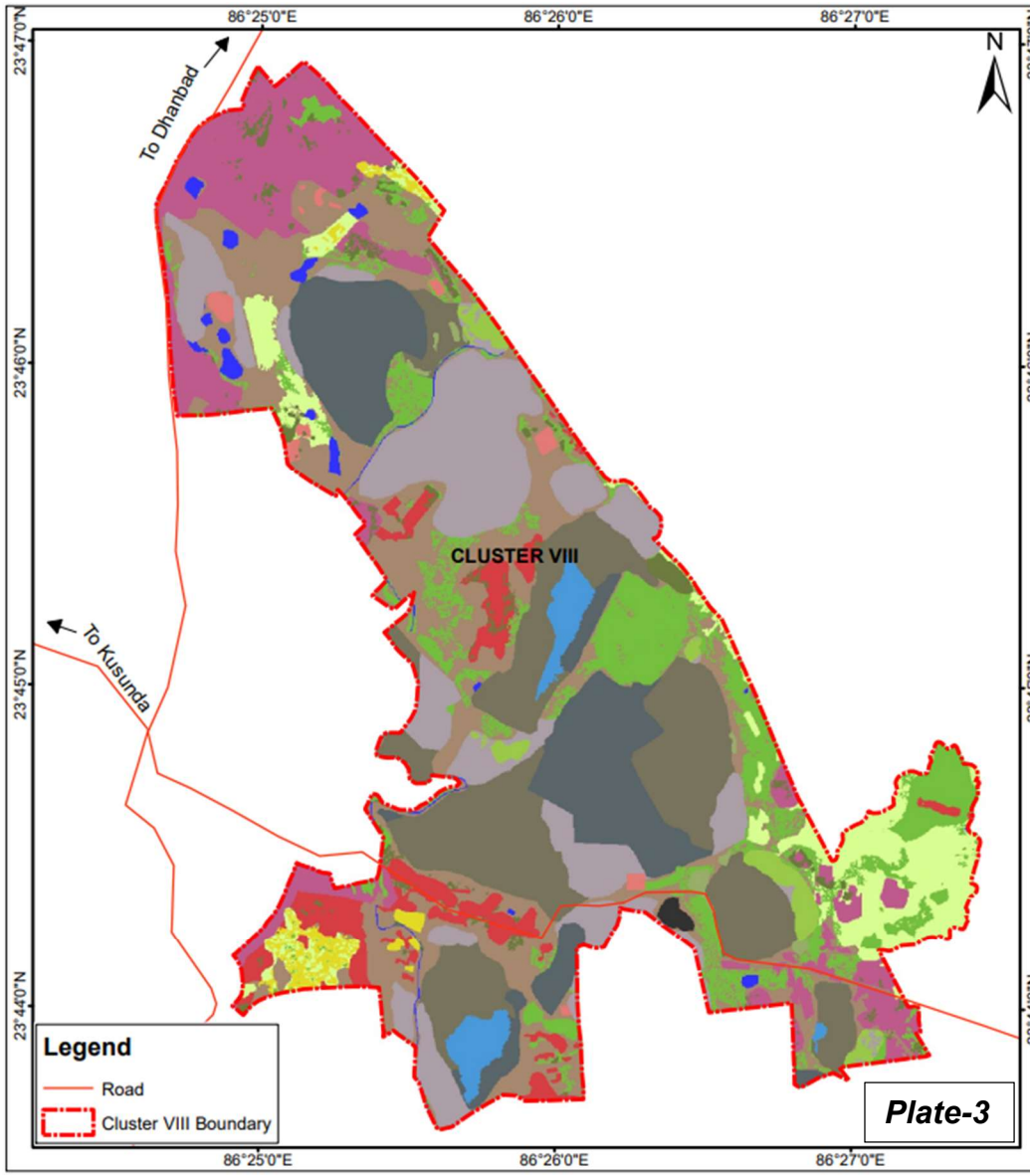
Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 564922120
Subject Land Reclamation Monitoring Status of Cluster-III Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hariharalal B	Ch.Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQ REM 23 R2 A4 CL-III				Rev No.0



Area Statistics - Cluster V (2023)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**306.59**	**15.67**
Plantation Area	Social Forestry		158.45	8.10
	Plantation on OB		19.84	1.01
	Plantation on Backfill		7.41	0.38
	Total Plantation Area (C)		**185.70**	**9.49**
	Total Vegetation (A+B+C)		**492.29**	**25.15**
Agriculture Land	Crop land		8.75	0.45
	Fallow Land		105.02	5.37
	Total Agriculture Land		**113.77**	**5.81**
Waste Land	Waste Land		499.52	25.52
	Sand Body		0.00	0.00
	Total Waste Land		**499.52**	**25.52**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		177.60	9.07
	Barren OB Dump		181.11	9.25
	Back Fill		193.60	9.89
	Coal Dump		1.71	0.09
	Water Filled Qry		5.26	0.27
	Total Mining Area		**559.28**	**28.58**
Settlements	Urban Settlements		254.37	13.00
	Rural Settlements		13.29	0.68
	Industrial Settlements		10.57	0.54
	Total Settlement Area		**278.23**	**14.22**
Water Body	**River/ Ponds**		**13.99**	**0.71**
	Total Area		**1957.08**	**100.00**

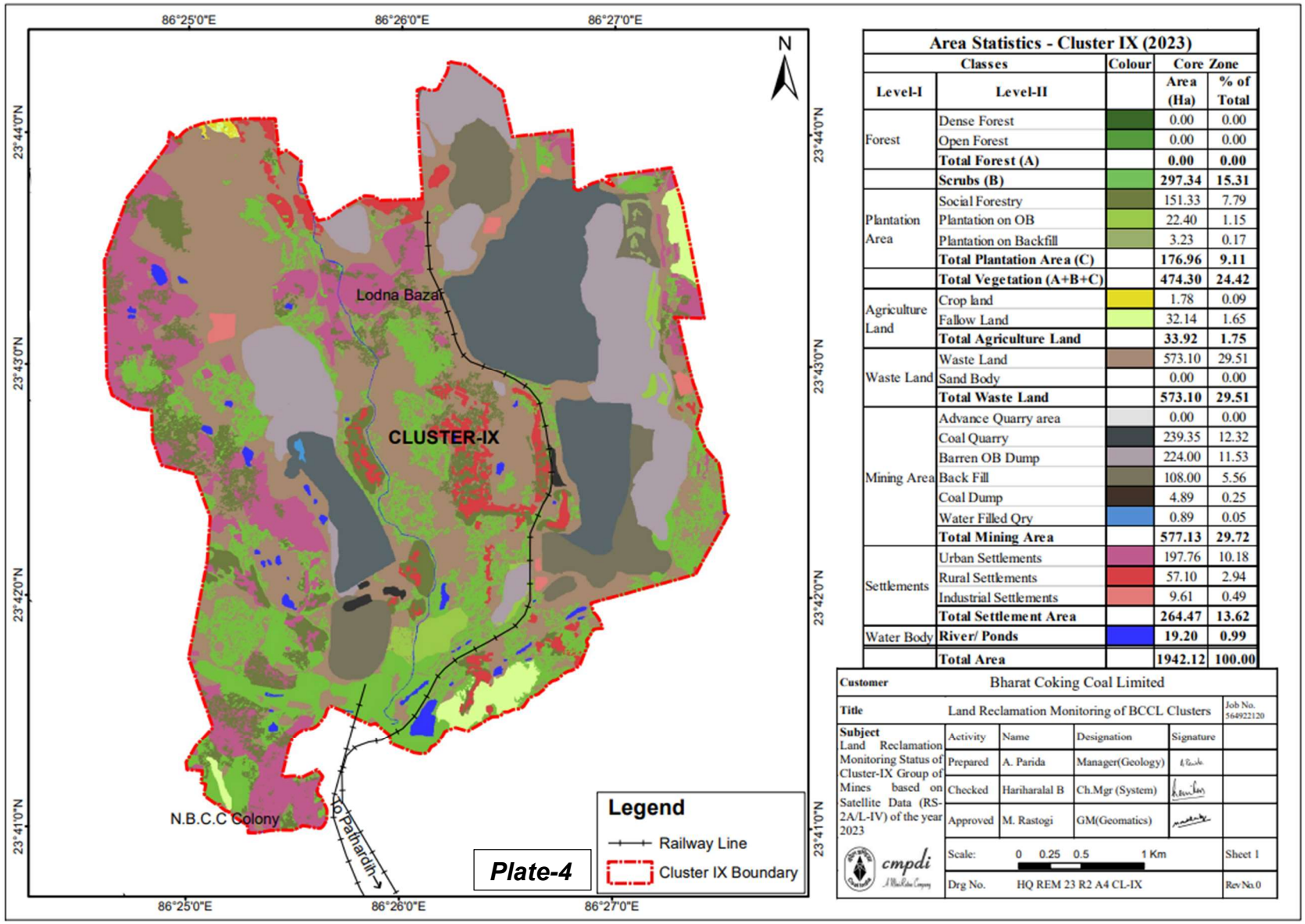
Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 564922120
Subject: Land Reclamation Monitoring Status of Cluster-V Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hariharalal B	Ch.Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
cmpdi	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQ REM 23 R2 A4 CL-V				RevNo.0



Area Statistics - Cluster VIII (2023)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**127.95**	**10.81**
Plantation Area	Social Forestry		22.63	1.91
	Plantation on OB		16.86	1.42
	Plantation on Backfill		4.08	0.34
	Total Plantation Area (C)		**43.57**	**3.68**
	Total Vegetation (A+B+C)		**171.52**	**14.49**
Agriculture Land	Crop land		14.00	1.18
	Fallow Land		67.72	5.72
	Total Agriculture Land		**81.72**	**6.90**
Waste Land	Waste Land		216.17	18.26
	Sand Body		0.00	0.00
	Total Waste Land		**216.17**	**18.26**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		130.42	11.02
	Barren OB Dump		170.51	14.40
	Back Fill		198.08	16.73
	Coal Dump		2.53	0.21
	Water Filled Qry		21.03	1.78
	Total Mining Area		**522.57**	**44.14**
Settlements	Urban Settlements		124.74	10.54
	Rural Settlements		49.23	4.16
	Industrial Settlements		7.49	0.63
	Total Settlement Area		**181.46**	**15.33**
Water Body	**River/ Ponds**		**10.48**	**0.89**
	Total Area		**1183.92**	**100.00**

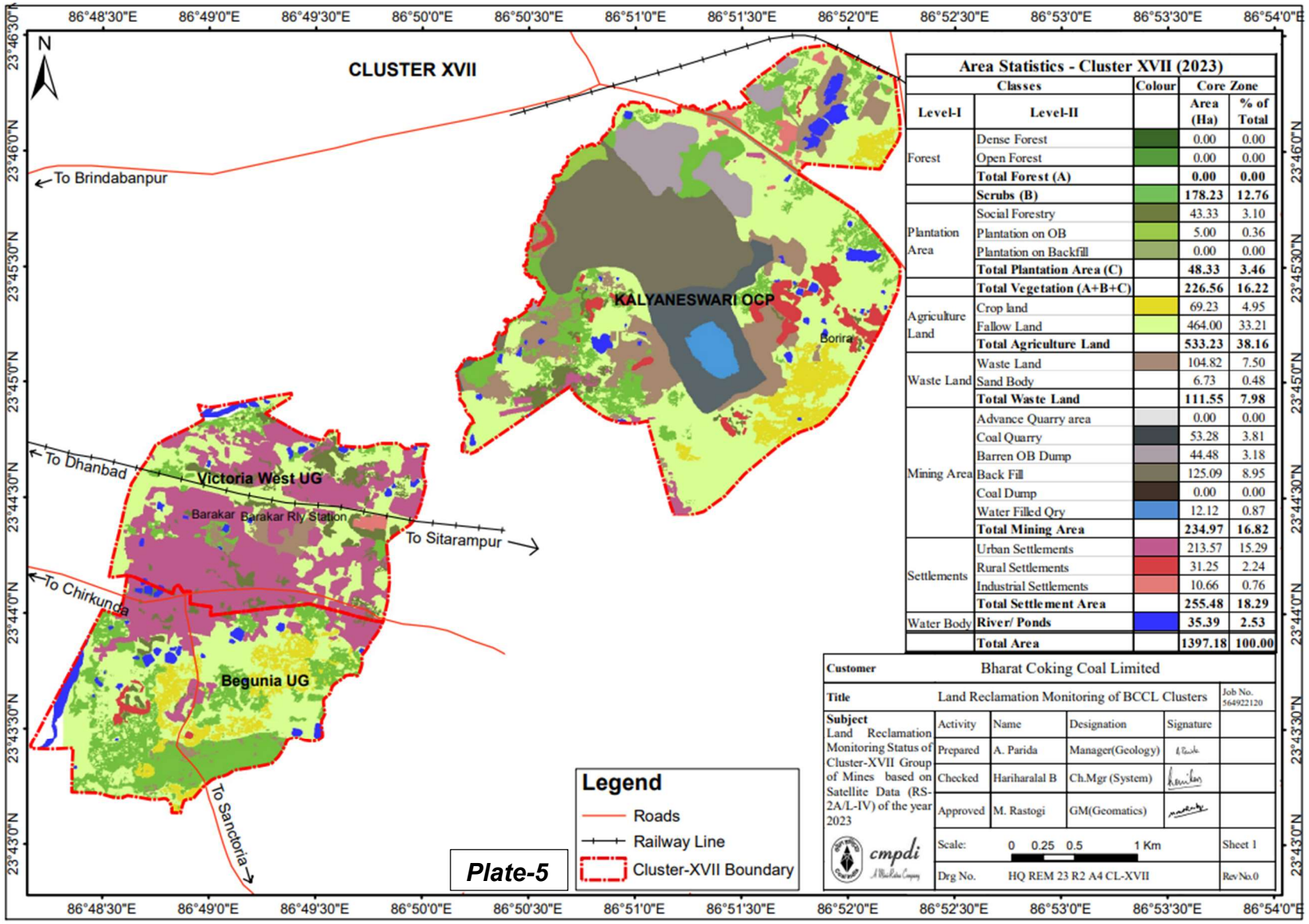
Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 564922120
Subject Land Reclamation Monitoring Status of Cluster-VIII Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hariharalal B	Ch.Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
cmpdi	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQ REM 23 R2 A4 CL-VIII				Rev No.0



Area Statistics - Cluster IX (2023)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**297.34**	**15.31**
Plantation Area	Social Forestry		151.33	7.79
	Plantation on OB		22.40	1.15
	Plantation on Backfill		3.23	0.17
	Total Plantation Area (C)		**176.96**	**9.11**
	Total Vegetation (A+B+C)		**474.30**	**24.42**
Agriculture Land	Crop land		1.78	0.09
	Fallow Land		32.14	1.65
	Total Agriculture Land		**33.92**	**1.75**
Waste Land	Waste Land		573.10	29.51
	Sand Body		0.00	0.00
	Total Waste Land		**573.10**	**29.51**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		239.35	12.32
	Barren OB Dump		224.00	11.53
	Back Fill		108.00	5.56
	Coal Dump		4.89	0.25
	Water Filled Qry		0.89	0.05
	Total Mining Area		**577.13**	**29.72**
Settlements	Urban Settlements		197.76	10.18
	Rural Settlements		57.10	2.94
	Industrial Settlements		9.61	0.49
	Total Settlement Area		**264.47**	**13.62**
Water Body	**River/ Ponds**		**19.20**	**0.99**
	Total Area		**1942.12**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 564922120
Subject Land Reclamation Monitoring Status of Cluster-IX Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hariharalal B	Ch.Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
cmpdi	Scale:	0 0.25 0.5 1 Km			Sheet 1
	Drg No.	HQ REM 23 R2 A4 CL-IX			Rev No.0



Area Statistics - Cluster XVII (2023)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**178.23**	**12.76**
Plantation Area	Social Forestry		43.33	3.10
	Plantation on OB		5.00	0.36
	Plantation on Backfill		0.00	0.00
	Total Plantation Area (C)		**48.33**	**3.46**
	Total Vegetation (A+B+C)		**226.56**	**16.22**
Agriculture Land	Crop land		69.23	4.95
	Fallow Land		464.00	33.21
	Total Agriculture Land		**533.23**	**38.16**
Waste Land	Waste Land		104.82	7.50
	Sand Body		6.73	0.48
	Total Waste Land		**111.55**	**7.98**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		53.28	3.81
	Barren OB Dump		44.48	3.18
	Back Fill		125.09	8.95
	Coal Dump		0.00	0.00
	Water Filled Qry		12.12	0.87
	Total Mining Area		**234.97**	**16.82**
Settlements	Urban Settlements		213.57	15.29
	Rural Settlements		31.25	2.24
	Industrial Settlements		10.66	0.76
	Total Settlement Area		**255.48**	**18.29**
Water Body	**River/ Ponds**		**35.39**	**2.53**
	Total Area		**1397.18**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 564922120
Subject Land Reclamation Monitoring Status of Cluster-XVII Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hariharalal B	Ch.Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
	Scale:	0 0.25 0.5 1 Km			Sheet 1
	Drg No.	HQ REM 23 R2 A4 CL-XVII			Rev No.0

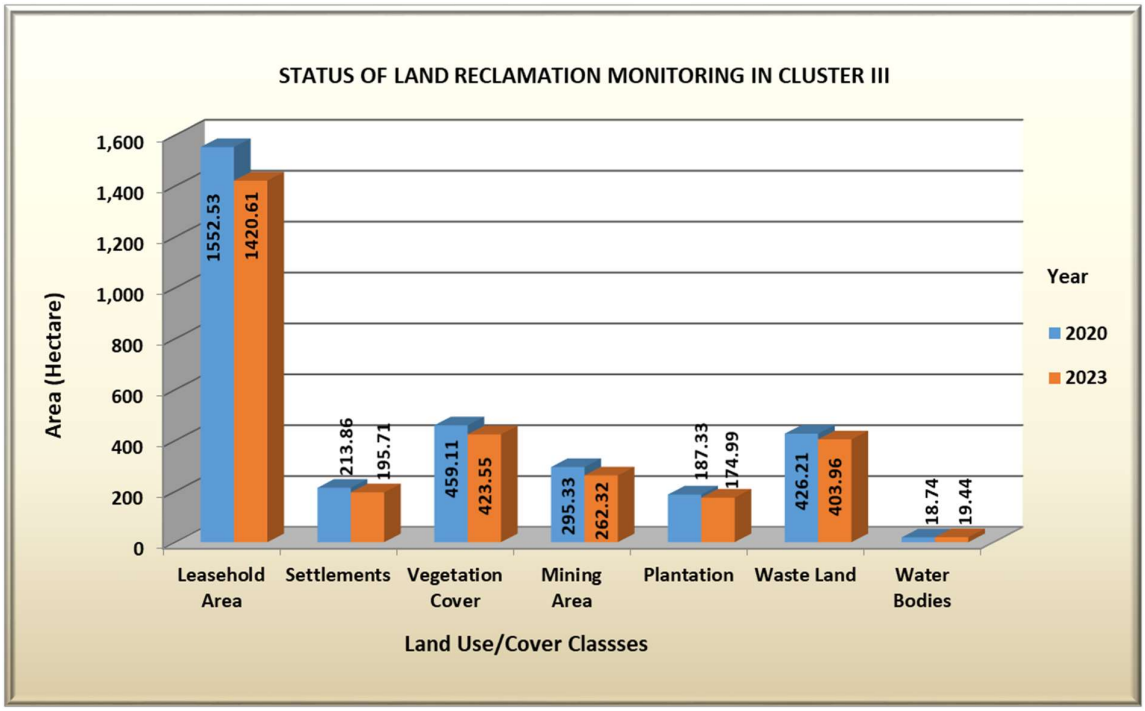


Fig. 3: Land Reclamation Status of Cluster III

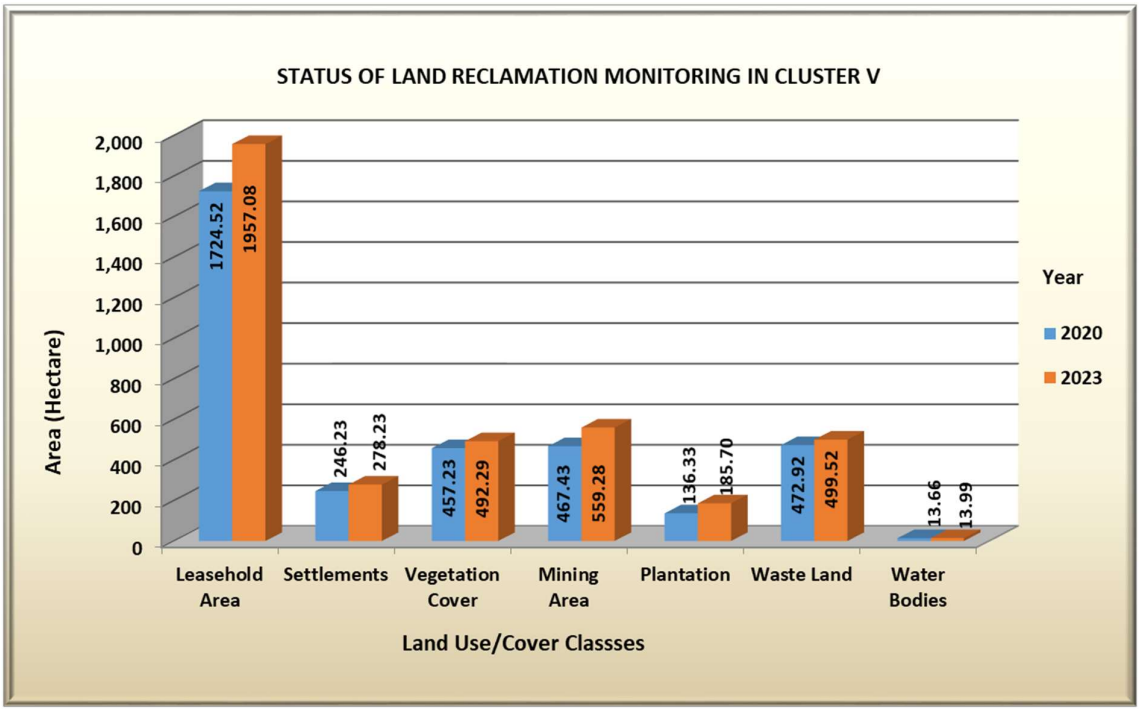


Fig. 4: Land Reclamation Status of Cluster V

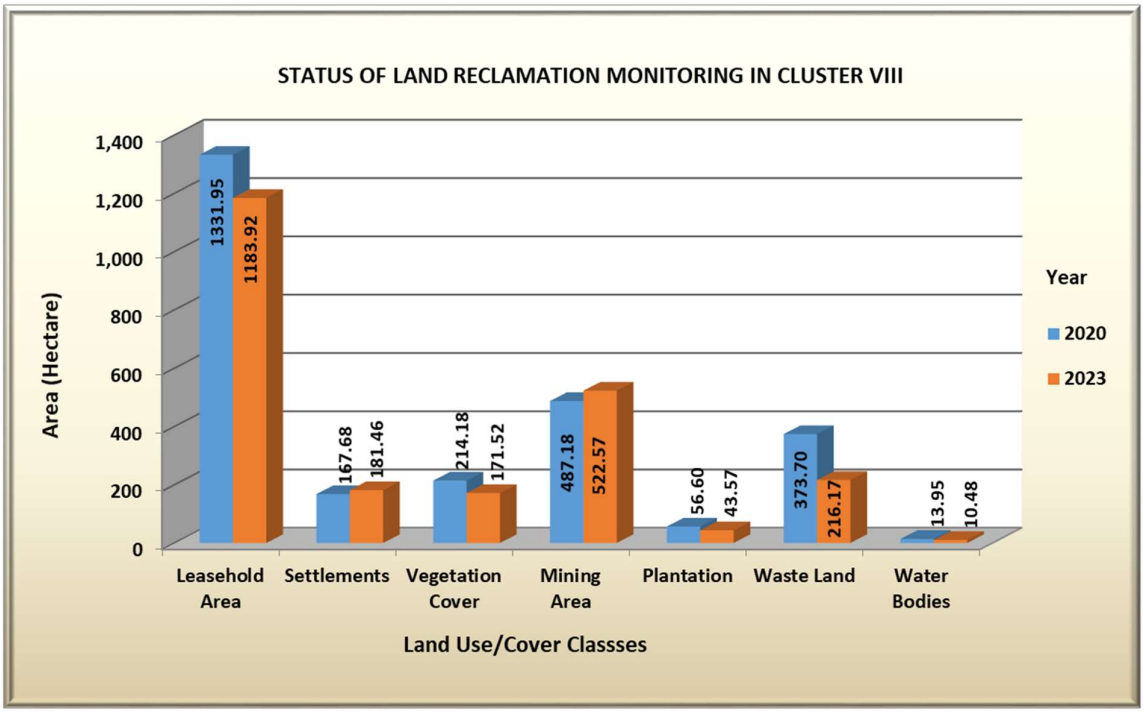


Fig. 5: Land Reclamation Status of Cluster VIII

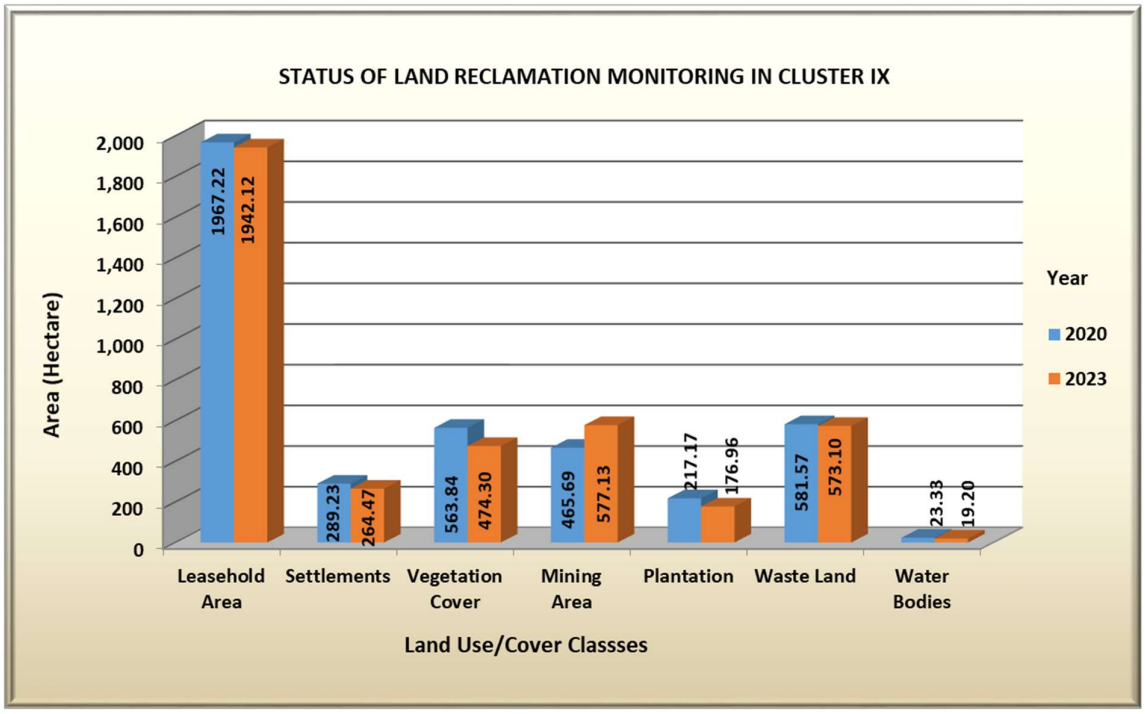


Fig. 6: Land Reclamation Status of Cluster IX

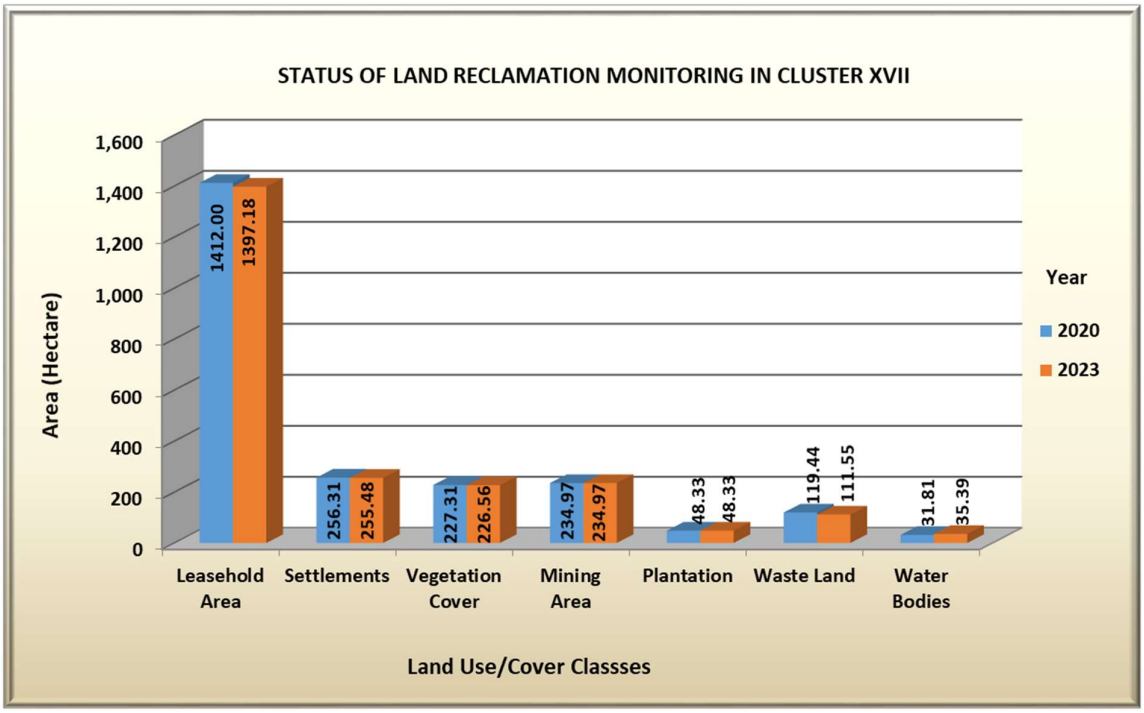


Fig. 7: Land Reclamation Status of Cluster XVII



Photo 1: Plantation on OB dump, Cluster XVII



Photo 2: Plantation on OB dump, Cluster III



Photo 3: Plantation on OB dump, Cluster III



Photo 4: Plantation on OB Dump, Cluster V



Photo 5: Plantation on OB Dump, Cluster V



Photo 6: Govardhan Eco Restoration Park - Bera, Cluster VIII



Photo 7: Plantation on OB Dump, Cluster VIII



Photo 8: Plantation on OB Dump, Cluster VIII



Photo 9: Ashok Vatika, Cluster VIII



Photo 10: Plantation on OB Dump, Cluster IX



Photo 11: Plantation on OB Dump, Cluster IX

शब्द-कोष

1	Land Reclamation	भूमि पुनरुद्धार
2	Over Burden	अधिभार
3	Monitoring	निगरानी
4	Report	प्रतिवेदन
5	Executive Summary	कार्यकारी सारांश
6	Opencast Mine	खुली खदान
7	Objective	उद्देश्य
8	Methodology	कार्य प्रणाली अथवा प्रक्रिया
9	Table	तालिका
10	List of Tables	तालिकाओं की सूची
11	Map	मानचित्र
12	Social Forestry	सामाजिक वानिकी
13	Plantation	पौधारोपण
14	Million	घनमीटर
15	Background	पृष्टभूमि
16	Planning	योजनाबद्ध
17	Asses	आकलन
18	Status	स्थिति
19	Regularly	निरंतर
20	Satellite	उपग्रह
21	Subsidiary	अनुषांगिक
22	Production	उत्पादन
23	Biological Reclamation	जैविक पुनरुद्धार
24	Technical Reclamation	तकनिकी पुनरुधार
25	Leasehold Area	पट्टाक्षेत्र
26	Excavated Area	उत्खनन क्षेत्र
27	Active mining	सक्रिय खनन
28	Environmental Protection	पर्यावरण संरक्षण
29	Remedial Measure	उपचारात्मक उपाय
30	Interval	अंतराल
31	Systematic Error	व्यवस्थित त्रुटियँ।
32	Error	अशुद्धियाँ
33	Curvature	वक्रता
34	Geometric	ज्यामितिक
35	Distortion	विरुपण
36	Plantation	पौधारोपण

37	Capacity	क्षमता
38	Software	सॉफ्टवेयर
39	Class	वर्ग
40	Accuracy	सटीकता
41	Statistical Separation	सांख्यिकीय पृथक्करण
42	Cubic meter	घनमीटर
43	Depicted	दर्शाया गया
44	Percentage	प्रतिशत
45	Salient Findings	मुख्य निष्कर्ष
46	Methodology	पद्धति
47	Data Procurement	डाटाक्रय
48	Satellite data Processing	उपग्रह डाटा प्रसंस्करण
49	Rectification and geo-referencing	सुधार और भूसन्दर्भ-
50	Image enhancement	छवि गुण वृद्धि
51	Training set selection	प्रशिक्षण सेट का चयन
52	Classification and Accuracy assessment	वर्गीकरण और मूल्यांकन की सटीकता
53	Area calculation	क्षेत्र गणना
54	Temporal	लौकिक
55	Processing	प्रसंस्करण
56	Overlay of Vector data base	वेक्टर डाटाबेस का अरोपन
57	Pre-field map preparation	क्षेत्र जाने के पहले नक्शे की त्तैयारी
58	Ground Truthing	भू-सत्यापन
59	Ground Information	भू- सुचना
60	Interpretation	व्याख्या
61	Eco-system	पारिस्थितिकी तंत्र
62	Minor	मामुली
63	Water Drainage	जलनिकाय
64	Interval	अंतराल
65	Maximum	अधिकतम
66	Coal field	कोयला क्षेत्र
67	Design	परिकल्पना
68	Superimpose	आरोपित
69	Update	अद्यतनीकरण/नवीनीकरण
70	Cumulative	संचयित
71	Embankment	तटबंध
72	Cluster	खुली तथा भूमिगत खदानों के समूह

ABBREVIATIONS

SoI	Survey of India
MoEF & CC	Ministry of Environment, Forest & Climate Change
CIL	Coal India Limited
ECL	Eastern Coalfields Limited
BCCL	Bharat Coking Coal Limited
CCL	Central Coalfields Limited
WCL	Western Coalfields Limited
SECL	South Eastern Coalfields Limited
NCL	Northern Coalfields Limited
MCL	Mahanadi Coalfields Limited
NEC	North Eastern Coalfields
CMPDIL	Central Mine Planning & Design Institute Ltd
NRSC	National Remote Sensing Centre
R2/ R2A	Resource Sat Satellites
LISS - 4	Linear Imaging and Self Scanning Sensor
FCC	False Color Composite
OCP	Opencast Project
UGP	Underground Project
OB	Over Burden
GCP	Ground Control points
GIS	Geographic Information System
WGS-84	World Geodetic System
UTM	Universal Transverse Mercator

GLOSSARY

Sl.	Term	Definition
1.	Land Reclamation	To manage, reclaim and restore mined out/ degraded land as close as possible to its original stage.
2.	Over Burden	The material that lies above the coal seam/ deposit
3.	Monitoring	A process of evaluation to check or keep record for a period of time.
4.	Opencast Coal Mine	Open-pit mining, also known as opencast mining, is a surface mining technique that extracts minerals from an open pit in the ground.
5.	Social Forestry	Social forestry is the management and protection of forests and afforestation of barren and deforested lands with the purpose of helping environmental, social and rural development. Plantation (Social/ Avenue or other) carried out outside mining area.
6.	Biological Reclamation	Plantation on Backfilled areas (Stabilized Internal Dumps)
7.	Technical Reclamation	Area under backfilling (Over burden dumped inside the mine voids) in mining area.
8.	Green Cover Generated	Total Plantation carried out in the lease area of Project. This includes Plantation on Backfill, Plantation on OB and Social Forestry.
9.	Leasehold Area	The area, for which lease is granted for the purpose of undertaking mining and allied operations.
10.	Excavated area	Mined out area which includes active mining, area under backfilling and plantation on backfilled areas
11.	Active Mining	Mining areas which include Coal Quarry, Advance Quarry, Quarry Filled with Water etc.
12.	Environmental Protection	It is the practice of protecting the natural environment by individuals, organizations and governments. Its objectives are to conserve natural resources and the existing natural environment and, where possible, to mitigate damage and reverse trends.
13.	Remedial Measure	Any measure or action required or undertaken to investigate, monitor, clean up, remove, treat, prevent, contain or otherwise remediate the presence or release of any hazardous substance or activity.
14.	Systematic Error	Every measurement differing from the true measurement in the same direction, and even by the same amount in some cases.

15.	Geometric Distortion	It refers to the improper positioning of any image with respect to their true geographic position when viewed in a properly scaled common image display plane.
16.	Land Use/ Cover Class	Land cover is what covers the surface of the earth and land use describes how the land is used.
17.	Accuracy	The closeness of agreement between a measured quantity value and a true quantity value.
18.	Environmental Clearance	Environmental Clearance (EC) for any developmental projects like coal mining projects etc. has been made mandatory by the Ministry of Environment, Forests and Climate Change (MoEF & CC) through its Notification issued on 27.01.1994 under the provisions of Environment (Protection) Act, 1986.
19.	Rectification and Geo-referencing	Geo-referencing is the assigning of absolute location of a data point or data points. Geo-rectification refers to the removal of geometric distortions between sets of data points, most often the removal of terrain, platform, and sensor induced distortions from remote sensing imagery.
20.	Image Enhancement	It is the process of modifying digital images so that the results are more suitable for processing or further image analysis.
21.	Training set selection	It is a portion of a data set used to fit or train a model for prediction or classification of values that are known in the training set, but unknown in other (future) data.
22.	Image Classification	It refers to the task of extracting information classes from a multiband raster image. The resulting raster from image classification can be used to create thematic maps.
23.	Temporal Changes	The 'temporal change' means the change in any entity with a period of time.
24.	Ground Truthing	Collection of primary/ basic information from ground realities for satellite image interpretation and thematic mapping.
25.	Cluster	Group of opencast and/ or underground mines clubbed together for administrative purposes.
26.	Arc GIS	GIS Software used for Map preparation
27.	ERDAS IMAGINE	Satellite Image Data Classification Software

Central Mine Planning & Design Institute Ltd.
(A Subsidiary of Coal India Ltd.)
Gondwana Place, Kanke Road, Ranchi 834031, Jharkhand
Phone : (+91) 651 2230001, 2230002, 2230483, FAX (+91) 651 2231447, 2231851
Website : www.cmpdi.co.in, Email : cmpdihq@cmpdi.co.in

Annexure-X

बीसीसीएल
BCCL
Coal India
भारत कोकिंग कोल लिमिटेड
(कोल इण्डिया लिमिटेड की एक अनुषंगी कंपनी)
Bharat Coking Coal Limited
(A Subsidiary of Coal India Limited)
(एक मिनीरत्न कंपनी - A Miniratna Company)
(भारत सरकार का उपक्रम - A Government of India Undertaking)
G20 भारत 2023 INDIA
वसुधैव कुटुम्बकम्
ONE EARTH • ONE FAMILY • ONE FUTURE

Ref: BCCL/AR.III/GM/2025/282

Date: 07.05.2025

Office-Order

Following committee is hereby constituted for regular monitoring of subsidence and its mitigation measures in Cluster-III coal mining project:

1. Addl. GM, Govindpur Area- Chairman
2. Area Manager (Survey)
3. Area Manager (Safety)
4. All Project Officers/their representative
5. All Colliery Surveyor

The above-mentioned committee shall hold review meeting regularly i.e., once in a month and submit the inspection report/mitigation measures report to the undersigned.

This shall come into force with immediate effect.

General Manager
Govindpur Area (Cluster-III)

Distribution:

1. All Concerned
2. Office Copy

THE TIMES OF INDIA, RANCHI
TUESDAY, MARCH 11, 2025

Bharat Coking Coal Limited

A Mini Ratna Company
(A Subsidiary of Coal India Limited)
www.bcclweb.in

ADVERTISEMENT

This is to bring to notice of all concerned that the Amendment in Environmental Clearance to Cluster-III group of mines of Bharat Coking Coal Limited, located at Dhanbad District, Jharkhand has been amended as following by Ministry of Environmental, Forests and Climate Change. Details are following:

Name & details of Cluster	Sanction order number & date
Environment clearance of Cluster III of BCCL dated 06.02.2013 with a rated capacity of 3.6 MTPA in an area of 1420.61 ha, located in the Jharia Coalfield in Dhanbad district of Jharkhand state has been amended by Ministry of Environmental, Forests and Climate by amalgamating seven mines in to single mine to enable mining with OC cum UG with Highwall Mining Method without no change in lease area and production capacity .	**J-11015/213/ 2010-IA.II(M)** dated 03 March, 2025

Copy of the clearance letter may be seen at the website of the Ministry of Environment, Forests and Climate Change at **https://parivesh.nic.in/certificates/BHARAT_COKING_COAL_LIMITED/37/114181011/ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf** and also on Bharat Coking Coal Limited official website **www.bcclweb.in**

Sd/- General Manager (Environment)

This information is also available on BCCL website www.bcclweb.in

भारत कोकिंग कोल लिमिटेड

'एक मिनीरत्न कम्पनी'

(कोल इण्डिया लिमिटेड का एक अंग)

बीसीसीएल BCCL

सभी सम्बंधित व्यक्तियो को सूचित किया जाता है कि भारत कोकिंग कोल लिमिटेड के क्लस्टर-3 को पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय के द्वारा पर्यावरणीय स्वीकृति में बदलाव कीमंजूरी प्राप्त हुई है। विवरण निम्न है :

ख़ान का नाम	स्वीकृति आदेश संख्या एवं तिथि
झारखंड राज्य के धनबाद जिले के झरिया कोयला क्षेत्र में स्थित क्लस्टर ~~क~~ (1420.61 हेक्टेयर क्षेत्र में 3.6 एमटीपीए की क्षमता) के पर्यावरण मंजूरी 9 दिनांक 06.02.2013) को पर्यावरण, वन और जलवायु मंत्रालय द्वारा संशोधित किया गया है एवं सात खदानों को एक खदान में मिलाकर (पट्टा क्षेत्र एवं क्षमता में कोई बदलाव किए बिना) हाईवॉल खनन विधि के साथ ओसी सह यूजी के साथ खनन उत्पादन करने की अनुमति प्राप्त हुई है।	J-11015/213/2010-IA.II(M) dated 03 March, 2025.

प्रतिलिपि पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय की आधिकारिक वेबसाईड https://parivesh.nic.in/certificates/BHARAT COKING COAL LIMITED/37/114181011/ec mining am endmentIA JH CMIN 513800 2024 114181461-signed.pdf और भारत कोकिंग कोल लिमिटेड के आधिकारिक वेबसाईड www.bcclweb.in पर उपलब्ध है।

महाप्रंधक (पर्यावरण)
भारत कोकिंग कोल लिमिटेड

यह सूचना बीसीसीएल की वैबसाइट www.bcclweb.in पर भी उपलब्ध है।

हिन्दुस्तान, धनबाद - 11.03.2025

Annexure-XII

Email **Vivek Sharma**

Submission of Copy of Amended EC granted by MoEF&CC, New Delhi to Cluster-III, BCCL dated 03.03.2025

From : Ganesh Chandra Saha <gmgovindpur.bccl@coalindia.in> Thu, Mar 13, 2025 11:13 AM

Subject : Submission of Copy of Amended EC granted by MoEF&CC, New Delhi to Cluster-III, BCCL dated 03.03.2025 1 attachment

To : dc-dhn@nic.in

Cc : Vivek Sharma <amenv.govindpur.bccl@coalindia.in>

Respected Madam

This is to bring to your kind attention that amendment in Environment Clearance (EC) has been granted to Cluster-III, BCCL by MoEF&CC, New Delhi dated 03.03.2025 and copy of the same is enclosed herewith.

Further, Copy of the amended EC is also available on PARIVESH Portal (https://parivesh.nic.in/certificates/BHARAT_COKING_COAL_LIMITED/37/114181011/ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf) and BCCL website (bcclweb.in)

This is for compliance of condition enforced in amended EC.

Warm regards

Ganesh Chandra Saha
General Manager
Govindpur Area-III

Cluster-III ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf
354 KB

Email **Vivek Sharma**

Fwd: Submission of Copy of Amended EC granted by MoEF&CC, New Delhi to Cluster-III, BCCL dated 03.03.2025

From : Vivek Sharma <amenv.govindpur.bccl@coalindia.in> Wed, Mar 12, 2025 12:44 PM
Subject : Fwd: Submission of Copy of Amended EC granted by MoEF&CC, New Delhi to Cluster-III, BCCL dated 03.03.2025 1 attachment
To : Dhanbad Municipal Corporation <admin.dmc@gov.in>
Cc : Ganesh Chandra Saha <gmgovindpur.bccl@coalindia.in>

Respected Sir

Please refer to the trailing mail.

This is to bring to your kind attention that amendment in Environment Clearance (EC) has been granted to Cluster-III, BCCL by MoEF&CC, New Delhi dated 03.03.2025 and copy of the same is enclosed herewith.

Copy of the amended EC is also available on PARIVESH Portal (https://parivesh.nic.in/certificates/BHARAT_COKING_COAL_LIMITED/37/114181011/ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf) and BCCL website (bcclweb.in)

This is for your kind information and further display of the same at your office, please.

With Regards

Vivek Sharma
Area Manager (Environment)
Govindpur Area, BCCL
Mob: 6287696312

From: "Vivek Sharma" <amenv.govindpur.bccl@coalindia.in>
To: dhanbadmunicipalcorporationadm@gmail.com
Cc: "Ganesh Chandra Saha" <gmgovindpur.bccl@coalindia.in>
Sent: Wednesday, March 12, 2025 12:27:13 PM
Subject: Submission of Copy of Amended EC granted by MoEF&CC, New Delhi to Cluster-III, BCCL dated 03.03.2025

Dear Sir

This is to bring to your kind attention that amendment in Environment Clearance (EC) has been granted to Cluster-III, BCCL by MoEF&CC, New Delhi dated 03.03.2025 and copy of the same is enclosed herewith.

Copy of the amended EC is also available on PARIVESH Portal (https://parivesh.nic.in/certificates/BHARAT_COKING_COAL_LIMITED/37/114181011/ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf) and BCCL website (bcclweb.in)

This is for your kind information and further display of the same at your office, please.

With Regards

Vivek Sharma
Area Manager (Environment)
Govindpur Area, BCCL
Mob: 6287696312

Cluster-III ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf
354 KB

Email **Vivek Sharma**

Submission of Copy of Amended EC granted by MoEF&CC, New Delhi to Cluster-III, BCCL dated 03.03.2025

From : Vivek Sharma <amenv.govindpur.bccl@coalindia.in> Wed, Mar 12, 2025 12:22 PM

Subject : Submission of Copy of Amended EC granted by MoEF&CC, New Delhi to Cluster-III, BCCL dated 03.03.2025 1 attachment

To : dhanbadjspcb@gmail.com, ro dhanbad <ro_dhanbad@jharkhandspcb.in>

Cc : Ganesh Chandra Saha <gmgovindpur.bccl@coalindia.in>

Dear Sir

This is to bring to your kind attention that amendment in Environment Clearance (EC) has been granted to Cluster-III, BCCL by MoEF&CC, New Delhi dated 03.03.2025 and is enclosed herewith.

Copy of the amended EC is also available on PARIVESH Portal (https://parivesh.nic.in/certificates/BHARAT_COKING_COAL_LIMITED/37/114181011/ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf) and BCCL website (bcclweb.in)

This is for your kind information and further display of the same at your office, please.

With Regards

Vivek Sharma
Area Manager (Environment)
Govindpur Area, BCCL
Mob: 6287696312

Cluster-III ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf
354 KB

भारत कोकिंग कोल लिमिटेड
(कोल इण्डिया लिमिटेड का एक अंग)
ऐक मिनीरतन कम्पनी
क्षेत्र संख्या– 3

Bharat Coking Coal Limited
(A Subsidiary of Coal India Limited)
A Miniratna Company
Govindpur Area No. III
OFFICE OF THE GENERAL MANAGER
PO- Sonardih, DHANBAD – 828125
Contact No: 0326-2392162
Email-*gmgovindpur.bccl@coalindia.in*
CIN : U10101JH1972GOI000918

Ref. BCCL/GM/Ar.III/Envt/25-26/30 Date- 12-05-2025

To
The Regional Engineer/Officer,
Jharkhand State Pollution Control Board,
Sardar Patel Nagar, Dhanbad.

Subject: Submission of Environment Statement and Hazardous Waste Return along with Ambient Air & Water Analysis Report (in photocopies) in Form –V & IV of Cluster-III Mine, Govindpur Area for the financial year 2024-25.

Dear Sir,

Enclosed please find herewith the Environment Statement and Hazardous Waste Return for the financial year 2024-25 of Cluster-III Mine, Govindpur Area of M/s BCCL.

Enclosure: -

1. Copy of Water Analysis Report& Ambient Air Report.
2. Form-V.
3. Form-IV

Yours faithfully

12/5/25

Addl. GM
Govindpur Area

FORM – 4

[See rules 5(6) and 22(2)]

FORM FOR FILING ANNUAL RETURNS BY THE OCCUPIER OR OPERATOR OF A FACILITY

[To be submitted by occupier/operator of disposal facility to State Pollution Control Board/Pollution Control Committee by 30th June of every year for the preceding period April'24 to March'25]

1.	**Name and address of the generator/operator of facility**	:	M/s Cluster-III Mine, BCCL PO: Sonardih, Dist: Dhanbad, 828125	
2.	**Name of the authorized person and full address with telephone number and fax**	:	Shri G.C Saha Office of the General Manager, Govindpur Area(III), BCCL PO: Sonardih, Dist: Dhanbad, 828125	
3.	**Description of hazardous waste**	:	**Physical form with description**	**Chemical Formula**
			Burnt Oil (Liquid)	HFD4-68
4.	**Consented quantity of product/others**	:	Coal: 3.6 MTPA	
5.	**Manufactured quantity of product/~~others~~ →**	:	Coal: **1.24** MTe	
6.	**Quantity of hazardous wastes (in KL)** **Note: If the space is not sufficient enclose annexure**	:	**Type of hazardous waste as per Authorization**	**Quantity (in KL)**
				Generated
			(a) Burnt Oil	10
7.	**Description of Storage**	:	Stored in properly covered plastic drums	
8.	**Description of Treatment**	:	1. E-auction to certified recyclers. 2. Reused as lubricant oil. Quantity of Reused burnt oil is 2 KL	

9.	**Details of transportation**	:	**Name & address of consignee**	**Mode of packing**	**Mode of transportation**	**Transportation**	
						Date	**Quantity**
			NA				
10.	**Details of disposal of hazardous waste**	:	**Name & address of consignee**	**Mode of packing**	**Mode of transportation**	**Transportation**	
						Date	**Quantity**
			1. E-auction to certified recyclers. 2. Reused as lubricant oil. Quantity of Reused burnt oil is 2 KL				
11.	**Quantity of useful materials sent back to the manufacturers* and others#**	:	**Name and type of material sent back to manufacturers* and others# :** NA		**Quantity in Tones/KL:** NIL		

*delete whichever is not applicable #enclose list of other agencies

Note: The Quantity shall be match with Form-5, Environmental Audit.

Date:

Place:

Signature: 12/05/25

Designation: Area Manager (Env)
Govindpur Area

FORM – V

(See rule-14)

Environmental statement for the financial year ending the 31st March 2025

PART – A

1. Name of the address of the owner of the industry operation or process : BCCL, Nominated owner
   Shri Manoj Kumar Agarwal, DT (P&P), Koyla Bhawan, Koyla Nagar, Dhanbad (Jharkhand).
2. Industry category : Large Scale
   Primary (STC code)
   Secondary (SIC code)
3. Production capacity (units) : 3.6 MTPA
4. Year of establishment : 1972
5. Date of the last environmental statement submitted : 16.06.2024

PART – B

1. Water & river material consumption

   Water consumption KL /d : 9505 KL /d
   Process : 1405 KL/d
   Domestic : 8100 KL /d

Name of the products	Process water consumption per unit of product output	
	During the previous financial year	During the current financial year
1	0.31 KL /Te	0.0079 KL/Te

2. Raw material consumption

Name of the raw material	Name of the product	Consumption of raw material per unit of out put	
		During the financial year	During the current financial year
Explosive	Coal	0.00184 Te/Te of coal	0.0015 Te/Te of coal

Industry may use cades if disclosing details of raw material would violate contractual obligations, otherwise all industries have to name the raw materials uses.

PART-C

Pollution discharged to environment/unit of output (parameter as specified in the consent issued)

Pollutants	Quantity of pollutions discharged (mass/day)	Concentration of pollutions discharged (mass/day)	Percentage of variation from prescribed standards with reasons
a) Water (As on 06.01.2025)	Total suspended solids -45 PH – 7.41 Oil &grease < 2.0 COD - 36		
b) Air (As on 17.01.2025)	SPM PM 10 – 85 PM 2.5 - 43		
	SO_2 < 10		
	NOx 29		

Monitoring Reports Attached

PART-D

Hazardous Wastes
(as specified under hazardous management and Handling Rules 1989)

Hazardous Wastes	Total quantity (Kg/KL)	
	During the previous financial year	During the current financial year
a) From process	10.3	10
b) From pollution control facilities	NA	NA

PART-E

Solid Wastes

	Total quantity	
	During the previous financial year	During the current financial year
a) From process (In situ & rehandled)	30.43 Lakh cum	73 Lakh cum
b) From pollution control facilities	Nil	Nil
c) 1. Quantity recycled or reutilized within the unit. 2.Sold 3.Disposed	30.43 Lakh cum	73 Lakh cum

PART-F

Please specify the characterizations (in terms of composition of quantum) of hazards as well as solid wastes and indicate disposal practice adopted for both these categories of wastes.

For underground mines : NA

For OCP : Burnt Oil and Over Burden Material.

PART-G

Impact of the pollution abatement measures taken on conservation of natural resources and on the cost of production.

The abatement measures are undertaken and practiced by which the impact on the atmosphere has been become positive. Due care is taken to conserve the natural resources and protect the environment and all its components.

PART-H

Additional measures/investment proposal for environmental protection including abatement of pollution, prevention of pollution.

1. Water sprinkling: - Regular Water sprinkling is carried out through mist type sprinkler in all haul roads, siding, and coal transportation route. Also, 03 nos. fog cannons have been installed in SLG railway siding for abating the pollution. Road maintenance: - Regular maintenance of roads is carried out.
2. Exhaust of vehicle control: - Coal transport vehicle with valid PUC.

PART-I

Any other particulars for improving the quality of the environment.

1. Tree plantation- 1978 nos. bamboo gabion plantation have been carried out along coal transportation route and public roads.
2. 150 nos. bamboo gabion plantation have been done in SLG railway siding.
3. Ambient air & water monitoring is carried out through CMPDIL.
4. Online PM10 analyzer has been installed for regular monitoring of air quality.
5. 02 nos. of Digital Water Level Recorder have been installed for monitoring the ground water level.
6. 01 no. truck mounted fog cannon has been procured for water sprinkling within mine premises.
7. 03 nos. trolley mounted fog cannon have been installed in SLG railway siding.

12/05/25

Area Manager (Env.)
Govindpur Area

AMBIENT AIR QUALITY DATA

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL,
KOYLA BHAWAN COMPL
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

TC-14521

Test Report for Ambient Air Samples

Month & Year	1/2025	Cluster	Cluster III			ULR NO.	TC1012224000001417F
Customer	Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)					Date of Issue	18.02.2025
Project	Block-IV	Sample Ref. No.	REM/BCCL/2025/01		Sampling Method	CMPDI/RI-II/LPM 13 , (IS 5182)	
Date of Sampling	02.01.2025	17.01.2025	Period of Analysis	02.01.2025	15.02.2025	Zone of Station:	Core Zone

Sl. No.	Parameter	Method of Analysis	Observed Values (in µg/m³)		Range Of Testing	LDL	MoEF Standards Notification dated 25th September,2000 (GSR 742 E)	NAAQS, 2009
			1st FN A3232	2nd FN A3310				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	85	82	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	43	46	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	29	27	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

MINE EFFLUENT TEST REPORT

Test Report for Mine Effluent samples

Month & Year	01/2025	Cluster	Cluster III	ULR NO.		TC1012224000001435F	
Customer	Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)					Date of Issue	18.02.2025
Project		Sampling Ref. No.	REM/BCCL/2025/01	Sampling Method	IS 3025 (Part-1) CMPDI/RI-II/LPM 13		
Sampling Stations	(i)	Govindpur	Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent			Period of Analysis	06.01.2025 TO 31.01.2025

Sl. No.	Parameter	Method of Analysis	Date of Sampling: 06.01.2025 – 20.01.2025 Observed Values: First Fortnight M1293	Second Fortnight M1319	STANDARDS FOR COAL MINES (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)	LDL
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	45	39	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.41	7.39	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<2.0	<2.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	36	40	*250 (Max)*	4

***All units in mg/L unless specified otherwise. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*
***Grab sampling carried out for water samples.*

ANALYSED BY (Kumar Vaibhav) ***REVIEWED BY*** (Amit Raj Mishra) ***Authorised Signatory***

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

भारत कोकिंग कोल लिमिटेड
(एक मिनीरत्न कंपनी)
(कोल इण्डिया लिमिटेड की एक अनुषंगी कंपनी)
(भारत सरकार का उपक्रम)

बीसीसीएल BCCL भारत कोकिंग कोल लिमिटेड Bharat Coking Coal Limited

Bharat Coking Coal Limited
(A Miniratna Company)
(A Subsidiary of Coal India Limited)
(A Government of India Undertaking)

OFFICE OF THE GENERAL MANAGER, GOVINDPUR AREA, BCCL
ENVIRONMENT DEPARTMENT

BCCL/GM/AR.III/ENVT/25-26/ 91 Dated: 19/11/2025

To
Dr. Manish Jain
Professor, Department of Environmental Science & Engineering
Indian Institute of Technology (Indian School of Mines), Dhanbad

Subject: LOA (Letter of Acceptance) for the work "Third party audit for air & water quality in Cluster-III" Govindpur Area, BCCL

Ref: 1. Our E-mail dated 06.10.2025.
2. Your Offer vide E-mail dated 13.10.2025 (letter no. ESE/BCCL/2025-26/05).

Dear Sir,

With reference to the above referred emails, this is to bring to your kind attention that competent authority is pleased to accept your offer for the work **"Third party audit for air & water quality in Cluster-III"** Govindpur Area, BCCL for a value of Rs. 3,54,000 (Rs. Three Lakh Fifty-Four Thousand only) including GST@18% with following terms and condition:

1. **Scope of Work:** Scope of work will be as follows:
   - Air quality monitoring on 4 nos. station (parameters PM10, PM2.5, Sox, Nox) on fortnight basis (24 hr) for one month.
   - Water quality monitoring of mine water at 1 station (parameters: TSS, pH, COD, Oil & grease) on fortnight basis for one month.
2. Duration of the work shall be 03 months from the date of acceptance of work by IIT (ISM) Dhanbad.
3. Paying Authority: **Area Finance Manager**, Govindpur Area, BCCL.
4. BCCL shall provide local accommodation and travel arrangements for visiting the site.
5. BCCL shall not be liable to any loss/damage caused to IIT (ISM) Dhanbad during your site visits for the work.
6. Data generated during the study shall be property of BCCL only. The copyright of all documents prepared by the consultant in connection with the study shall rest with the BCCL.
7. 80 % advance payment shall be made to IIT (ISM) Dhanbad after acceptance of the work by you.
8. Final 20% payment will be made after acceptance of the report by General Manager, Govindpur Area, BCCL.
9. Any dispute shall be in jurisdiction of Dhanbad Court Only.
10. **Deliverable:** 02 colour copies of final report. All the studies, data generated during study shall be submitted to BCCL in editable soft copies.
11. If due to any reasons, beyond control of BCCL and IIT (ISM) Dhanbad, work cannot be completed after 80% advance payment, IIT (ISM) Dhanbad shall return the amount to BCCL after deducting expenses incurred by IIT (ISM), if any.

12. **Force Majeure:** For the purpose of and within the scope of the contract by way of indication and not of limitation, the term `Force Majeure' shall mean acts of nature, strikes, Lockouts, or other industrial disturbances, act of public/enemy, wars, blockades, insurrection, riots, epidemics, landslides, earthquakes, storms, lightening, flood, washouts, civil disturbances, explosions and any other similar event not within the control of either party and which by exercises of due care and diligence neither party is able to prevent or overcome. Should the occurrence of force majeure last more than 15 days, extension of time will be given with the mutual consent of IIT (ISM), Dhanbad and BCCL.
13. **Penalty Clause:** The BCCL management reserve the right to impose penalty at the rate of 0.5% of the total awarded value of the work for each week of delay or par thereof in submission of final report up to the ceiling limit of 10% of the awarded value of the work. The aforesaid penalty will be deducted from the payment of bills.

You are hereby requested to return a copy of the LOA by signing on each page of it as a token of acceptance so that Work order may be issued to IIT (ISM) Dhanbad at the earliest.

Yours faithfully

19.11.25

General Manager
Govindpur Area

CC to:

1. HoD (Env), BCCL
2. Area Manager (Env), Govindpur Area
3. AFM, Govindpur Area.
4. Office copy

BHARAT COKING COAL LIMITED
(A Subsidiary of Coal India Ltd.)
भारत कोकिंग कोल लिमिटेड
OFFICE OF THE AREA GENERAL MANAGER
Govindpur area,,

PO: Sonardih,Dist- Dhanbad,Jharkhand,India-828125

Phone No:
Fax :

Website :
Email :

CIN : U10101JH1972GOI000918
GSTN : 20AAACB7934MFZB

Coal India Limited
A Maharatna Company
www.coalindia.in

Purchase Order No: 5100017812

PURCHASE ORDER

Document Date: Oct 27, 2025

To,
SIRTDO SINDRI

SIRTDO, BIT SINDRI DHANBAD

828123
Jharkhand
India

Department : Safety&Consrvation
MSE Status : NON-MSE

PCC BY REGD. POST/MAIL

E-Mail Address :
Telephone :
GST No : 20AAIAS1867N2Z5
Vendor Code : 10001611

PO for the work "Conducting Scientific Study on Controlled Blasting for Patch-C, ABG Colliery as per Regulation 196(3) of CMR 2017"

Item No	Material No.	Short Text	HSN/SAC	UOM	Quantity	Unit Price	Price (Rs)
10		Controlled Blasting Scientific Study		NO	1	435000.00 INR Per 1 NO	513300.00

Manufacturer Part No :
Material Description :
Batch :
Batch Description :

Gross Price	435000.00
CGST%(9.00)	39150.00
SGST%(9.00)	39150.00

Total Net Value Exclusive of Tax	INR	435000.00
Total Net Value Inclusive of Tax	INR	513300.00

Amount in words: Five Lakh Thirteen Thousand Three Hundred Rupees Only

General Terms and Conditions

1. There will be no further change in rate as quoted in the offer letter no. CNP/BIT/MN/2024/OC-3, dated 19.11.24 issued by the Department of Mining Engineering, BIT, Sindri.
2. The paying authority is AFM, Govindpur Area.
3. 100% payment will be made in advance.
4. The work should be started within five (5) days after receiving the Work Order/Purchase Order.
5. The period of the work will be 90 days from the day of advance payment.
6. Data pertaining to geological, structural, mining and geotechnical parameters with relevant to borehole section and plan of working areas will be provided by the Management during the course of report preparation.

7. Lodging and Boarding facilities for two faculty members will be provided by the Management at its own guest house on free of cost (for required days).

8. Penalty LD Clause in case of delay in the completion of subject job is as under:

"LD (Liquidated Damage) @ ½ % of the basic value of the work will be imposed per week or part of the week of delay after schedule time period. The aggregate of such compensation/compensations shall not exceed 10% (Ten) percent of the total value of the work."

9. The Project Officer, ABG Colliery, shall be the Nodal Officer for the said job and will monitor the work undertaken by BIT, Sindri.

10. Matter related to any dispute or differences arising out of this work shall be subject to jurisdiction of District Court, Dhanbad, Jharkhand only.

11. Other than the assistance specified above, the management shall not be responsible for providing any additional support or facilitation.

अनुबंध|Contract

अनुबंध क्रमांक|Contract No: GEMC-511687775012341
अनुबंध तिथि|Generated Date : 08-Sep-2025
बोली/आरए/पीबीपी संख्या|Bid/RA/PBP No.: GEM/2025/B/6187426

अनुसूची नाम|Schedule Name: Schedule 2,Schedule 1

संगठन विवरण|Organisation Details

प्ररूप|Type :	Central PSU
मंत्रालय|Ministry :	Ministry of Coal
विभाग|Department :	COAL INDIA LIMITED
संगठन का नाम|Organisation Name :	Bharat Coking Coal Limited
कार्यालय क्षेत्र|Office Zone:	BCCL Dhanbad Jharkhand

खरीदार विवरण|Buyer Details

पद|Designation :	Manager
संपर्क नंबर|Contact No. :	94705-95938-
ईमेल आईडी|Email ID :	vignesh.m@nic.in
जीएसटीआईएन|GSTIN :	20AAACB7934MFZB
पता|Address :	MM Department, level 3, Commercial Building, Koyla Bhawan, Koyla Nagar, DHANBAD, JHARKHAND-826005, India

वित्तीय स्वीकृति विवरण|Financial Approval Detail

आईएफडी सहमति|IFD Concurrence :	No
प्रशासनिक अनुमोदन का पदनाम| Designation of Administrative Approval:	D(T)P&P
वित्तीय अनुमोदन का पदनाम| Designation of Financial Approval :	GM(MM)/HOD(MM)-P

भुगतान प्राधिकरण विवरण|Paying Authority Details

Role:	PAO
भुगतान का तरीका| Payment Mode:	Offline
पद|Designation :	Senior Manager
ईमेल आईडी|Email ID :	pay8.bccl.dhn@gembuyer.in
जीएसटीआईएन|GSTIN :	20AAACB7934MFZB
पता|Address:	MM Department, level 3, Commercial Building, Koyla Bhawan, Koyla Nagar, DHANBAD, JHARKHAND-826005, India

विक्रेता विवरण|Seller Details

जेम विक्रेता आईडी|GeM Seller ID :	A866180000503281
कंपनी का नाम|Company Name :	ANALYSER INSTRUMENT COMPANY PRIVATE LIMITED
संपर्क नंबर|Contact No. :	09414188611
ईमेल आईडी|Email ID :	aicplsales@gmail.com
पता| Address :	E-29 (A),ROAD NO.2,I.P.I.AREA, Kota, RAJASTHAN-324005, -
एमएसएमई पंजीकरण संख्या|MSME Registration number :	UDYAM-RJ-24-0003154
जीएसटीआईएन|GSTIN:	08AACCA7730N1ZE (R) , (M)
खरीदार द्वारा मूल्यांकित एमआईआई स्थिति| MII Status as evaluated by buyer :	Verified
खरीदार द्वारा सत्यापित एमएसएमई स्थिति|MSME Status as verified by buyer :	Verified
एमएसई सामाजिक श्रेणी|MSE Social Category :	General
एमएसई लिंग श्रेणी|MSE Gender :	Male

*जिसके नाम के पक्ष में GST/TAX इनवॉइस पेश किया जाएगा|GST / Tax invoice to be raised in the name of - Consignee

वितरण निर्देश | Delivery Instructions : NA

उत्पाद विवरण|Product Details

#	आइटम विवरण|Item Description	आइटम विवरण| Ordered Quantity	इकाई | Unit	इकाई मूल्य (INR)| Unit Price (INR)	कर विभाजन (INR)| Tax Bifurcation (INR)	मूल्य (INR में सभी शुल्क और कर सहित)| Price (Inclusive of all Duties and Taxes in INR)
1	**उत्पाद का नाम |Product Name :** CAAQMS (without PM10 Analyzer) **ब्रांड|Brand :** AIC **ब्रांड प्रकार|Brand Type :** NA **कैटलॉग की स्थिति|Catalogue Status:** NA **कैसे बेचा जा रहा है|Selling As :** NA **श्रेणी का नाम और चतुर्थांश|Category Name & Quadrant :** NA (-) **मॉडल|Model:** CAAQM-SYS **एचएसएन कोड|HSN Code:** 9027	8	set	5,062,800	NA	40,502,400
2	**उत्पाद का नाम |Product Name :** CAAQMS (including PM10 Analyzer) **ब्रांड|Brand :** AIC **ब्रांड प्रकार|Brand Type :** NA **कैटलॉग की स्थिति|Catalogue Status:** NA **कैसे बेचा जा रहा है|Selling As :** NA **श्रेणी का नाम और चतुर्थांश|Category Name & Quadrant :** NA (-) **मॉडल|Model:** CAAQM-SYS **एचएसएन कोड|HSN Code:** 9027	2	set	5,805,000	NA	11,610,000

कुल ऑर्डर मूल्य | Total Order Value (in INR)	52,112,400

परेषिती विवरण\|Consignee Detail

क्र.सं.|S.No	परेषिती|Consignee	वस्तु|Item	लॉट नंबर| Lot No.	मात्रा|Quantity	दिनांक के बाद डिलीवरी शुरू करना है| Delivery Start After	वितरण पूरा कब तक करना है| Delivery To Be Completed By
1	पद| Designation : - ईमेल आईडी|Email ID : ajit.kumar2641@nic.in संपर्क|Contact : -9470595213- जीएसटीआईएन|GSTIN : - पता|Address : Office of General Manager, Barora Area (Area-I), BCCL, P.O. Nawagarh, Dhanbad, Pin code-828306., Dhanbad, JHARKHAND-828306, India	CAAQMS (without PM10 Analyzer)	-	1	08-Sep-2025	07-Mar-2026
2	पद| Designation : - ईमेल आईडी|Email ID : kumar.vatslya@nic.in संपर्क|Contact : 85800-26609- जीएसटीआईएन|GSTIN : - पता|Address : Depot Officer, Bera Regional Store, Near Dowari colliera, Bastacolla Area, P.O. Dhansar, Dhanbad., Dhanbad, JHARKHAND-828106, India	CAAQMS (including PM10 Analyzer)	-	1	08-Sep-2025	07-Mar-2026
3	पद| Designation : - ईमेल आईडी|Email ID : ampur.lodna.bccl@nic.in संपर्क|Contact : 94388-77464- जीएसटीआईएन|GSTIN : 20AAACB7934MFZB पता|Address : Office of Depot Officer , Post Office Lodna, DHANBAD, JHARKHAND., Dhanbad, JHARKHAND-828131, India	CAAQMS (without PM10 Analyzer)	-	1	08-Sep-2025	07-Mar-2026
4	पद| Designation : - ईमेल आईडी|Email ID : johnson.besra@nic.in संपर्क|Contact : 84285-63903- जीएसटीआईएन|GSTIN : 20AAACB7934MFZB पता|Address : Regional Store, Sinidih, Govindpur, Area-3, BCCL, Post-Tundu, Dhanbad, Pincode-828128., Dhanbad, JHARKHAND-828128, India	CAAQMS (without PM10 Analyzer)	-	4	08-Sep-2025	07-Mar-2026
5	पद| Designation : - ईमेल आईडी|Email ID : shubham.lawaniya@nic.in संपर्क|Contact : 62876-98739- जीएसटीआईएन|GSTIN : 20AAACB7934MFZB पता|Address : BCCL, Kusunda Area, Post: Kusunda, Dhanbad, JHARKHAND-828116, India	CAAQMS (including PM10 Analyzer)	-	1	08-Sep-2025	07-Mar-2026
6	पद| Designation : - ईमेल आईडी|Email ID : vishal.dwivedi@nic.in संपर्क|Contact : - जीएसटीआईएन|GSTIN : - पता|Address : Regional Store, Bhowra, EJ Area, BCCL, Post. - Bhowra, Dist. - Dhanbad., Dhanbad, JHARKHAND-828302, India	CAAQMS (without PM10 Analyzer)	-	1	08-Sep-2025	07-Mar-2026
7	पद| Designation : - ईमेल आईडी|Email ID : amdepot.block2.bccl@nic.in संपर्क|Contact : - जीएसटीआईएन|GSTIN : - पता|Address : Depot Officer, Regional Store, Block-II, P.O.-Nudkhurkee, Dist.-Dhanbad, Jharkhand, Pin code-828307., Bokaro, JHARKHAND-828307, India	CAAQMS (without PM10 Analyzer)	-	1	08-Sep-2025	07-Mar-2026

Product Specification for CAAQMS (without PM10 Analyzer)

विनिर्देश|Specification	उप-विनिर्देश|Sub-Spec	मूल्य|Value
Custom Specification	Custom Specification	Yes

व्यापक रखरखाव के लिए शुल्क\|Comprehensive maintenance charges for CAAQMS (without PM10 Analyzer)

सेवा वर्ष|Service Year	सीएमसी प्रतिशत|CMC Percentage	कर द्विभाजन|Tax Bifurcation
CMC charges for 1 st year after warranty period in % of cost of equipment	5%	NA
CMC charges for 2 nd year after warranty period in % of cost of equipment	5%	
CMC charges for 3 rd year after warranty period in % of cost of equipment	5%	
CMC charges for 4 th year after warranty period in % of cost of equipment	5%	

सेवा वर्ष|Service Year	सीएमसी प्रतिशत|CMC Percentage	कर द्विभाजन|Tax Bifurcation
CMC charges for 5 th year after warranty period in % of cost of equipment	5%	

विक्रेता विशिष्टता दस्तावेज़\|Seller Specification Document:

1. SpecificationDocument1	mkp.gem.gov.in/catalog_data/catalog_support_document/58/33/136/CatalogAttrs/SpecificationDocument/2025/5/29/2025_05_29_18_46_39_aic_brochure_-_shelter___hvac_p_2025-05-29-18-46-40_ec8717e83ca1f5c5869731cb72bfe01d.pdf

खरीदार विशिष्टता दस्तावेज़\|Buyer Specification Document:

1. SpecificationDocument	mkp.gem.gov.in/catalog_data/catalog_support_document/buyer_documents/48366/54/78/703/CatalogAttrs/SpecificationDocument/2025/4/30/tech_specs_bccl_-without_pm10-__without_ct_2025-04-30-17-26-01_c1c3c69dbeed92598edecc31f35d2132.pdf

Product Specification for CAAQMS (including PM10 Analyzer)

विनिर्देश|Specification	उप-विनिर्देश|Sub-Spec	मूल्य|Value
Custom Specification	Custom Specification	Yes

व्यापक रखरखाव के लिए शुल्क\|Comprehensive maintenance charges for CAAQMS (including PM10 Analyzer)

सेवा वर्ष|Service Year	सीएमसी प्रतिशत|CMC Percentage	कर द्विभाजन|Tax Bifurcation
CMC charges for 1 st year after warranty period in % of cost of equipment	5%	NA
CMC charges for 2 nd year after warranty period in % of cost of equipment	5%	
CMC charges for 3 rd year after warranty period in % of cost of equipment	5%	
CMC charges for 4 th year after warranty period in % of cost of equipment	5%	
CMC charges for 5 th year after warranty period in % of cost of equipment	5%	

विक्रेता विशिष्टता दस्तावेज़\|Seller Specification Document:

1. SpecificationDocument1	mkp.gem.gov.in/catalog_data/catalog_support_document/58/33/136/CatalogAttrs/SpecificationDocument/2025/5/29/2025_05_29_18_44_29_aic_brochure_-_shelter___hvac_p_2025-05-29-18-44-30_73b2f4a347c62a283f782a9b75d04372.pdf

खरीदार विशिष्टता दस्तावेज़\|Buyer Specification Document:

1. SpecificationDocument	mkp.gem.gov.in/catalog_data/catalog_support_document/buyer_documents/48366/54/78/703/CatalogAttrs/SpecificationDocument/2025/4/30/tech_specs_bccl_with_pm_10_2025-04-30-17-22-14_0874e5431b4d1ef37be881797f835b1f.pdf

ईपीबीजी विवरण \| ePBG Detail

सलाहकार बैंक | Advisory Bank :	State Bank of India
ईपीबीजी प्रतिशत (%) | ePBG Percentage(%):	5.00
बोली लगाने वाले को बोली के नियमों और शर्तों के अनुसार लागू ईपीबीजी प्रस्तुत करना होगा |The bidder shall furnish ePBG as applicable as per bid's terms and conditions	

नियम और शर्तें\|Terms and Conditions

1. General Terms and Conditions-

1.1 This contract is governed by the General Terms and Conditions, conditions stipulated to this Product/Service as provided in the Marketplace.

1.2 This Contract between the Seller and the Buyer, is for the supply of the Goods and/ or Services, detailed in the schedule above, in accordance with the General Terms and Conditions (GTC) unless otherwise superseded by Goods / Services specific Special Terms and Conditions (STC) and/ or BID/Reverse Auction Additional Terms and Conditions (ATC), as applicable

1.3 All GeM Sellers / Service Providers are mandated to ensure compliance with all the applicable laws / acts / rules including but not limited to all Labour Laws such as The Minimum Wages Act, 1948, The Payment of Wages Act, 1936, The Payment of Bonus Act, 1965, The Equal Remuneration Act, 1976, The Payment of Gratuity Act, 1972 etc. Any non-compliance will be treated as breach of contract and Buyer may take suitable actions as per GeM Contract.

2. Buyer Added Bid Specific Terms and Conditions-

2.1 *Scope of Supply*:
Scope of supply (Bid price to include all cost components) : Supply Installation Testing Commissioning of Goods and Training of operators and providing Statutory Clearances required (if any)

2.2 *Generic*
Buyer Organization specific Integrity Pact shall have to be complied by all bidders. Bidders shall have to upload scanned copy of signed integrity pact as per Buyer organizations policy along with bid. Click here to view the file

2.3 *Certificates*:
The bidder is required to upload, along with the bid, all relevant certificates such as BIS licence, type test certificate, approval certificates and other certificates as prescribed in the Product Specification given in the bid document.

2.4 *Service & Support*:
Dedicated /toll Free Telephone No. for Service Support : BIDDER/OEM must have Dedicated/toll Free Telephone No. for Service Support.

2.5 *Forms of EMD and PBG*:
Bidders can also submit the EMD with Account Payee Demand Draft in favour of

BHARAT COKING COAL LTD.
payable at
Dhanbad
.
Bidder has to upload scanned copy / proof of the DD along with bid and has to ensure delivery of hardcopy to the Buyer within 5 days of Bid End date / Bid Opening date.

2.6 *Forms of EMD and PBG*:
Bidders can also submit the EMD with Payment online through RTGS / internet banking in Beneficiary name

Bharat Coking Coal Limited
Account No.
10976596836
IFSC Code
SBIN0000066
Bank Name
State Bank of India
Branch address
Bank More, Dhanbad
.
Bidder to indicate bid number and name of bidding entity in the transaction details field at the time of on-line transfer. Bidder has to upload scanned copy / proof of the Online Payment Transfer along with bid.

2.7 *Buyer Added Bid Specific ATC*:
Buyer Added text based ATC clauses

A. Delivery

Delivery period 180 days includes Supply Installation Testing Commissioning of Goods and Training of operators and providing Statutory Clearances required (if any).

B. Optional Site Visit

Bidder may be visit the site as per their requirement before quoting the tender. Bidder is requested to contact on mail gmenv.bccl@coalindia.in.

C. Integrity Pact:-

The bidders will have to upload along with their offer, digitally signed Pre-Contract Integrity Pact as per attached format in Bid.

In terms of the Integrity Pact, the Independent External Monitor(s) (IEMs) nominated for this tender are as follows,

Sl	Name of IEM	Address	e-Mail ID
1	Shri Awind Kumar Kadyan, IDAS(Retd.),	Add: B-2l1, Paschim Vihar, New Delhi – 110063.	arvindkadyan17@gmail.com
2	Shri Amrit Lugun, IFS(Retd.),	A2/122, Ground floor, Safdarjung enclave, New Delhi-110029.	a.lugan@ymail.com

In the event of any dispute between the management and the bidder relating to this Bid/thereafter contracts (where Integrity Pact is applicable), in case, both the parties are agreeable, they may try to settle dispute through mediation before the panel of IEMs in a time bound manner. If required, the organizations may adopt any mediation rules for this purpose. The fees/expenses on dispute resolution shall be equally shared by both the parties.

D. Security Deposit – ePBG mentioned in Bid document will work as Security Deposit.

a. The successful tenderers will have to submit Security Deposit for the 5% value of the total landed value of the contract including all taxes, duties and other costs and charges. In case of Rate / Running Contracts the Security Deposit shallbe for an amount of 5% of average annual offtake contractual value; and in case RC period is longer than 1 year, SD amount shall be 5% of average annual offtake. In case of Contracts for procurement of Capital Goods along with WarrantySpares & Consumables (if applicable) and additional Spares & Consumables / AMC / CMC for more than one year, the Security Deposit shall be for 5% of equipment landed value along with maximum annual landed value of Spares & Consumables.

b. The Security Deposit shall be deposited through RTGS / NEFT / IMPS /e-BG/ other digital modes or in the form of a Bank Guarantee in the prescribed format from a RBI Scheduled Bank in purchaser's country (on a non-judicial stamp paper) within 15 days from date of notification of award or placement of order.

c. The Security Deposit shall be in the same currency(ies) in which contract is to be signed/ issued. In case of multi-currency contract, separate Security Deposit Bank Guarantee (SDBG) in respective currency for required value as above shall be submitted.

d. In case of equipment, SDBG shall not be individual equipment wise. However, multiple Bank Guarantees for Security Deposit shall be permissible provided value of all the SD BGs totals to 5% of the contract value, and all are submitted simultaneously within the specified time schedule and all of them are in the same prescribed format of SDBG with out linking to any particular equipment.

e. The SDBG shall remain valid up to 3 months after completion of supplies and acceptance of materials by the consignee in case of supply contracts and in case of contracts fo r equipment involving installation and commissioning, 3 months after the supply and commissioning of all the equipment covered in the contract.

f. If the successful tenderer fails to deposit the security deposit within 15 (fifteen) days from date of notification of award/ placement of order, another opportunity may be giv en to them for submission of Security Deposit within next 15days. If the successful tenderer still fails to deposit the security deposit within the extended period but executes th e supplies within scheduled delivery period, the submission of Security Deposit may be waived, as the purpose of submission of SD is fulfilled.

g. In cases where the successful tenderer did not submit the security deposit even within the extended period for SD submission but has supplied the materials either in full or in part after the extended period for SD submission, a penalty equivalent to 0.5% (half percent) of SD amount for delay of each week or part thereof (period of delay is to be cal culated from the 31st day from the date of notification of award/placement of order to the date of receipt of full SD) shall be levied subject to a maximum of 5% of the contract value.

h. Security Deposit will be released with the approval of HOD of MM Department / Area GM within 30 days after completion of supplies and acceptance of material by the consi gnee in case of supply contract or after successful commissioning and on receipt of confirmation of Performance Bank Guarantee(s) for all the equipment covered in the contr act in case of contracts for equipment and all those items/ goods involving installation and commissioning and PBG.

i. All Central/State Government Organization/PSUs shall be exempted from submission of Security Deposit. OEM/OES shall also be exempted from submission of Security Depo sit in case of procurement of Spare Parts for equipment against Single Tender Enquiry/Open/Limited Tenders.

f. The SDBG will be submitted Through Structured Financial Management System (SFMS).

E. Performance Bank Guarantee (PBG)

Apart from 5 % e-PBG as per GeM format (which is towards security Deposit), the successf ul bidder shall be required to furnish a performance bank Guarantee as per following,

i. The successful tenderer shall be required to furnish a Performance Guarantee equivalent to 10% value of the contract to cover the warranty/guarantee period.

ii. The Performance Guarantee shall be in the form of a Bank Guarantee issued by a RBI scheduled bank in India as per given format attached in buyer added bid specific ATC document on a non-judicial stamp pa per.

iii. The Performance Bank Guarantee (PBG) shall be in the same currency (ies) in which contract has been si gned/created. In case of multi-currency contract, separate PBG in respective currency for required value s hall be submitted.

iv. The PBG (s) shall remain valid till 3 months after the completion of warranty period of all the equipment/ items covered in the contract. The PBG is of total 39 months duration from the date of successful installat ion, commissioning etc. as per GeM contract terms in present case.

v. The PBG shall be submitted, sufficiently in advance (say 3-4 weeks) to enable its verification before sub mission of the invoice for payment of the supplied material(s).

vi. The PBG issued by Issuing bank on behalf of the bidder in favour of "Bharat Coking Coal Limited" shall b e in paper form (Stamp Paper) as well as issued under "Structured Financial Messaging System". The detai ls of beneficiary Bank for issue of BG through SFMS Platform shall be as under,
Issuing Bank should send the underlying confirmation to either of following banks:

Name of beneficiary & its details	Name	Bharat Coking Coal Limited
	Area	HQ,BCCL
	Bank Account no.	35160317947
	Deptt.	MM Department
Beneficiary Bank, Branc h & Address	State Bank of India	
	Main Branch Dhanbad	
IFSC code	SBIN0000066	

Or

Name of beneficiary & its details	Name	Bharat Coking Coal Limited
	Area	HQ,BCCL
	Bank Account no.	019605001057
	Deptt.	MM Department
Beneficiary Bank, Branch & Address	ICICI Bank	
	ICICI Bank, Dhanbad	
IFSC code	ICIC0000196	

vii. Original copy of the Bank Guarantee issued by the Issuing Bank shall be sent by the issuing bank to MM department, BCCL.

viii. The release of the Performance Bank guarantee(s) after above indicated period, shall be subject to satisfactory performance of the equipment/items during the warrant y period and fulfilment of contractual obligations failing which, action for further extension or encashment of PBG, as deemed suitable shall be taken. The Performance Bank Guarantee shall be released after expiry of validity period if no claim is pending, with the approval of the concerned HOD (MM) after expiry of validity period after o btaining the following:
   1. 'No Claim Certificate' from the concerned HOD (User Dept.) indicating that there is no claim pending.
   2. 'No Claim Certificate' from the contractor indicating that there is no claim pending and that there is no dispute pending as per attached annexure in buyer added bid specific ATC document.

ix. After completion of warranty period successful tenderer needs to submit 'No Claim Certificate' indicating that there is no claim pending and that there is no dispute pe nding as per attached annexure in buyer added bid specific ATC document.

x. In cases where the supplier does not submit the PBG in time or as per the prescribed format in line with the contract stipulations, the PBG amount may be deducted fr om the first bill or in case of insufficient amount, from subsequent bill(s) of the supplier till the full PBG amount is deducted. This amount shall be refunded to the supplie r upon acceptance of PBG submitted by them.

F. DOCUMENTS TO BE SUBMITTED BY BIDDERS WHO HAVE SUBMITTED EMD IN FORM OF DD/ RTGS / INTERNET BANKING

Bidders submitting EMD in the form of DD/RTGS / internet banking shall also submit the following documents along with their bid for Vendor Code Creation to return the EMD amount post finalization of tender:

a. Copy of PAN Card.

b. Copy of GSTIN.

c. Copy of Cancelled Cheque.

d. Copy of EFT Mandate duly certified by Bank.

G. TReDS: Trade Receivables Discounting System (TReDS) is an initiative of Reserve bank of India (RBI) to facilitate MSME receivable payments from corporates.

BCCL has on boarded on following four TReDS platforms

- **i. Receivables Exchange of India Limited (RXIL), websitewww.rxil.in**
- **ii. A-treds Ltd (Invoicemart) , website- www.invoicemart.com11 / 14**
- **iii. Mynd Solutions Pvt.Ltd. (M1 exchange) , website- www.m1exchange.com**
- **iv. C2FO Factoring Solutions Private Limited, website – www.c2treds.com**

MSE bidders willing to get payment through this system may get registered on TReDS platform and confirm the respective member code of TReDS Portals in their offer. The bidder may contact respective portals for any queries /details.

H. The details of shipping documents to be furnished by the Supplier are specified below:

Upon dispatch of the Goods to the consignee, the Supplier shall notify the Purchaser and Ultimate Consignee,

i. Supplier's invoice showing Contract Number, Goods description, quantity, unit price, total amount;

ii. Railway receipt/ Transporter’s consignment note /acknowledgement of receipt of Goods from the consignee(s);

iii. Manufacturer's/Supplier's warranty / guarantee certificate;

iv. Manufacturer’s Test & Inspection certificate (if any)

The above documents shall be provided by the supplier at the time of arrival of the Goods at the consignee’s end. In case of delay, the Supplier will be responsible for any consequent expenses.

I. PBG for CAMC

Performance Bank Guarantee applicable for CAMC is to be submitted at the start of the CAMC and shall be applicable at a rate of 5 % of the order value of equipment only (landed cost of items ordered inclusive GST) which shall be given by supplier after completion of warranty period. The PBG submitted after award of contract shall be released only after new PBG for the CAMC period is submitted and accepted by buyer/consignee after due verification. Bank guarantee for CAMC is to remain valid till completion of CAMC period plus 3 months. The bank guarantee for CAMC shall be submitted to buyer directly. In case, seller fails to submit the PBG or does not provide services for the CAMC contract after expiry of warranty period then PBG of equipment shall be forfeited.

J. Certificate of Local Content as per Public Procurement (Preference to Make in India) Order, 2017 (as amended from time to time) for tender value less than 10 Cr.

Ref. No: ……..…… Date: ……

Tender No.: ……..…… dated ……

We, M/s ……, having registered office at ……, being OEM of the offered product/services do hereby confirm that the percentage of local content in the offered product / service is ____ % and meets the local content requirement for ‘Class – I local supplier/ Class – II local supplier’ (Strike off which is not applicable) as prescribed under Public Procurement (Preference to Make in India) Order, 2017 (as amended from time to time).

The complete address of the location(s) at which the local value addition is made, is / are as under:

1.

2.

(Signature of the authorised signatory)

Name:

Designation:

Email id:

Mobile No:

Place:

Date:

Note: Percentage of local content is to be mentioned as per the formula given in Annexure 28 (page no 285) of Manual for Procurement of Goods, Second Edition, 2024 issued by Department of Expenditure, MoF, GoI. (https://doe.gov.in/circulars/manual-procurement_goods-second-edition-2024).

κ. Primary Product Category:

Item Schedule no. 1: Caaqms (including Pm10 Analyzer)

Item Schedule no. 2: Caaqms (without Pm10 Analyzer)

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2.8 *Buyer Added Bid Specific ATC*:
Buyer uploaded ATC document Click here to view the file .

2.9 *Generic*
OPTIONAL SITE VISIT:

1. The Bidder is advised to visit and examine the installation site and its surroundings and obtain for itself on its own responsibility all information that may be necessary for preparing the Bid. The costs of visiting the site shall be borne by the Bidder.

Yes

2. The Bidder representative shall be allowed entry upon consignee premises for such visits, only upon the express conditions that the Bidder will release and indemnify the Buyer and Consignee against all liabilities arising out of such visit including death or injury, loss or damage to property, and any other loss, damage, costs, and expenses incurred as a result of such visit.

3. The Bidder shall not be entitled to hold any claim against Buyer for noncompliance due to lack of any kind of pre-requisite information as it is the sole responsibility of the Bidder to obtain all the necessary information with regard to site, surrounding, working conditions, weather etc. on its own before submission of the bid.

नोट: यह सिस्टम जनरेटेड फाइल है। कोई हस्ताक्षर की आवश्यकता नहीं है। इस दस्तावेज़ का प्रिंट आउट भुगतान/लेनदेन उद्देश्य के लिए मान्य नहीं है।

Note: This is system generated file. No signature is required. Print out of this document is not valid for payment/ transaction purpose.

भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन, नदी विकास
और गंगा संरक्षण विभाग
केन्द्रीय भूमि जल प्राधिकरण
Government of India
Ministry of Jal Shakti
Department of Water Resources,
River Development & Ganga Rejuvenation
Central Ground Water Authority

(भूजल निकासी हेतु अनापत्ति प्रमाण पत्र)
NO OBJECTION CERTIFICATE (NOC) FOR GROUND WATER ABSTRACTION

Project Name:	Cluster Iii Mines Of Bccl		
Project Address:	Office Of General Manager, Govindpur Area, M/s Bccl, Po- Sonardih		
Village:	Sonardih	Block:	Baghmara
District:	Dhanbad	State:	Jharkhand
Pin Code:			
Communication Address:	Office Of The General Manager, Govindpur Area.iii Bccl, Po. Sonardih, Baghmara, Dhanbad, Jharkhand - 828125		
Address of CGWB Regional Office :	Central Ground Water Board Mid Eastern Region, 6th & 7th Floor, Lok Nayak Jai Prakash Bhawan, Frazer Road Dak Banglow, Patna, Bihar - 800011		

1.	**NOC No.:**	CGWA/NOC/MIN/REN/1/2025/10882	2.	**Date of Issuence**	21/02/2025
3.	Application No.:	21-4/277/JH/MIN/2018	4.	Category: (GWRE 2024)	Semi Critical
5.	Project Status:	Existing With Additional Ground Water Requirment	6.	NOC Type:	Renewal
7.	**Valid from:**	03/12/2023	8.	**Valid up to:**	02/12/2025

9. Ground Water Abstraction Permitted:

Fresh Water		Saline Water		Dewatering		Total	
m³/day	m³/year	m³/day	m³/year	m³/day	m³/year	m³/day	m³/year
1800.00	657000.00			15677.00	5722105.00	17477.00	6379105.00

10. Details of ground water abstraction /Dewatering structures

	Total Existing No						Total Proposed No					
	DW	DCB	BW	TW	MP	MPu	DW	DCB	BW	TW	MP	MPu
Abstraction Structure*	0	0	0	0	1	7	0	0	0	0	0	0
Dewatering Structure*	0	0	7	0	0	0	0	0	0	0	0	0

*DW- Dug Well; DCB-Dug-cum-Bore Well; BW-Bore Well; TW-Tube Well; MP-Mine Pit;MPu-Mine Pumps

11.	Ground Water Abstraction/Restoration Charges paid (Rs.):	72688350.00
12.	Environment Compensation (if applicable) paid (Rs.):	0.00

13.	Number of Piezometers(Observation wells) to be constructed/ monitored & Monitoring mechanism.	No. of Piezometers	Monitoring Mechanism		
			Manual	DWLR**	DWLR With Telemetry
	**DWLR - Digital Water Level Recorder	2	0	1	1

CENTRAL GROUND WATER AUTHORITY

18/11, जामनगर हाउस, मानसिंह रोड, नई दिल्ली - 110011 / 18/11, Jamnagar House, Mansingh Road, New Delhi-110011
Phone: (011) 23383561 Fax: 23382051, 23386743
Website: cgwa-noc.gov.in

CENTRAL GROUND WATER AUTHORITY

18/11, जामनगर हाउस, मानसिंह रोड, नई दिल्ली - 110011 / 18/11, Jamnagar House, Mansingh Road, New Delhi-110011
Phone: (011) 23383561 Fax: 23382051, 23386743
Website: cgwa-noc.gov.in

(Compliance Conditions given overleaf)

This is an auto generated document & need not to be signed.

CENTRAL GROUND WATER AUTHORITY

18/11, जामनगर हाउस, मानसिंह रोड, नई दिल्ली - 110011 / 18/11, Jamnagar House, Mansingh Road, New Delhi-110011
Phone: (011) 23383561 Fax: 23382051, 23386743
Website: cgwa-noc.gov.in

Validity of this NOC shall be subject to compliance of the following conditions:

Mandatory conditions:

1) Installation of tamper proof digital water flow meter with telemetry on all the abstraction structure(s) shall be mandatory for all users seeking No Objection Certificate and intimation regarding their installation shall be communicated to the CGWA within 30 days of grant of No Objection Certificate.

2) Proponents shall mandatorily get water flow meter calibrated from an authorized agency once in a year.

3) Construction of purpose-built observation wells (piezometers) for ground water level monitoring shall be mandatory as per Section 14 of Guidelines. Water level data shall be made available to CGWA through web portal. Detailed guidelines for construction of piezometers are given in Annexure-II of the guidelines.

4) Proponents shall monitor quality of ground water from the abstraction structure(s) once in a year. Water samples from bore wells/ tube wells / dug wells shall be collected during April/May every year and analysed in NABL accredited laboratories for basic parameters (cations and anions), heavy metals, pesticides/ organic compounds etc. Water quality data shall be made available to CGWA through the web portal.

5) In case of mining projects, additional key wells shall be established in consultation with the Regional Director, CGWB for ground water level monitoring four (4) times a year (January, May, August and November) in core as well as buffer zones of the mine.

6) In case of mining project the firm shall submit water quality report of mine discharge/ seepage from Govt. approved/ NABL accredited lab.

7) The firm shall report compliance of the NOC conditions online in the website (www.cgwa-noc.gov.in) within one year from the date of issue of this NOC.

8) Industries abstracting ground water in excess of 100 m 3 /d shall undertake annual water audit through certified auditors and submit audit reports within three months of completion of the same to CGWA. All such industries shall be required to reduce their ground water use by at least 20% over the next three years through appropriate means.

9) Application for renewal can be submitted online from 90 days before the expiry of NOC. Ground water withdrawal, if any, after expiry of NOC shall be illegal & liable for legal action as per provisions of Environment (Protection) Act, 1986.

10) This NOC is subject to prevailing Central/State Government rules/laws/norms or Court orders related to construction of tube well/ground water abstraction structure / recharge or conservation structure/discharge of effluents or any such matter as applicable.

General conditions:

11) No additional ground water abstraction and/or de-watering structures shall be constructed for this purpose without prior approval of the Central Ground Water Authority (CGWA).

12) The proponent shall seek prior permission from CGWA for any increase in quantum of groundwater abstraction (more than that permitted in NOC for specific period).

13) Proponents shall install roof top rain water harvesting in the premise as per the existing building bye laws in the premise.

14) The project proponent shall take all necessary measures to prevent contamination of ground water in the premises failing which the firm shall be responsible for any consequences arising thereupon.

15) In case of industries that are likely to contaminate the ground water, no recharge measures shall be taken up by the firm inside the plant premises. The runoff generated from the rooftop shall be stored and put to beneficial use by the firm.

16) Wherever feasible, requirement of water for greenbelt (horticulture) shall be met from recycled / treated waste water.

17) Wherever the NOC is for abstraction of saline water and the existing wells (s) is /are yielding fresh water, the same shall be sealed and new tubewell(s) tapping saline water zone shall be constructed within 3 months of the issuance of NOC. The firm shall also ensure safe disposal of saline residue, if any.

18) Unexpected variations in inflow of ground water into the mine pit, if any, shall be reported to the concerned Regional Director, Central Ground Water Board.

19) In case of violation of any NOC conditions, the applicant shall be liable to pay the penalties as per Section 16 of Guidelines.

20) This NOC does not absolve the proponents of their obligation / requirement to obtain other statutory and administrative clearances from appropriate authorities.

21) The issue of this NOC does not imply that other statutory / administrative clearances shall be granted to the project by the concerned authorities. Such authorities would consider the project on merits and take decisions independently of the NOC.

22) In case of change of ownership, new owner of the industry will have to apply for incorporation of necessary changes in the No Objection Certificate with documentary proof within 60 days of taking over possession of the premises.

23) This NOC is being issued without any prejudice to the directions of the Hon'ble NGT/court orders in cases related to ground water or any other related matters.

24) Proponents, who have installed/constructed artificial recharge structures in compliance of the NOC granted to them previously and have availed rebate of upto 50% (fifty percent) in the ground water abstraction charges/ground water restoration charges, shall continue to regularly maintain artificial recharge structures.

25) Industries which are likely to cause ground water pollution e.g. Tanning, Slaughter Houses, Dye, Chemical/ Petrochemical, Coal washeries, pharmaceutical, other hazardous units etc. (as per CPCB list) need to undertake necessary well head protection measures to ensure prevention of ground water pollution as per Annexure III of the guidelines.

26) In case of new infrastructure projects having ground water abstraction of more than 20 m3/day, the firm/entity shall ensure implementation of dual water supply system in the projects.

27) In case of infrastructure projects, paved/parking area must be covered with interlocking/perforated tiles or other suitable measures to ensure groundwater infiltration/harvesting.

28) In case of coal and other base metal mining projects, the project proponent shall use the advance dewatering technology (by construction of series of dewatering abstraction structures) to avoid contamination of surface water.

29) The NOC issued is conditional subject to the conditions mentioned in the Public notice dated 27.01.2021 failing which penalty/EC/cancellation of NOC shall be imposed as the case may be.
30) This NOC is issued subject to the clearance of Expert Appraisal Committee (EAC) (if applicable).
31) In the self-compliance report, the PP shall submit details of Drilling Agency/ Agencies, which has/ have constructed BW(s)/ TW(s) along with undertaking to the effect that all necessary measures have been taken as per directions of Hon'ble Supreme Court provided in Annexure-VII of guidelines dated 24.09.2020 in respect of abandoned/ failed BW(s)/ TW(s)/Piezometer(s), if any. The PP is advised to engage registered drilling agency/ agencies. In the event of any mishap/ unfortunate incident due to negligence in taking measures for prevention of accident due to falling in Bore Well, both PP and concerned drilling agency shall jointly be held responsible and penal action as per extant Government rules shall be taken.

(Non-compliance of the conditions mentioned above is likely to result in the cancellation of NOC and legal action against the proponent.)

CENTRAL GROUND WATER AUTHORITY

CENTRAL GROUND WATER AUTHORITY

Department of Water Resources, River Development and Ganga Rejuvenation
Ministry of Jal Shakti, Govt. of India

Receipt

(As per the guideline Gazette Notification S.O. 3281(E) regarding the New Guidelines dated 24.09.2020 of CGWA, MoJS, Govt. of India)
https://cgwa-noc.gov.in

Application No,:	21-4/277/JH/MIN/2018	Date of Issuence:21/02/2025
Name of Firm:	CLUSTER III MINES OF BCCL	
AppType Category:	*Coal*	
Application Type:	*Mining*	
PAN/GSTIN No. of Firm/Individual:	/	

SN	Description	Amount (Rs.)
1.	Application Processing Fee	**5000.00**
2.	Ground Water Abstraction charges	**72688350.00**
3.	Ground Water Restoration charges	**0**
4.	Environmental Compensation Charges (ECRGW) *(Date From to) Days-*	
5.	Penalty for non-Compliance of NOC conditions *Condition to be mentioned*	
6.	Adjustment Charges	
7.	Rebate	
8.	Charges for correction/modification in the existing issued No Objection Certificate	

S.No.	Description	Rate
(i)	Change in User ID	Rs. 1000
(ii)	Change in firm Name	Rs. 5000
(iii)	Extension of No Objection Certificate	Rs. 5000
(iv)	Issuance of duplicate No Objection Certificate	Rs. 5000
(v)	Issuance of corrigendum to No Objection Certificate	Rs. 5000
(vi)	Any other items/correction etc.	Rs. 500

Rs. Rupees Seven Crore Twenty Six Lakh Ninty Three Thousand Three Hundred Fifty Only	**72693350.00**

This is an system generated invoice, hence, does not require ink signed.

CENTRAL GROUND WATER AUTHORITY

18/11, जामनगर हाउस, मानसिंह रोड, नई दिल्ली - 110011 / 18/11, Jamnagar House, Mansingh Road, New Delhi-110011
Phone: (011) 23383561 Fax: 23382051, 23386743
Website: cgwa-noc.gov.in

पानी बचाये – जीवन बचाये
SAVE WATER - SAVE LIFE

Term and conditions:

i. All disputes are subject to Delhi Jurisdiction.
ii. Any complaint in regard to the rates will not be entertained.

Member-Secretary
CGWA, New Delhi

CENTRAL GROUND WATER AUTHORITY

Gmail **Environment Department Govindpur Area <envgovindpur.bccl@gmail.com>**

Mining operation as per amended EC of Cluster-III, BCCL

1 message

Environment Department Govindpur Area <envgovindpur.bccl@gmail.com> 25 November 2025 at 13:54
To: ro.ranchi-mef@gov.in

Dear Sir

This is to bring to your kind attention that amendment in EC granted to Cluster-III, BCCL was obtained from MoEF&CC dated 03.03.2025.(proposal no. IA/JH/CMIN/513800/2024).

Accordingly, Consent to Establish and Consent to Operate has been obtained from JSPCB as per amended EC (copy is enclosed herewith).

With Best Regards,
Environment Department
Govindpur Area, BCCL
Don't print this mail unless it's necessary. Go Green

2 attachments

CTE for Cluster-III June 2025.pdf
160K

CTO Cluster-III upto 30.06.2030 (2).pdf
165K

IN THE HIGH COURT OF JHARKHAND AT RANCHI
W.P.(C) No.4944 of 2011

M/s. Bharat Coking Coal Limited, a Government Company within the meaning of S. 617 of the Companies Act, having its registered office at Koyla Bhawan, P.O. Koyla Nagar, P.S. Saraidhella, Dist. Dhanbad through Sri Harendra Kishore s/o Leeladhar Sharma, Head of Department (Legal), BCCL, r/o Kusum Vihar Colony, P.O. Koyla Nagar, P.S. Saraidhella, Dist. Dhanbad. ..... Petitioner.

-Versus-

1. The State of Jharkhand through its Secretary, Forests & Environment Department, Government of Jharkhand, Nepal House, P.O. & P.S. Doranda, Dist. Ranchi.
2. Jharkhand State Pollution Control Board, T.A. Division Building (Ground Floor), HEC Campus, P.O. Dhurwa, P.S. Jagannathpur, Dist. Ranchi through its Chairman.
3. Member Secretary, Jharkhand State Pollution Control Board, T.A. Division Building (Ground Floor), HEC Campus, P.O. Dhurwa, P.S. Jagannathpur, Dist. Ranchi.
4. Regional Officer, Regional Office-cum-Laboratory, Jharkhand State Pollution Control Board, P.O., P.S. & Dist. Dhanbad.
5. Deputy Commissioner, P.O., P.S. & Dist. Dhanbad.

..... Respondents.

CORAM : HON'BLE MR. JUSTICE RAJESH SHANKAR

For the Petitioner : Mr. Manish Kumar, A.C. to
Mr. Anoop Kumar Mehta, Advocate
For the Res.-State : Mr. Kunal Chandra Suman,
A.C. to G.P. II

Order No.26 **Date: 28.01.2025**

1. Mr. Manish Kumar, learned A.C. to Mr. Anoop Kumar Mehta, learned counsel for the petitioner, on instruction, prays for withdrawal of the present writ petition.

2. Considering the said prayer, the present writ petition is dismissed as withdrawn.

3. Pending interlocutory application(s), if any, is also dismissed.

(Rajesh Shankar, J.)

Rohit/


Plantation By
Shri Vikas Sarkar
District Mining Officer
Dhanbad
shiv jha


CPCB
#एक_पेड़_माँ_के_नाम
Plantation By
Shri Mrinal Kanti
Biswas
Rth, CPCB, Kolkata
Date: 07.08.2024
GPS Map Camera

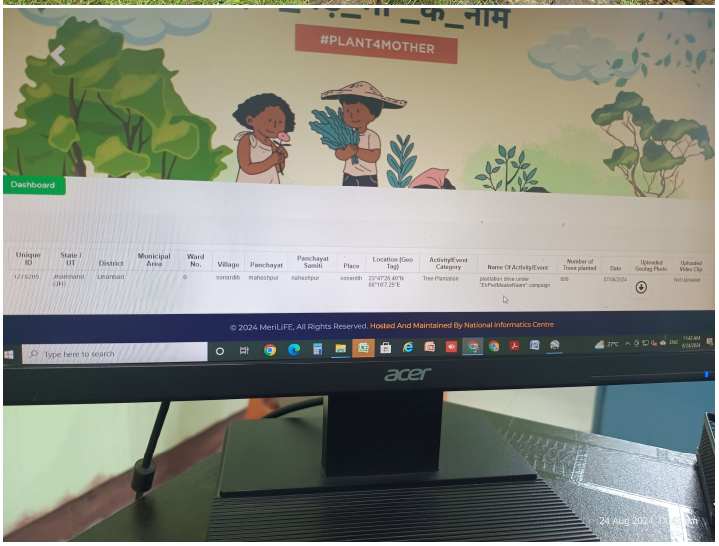

Plantation By
Shri Ram Pravesh
Kumar
Regional Officer
JSPCB, Dhanbad
Date: 07.08.2024


Plantation By
Shri Sandeep Nandi
Scientist 'B'
MoEF&CC, Ranchi
Date: 07.08.2024


ntation By
Sandeep Roy
ientist 'D'
CB, Kolkata
te: 07.08.2024


Plantation By
Shri G.C. Saha
Area General Manager
Govindpur Area, BCCL
Date: 07.08.2024




#PLANT4MOTHER
Dashboard
Unique ID
State / UT
District
Municipal Area
Ward No.
Village
Panchayat
Panchayat Samiti
Place
Location (Geo Tag)
Activity/Event Category
Name Of Activity/Event
Number of Trees planted
Date
Uploaded Geotag Photo
Uploaded Video Clip
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