



बीसीसीएल
BCCL



भारत कोकिंग कोल लिमिटेड

(कोल इण्डिया लिमिटेड की एक अनुषंगी कंपनी)

Bharat Coking Coal Limited

(A Subsidiary of Coal India Limited)

(एक विनीयन कंपनी - A Miniratna Company)

(भारत सरकार का उपक्रम - A Government of India Undertaking)

Ref. No. BCCL/GM/Ar. III/Envt./2023-24/ 63

Dated: 30.05.2023

To

The Director

Ministry of Environment, Forest & CC

Regional Office (ECZ), Bungalow No.-2

Shyamali Colony

Ranchi- 834002

Subject: Six monthly compliance report on implementation of Environmental measures for the period from Oct' 2022 to March'2023 in respect of Cluster -III groups of mines.

Ref:-EC Order No. J-11015/213/2010-IA.II (M) dated 06.02.2013

Dear Sir,

Kindly find herewith the enclosed six-monthly compliance report on implementation of Environmental measures for the period from Oct' 2022 to March'2023 in respect of Cluster -III groups of mines. BCCL.

This is for your kind information.

Encl. As above

Yours faithfully

General Manager
Govindpur Area

1. C to (Through e-mail)

1. Regional officer, JSPCB, Housing colony, Dhanbad

2. CPCB Zonal office, Kolkata

3. HoD (Env.) BCCL, Koyla Bhawan, Dhanbad

4. Area Manager (Env), Govindpur Area

पंजीकृत कार्यालय: कोयला भवन, कोयला भवन, बीसीसीएल इलाहाबाद, राँची, जम्मू 834002, भारत

Registered Office: Koyla Bhawan, Koyla Bhawan, BCCL, Township, Dhanbad, Jharkhand-826005, India

वेबसाइट: 0326-2230000-वेबसाइट: www.bclweb.in, फोन: 0326-2230000/0326-2230001

COMPLIANCE OF EC CONDITIONS: - CLUSTER-III GROUP OF MINES, BCCL

EC Letter No. J – 11015/213/2010- IA, II (M), Dated 06.02.2013

Sl. No	EC Conditions (Specific)	EC compliance status																							
	A. Specific Conditions by MOEF:	Compliance																							
i	The maximum production from the two opencast sections in the cluster shall not exceed beyond that for which environmental clearance has been granted	Being Complied. The production from two opencast sections of the cluster is Within limit for which the environmental clearance has been granted. Details of production from two opencast sections is given below: <table><tr><th rowspan="2">Mine</th><th colspan="2">EC capacity (MTY)</th><th colspan="2">Actual Production (Te)</th></tr><tr><th>Normative</th><th>Peak</th><th>FY 2021-22</th><th>FY 2022-23</th></tr><tr><td>New Akashkinaree Colliery</td><td>1.000</td><td>1.300</td><td>4,73,011</td><td>5,88,646</td></tr><tr><td>Block-IV/Kooridih Colliery</td><td>1.100</td><td>1.430</td><td>2,39,300</td><td>1,82,010</td></tr></table>					Mine	EC capacity (MTY)		Actual Production (Te)		Normative	Peak	FY 2021-22	FY 2022-23	New Akashkinaree Colliery	1.000	1.300	4,73,011	5,88,646	Block-IV/Kooridih Colliery	1.100	1.430	2,39,300	1,82,010
Mine	EC capacity (MTY)		Actual Production (Te)																						
	Normative	Peak	FY 2021-22	FY 2022-23																					
New Akashkinaree Colliery	1.000	1.300	4,73,011	5,88,646																					
Block-IV/Kooridih Colliery	1.100	1.430	2,39,300	1,82,010																					
ii	The measure to identify in the Environmental Plan for Cluster- III groups of mine and the conditions given in this environmental clearance letter shall be dovetailed to the implementation of the Jharia Action Plan.	Being Complied. Master Plan activities are dovetailed with compliance of environmental clearance conditions.																							
iii	The proponent shall prepare time-series maps of the Jharia Coalfields through NRSA to monitor and prevent fire problems in the Jharia Coalfields by Isothermal mapping /imaging and monitoring temperatures of the coal seams (whether they are close to spontaneous ignition temperatures) and based on which, areas with potential fire problems shall be identified. Measures to prevent ingress of air (Ventilation) in such areas, to prevent restart fresh/spread fires in other areas including in mines of cluster III shall be undertaken. Expertise available internationally could also be utilized for control of fire in Jharia Coalfields and for their reclamation and to further minimize time for fire and subsidence control. Isothermal mapping using thermal imaging has been got done by NRSA. Measures would be taken to prevent ingress of air (ventilation) in such areas, which may re-start fresh fires.	Being Complied. NRSC is conducting thermal Infra-Red Survey periodically. Report for 2014 and 2018 are submitted and action are being taken accordingly (Report for year 2018 is attached herewith as Annexure-I)																							

iv	Underground mining should be taken up after completion of reclamation of Opencast mine area.	Being complied. No UG operation is being done below Opencast sections of the Mines.
v	The OB material should be crushed like sand and be used for stowing in Underground mines.	At present there is no requirement of stowing in cluster III.
vi	A detailed calendar plan of production with plan for OB dumping and backfilling (for OC mines) and reclamation and final mine closure plan for each mine of cluster-III shall be drawn up and implemented. The schedule of backfilling should be clearly brought out and submit the same to MoEFCC.	Being complied. Mine closure plan as per the guidelines of Ministry of Coal has already been prepared by Central Mine planning and Design Institute, Dhanbad and approved by BCCL Board on 21.09.2013. The financial provisions required for the implementation of mine closure plan are being kept in escrow accounts. Details of amount kept in escrow account and copy of mine closure plans are attached as Annexure-II .
vii	The embankment constructed along the river boundary shall be of suitable dimensions and critical patches shall be strengthened by stone pitching on the river front side and Stabilized with plantation so as to withstand the peak water flow and prevent mine inundation.	Being Complied. Embankments have been constructed as specified in EC and stone pitching has been done. Photographs of the stone pitching are attached as Annexure-III .
viii	The rejects of washeries in Cluster –III should be sent to FBC based plant.	Coal washery does not exist in cluster-III at present.
ix	No mining shall be undertaken where underground fires continue. Measure shall be taken to prevent/check such fire including in old OB dump areas where the fire could start due to presence of coal/shale with sufficient carbon content.	Being complied. Mining is being done as per the guidelines and permissions of Directorate General of Mines Safety (DGMS).
x	There shall be no external OB dumps. OB produce from the whole cluster will be 80Mm ³ . OB from 2 OCP in mixed mines shall be backfilled. At the end of the mining there shall be no void and The entire mined out area shall be re-vegetated. Areas where opencast mining was carried out and completed shall be reclaimed immediately thereafter. It was observed that most of the OBs are not reclaimed and abandoned. The proponent should dump all the OB material in abandoned mines.	Being Complied. Actions are being taken for regular backfilling of OB generated and stabilized OB dumps have been changed into ecological restoration sites (Photographs of biological reclaimed site are attached as Annexure-IV). Year wise data of OB generated and backfilling is attached as Annexure-V .
xi	Number of voids present in cluster – III at the end of mining should be backfilled up to ground level and no void should be left at the end of mining.	Includes Post mining condition. Being complied.
xii	A detailed calendar plan Of production with the plan for OB dumping and backfilling (for O/C mines) and reclamation and final mine closure plan for each mine of cluster-III shall be drawn up and implemented. The schedule of Backfilling should be clearly bought out and submit the same to MoEFCC.	Being complied. Mine closure plan as per the guidelines of Ministry of Coal has already been prepared by Central Mine planning and Design Institute, Dhanbad and approved by BCCL Board on 21.09.2013. The financial provisions required for the implementation of mine closure plan

		are being kept in escrow accounts. Details of amount kept in escrow account and copy of mine closure plans are attached as Annexure-II . Year wise data of OB generated and backfilling is attached as Annexure-V . Details of proposed coal production, OB production, and plantation for FY 2023-24 are attached as Annexure-VI .
xiii	Mining shall be carried out as per statute from the streams/nalas flowing within the lease and maintaining a safe distance from the Nalas flowing along the lease boundary. A safety barrier of a minimum 60m width shall be maintained along the nalas/water bodies. The small water bodies in OC shall be protected to the extent feasible and the embankment proposed along water body shall be strengthened with stone pitching.	Being Complied. Embankments have been constructed as specified in EC and stone pitching has been done. Photographs of the stone pitching are attached as Annexure-III .
xiv	Active OB dumps near water bodies and rivers should be rehandled for backfilling abandoned mine voids. However, those which have been biologically reclaimed need not be disturbed.	Being Complied. Old OB dump near water bodies is stabilized.
xv	Thick green belt shall be developed along undisturbed areas, mine boundary and in mine reclamation. A total area of 854.72 ha shall be reclaimed and afforested.	Includes post mining requirement and it shall be complied . Yearly plantation is being done for development of green belts as per EC. Apart from this avenue/block plantation is being done at spaces available. (Photographs of biological reclaimed site are attached as Annexure-IV). Details of year wise plantation up to FY 2022-23 and proposed plantation in FY 2023-24 attached as Annexure-VII
xvi	Details of transportation, CSR, R&R and implementation of environmental action plan for the clusters-III should be brought out in a booklet form within a year and regularly updated.	Being Complied. The booklet is maintained at cluster level.
xvi i	Specific Mitigative measures identified for the Jharia Coalfields in the Environmental Action Plan prepared for Dhanbad as a critically polluted area and relevant for Cluster III shall be implemented.	Being Complied. Dhanbad Action Plan has been prepared in consultation with Jharkhand Pollution Control Board for entire BCCL and not cluster wise. It is being implemented comprehensively for all the mines of BCCL. Some of the salient actions of this cluster are as under: 1. Construction of pucca road/WBM road for coal transportation passing through public transportation routes. 2. Construction of water reservoir for mine water utilization 3. OB dumps biological reclamation and avenue plantation. 4. Transportation of coal on public roads is being done in tarpaulin covered vehicles.

		5. Regular water sprinkling in dust prone areas. 6. Installation of trolley mounted fog cannons at railway siding. (Photographs of ponds, roads constructed within colliery, avenue plantation are attached as Annexure-VIII).
xvi ii	The locations of monitoring stations in the Jharia Coalfields should be finalized in consultation with the Jharkhand State Pollution Control Board. The Committee stated that smoke/dust emission vary from source to source (fuel wood, coal, fly ash from TPPs, silica from natural dust, etc.) and a Poll Mineralogical composition study should be undertaken on the composition of the suspended particulate matter (PM₁₀ and PM_{2.5}) in Jharia Coalfields and also quantified. These studies would help ascertain source and extent of the air pollution, based on which appropriate Mitigative measures could be taken.	Being Complied. The locations of monitoring stations are approved by Jharkhand Pollution Control Board. BCCL has awarded the work order for the Project "Source apportionment of ambient air particulate matter in Jharia coalfields region, Jharkhand" to CSIR-NEERI, Nagpur vide Ref no. BCCL/AGM/Envr./SOURCE APPORTIONMENT(MoU)/NEERI/2018/Dated 12.05.2018.NEERI, Nagpur and had submitted the final report on the Source apportionment study and the mineralogical composition study in the Jharia Coalfields on 27.04.2022 (report is attached as Annexure- IX).
xix	The Plan for conveyor-cum-rail for Cluster-III should be dovetailed with Jharia Action Plan. The Committee desired that road transportation of coal during Phase-I should be by mechanically covered trucks, which should be introduced at the earliest. Coal dispatch shall be diverted from the present rail sidings to Rapid Loading System (RLS) soon after the construction and commissioning of the RLS at Maheshpur is completed. The railway siding order issued and same would come in 3 years. The details of same should be provided to ministry. The mode of transportation of coal by truck till Railway Siding should be by mechanically covered trucks.	Being Complied. At present transportation on public roads is being done by covered vehicle with a tarpaulin cover. The feasibility of mechanically covered trucks is being studied. Construction of Rapid Loading System at Maheshpur is completed and will be operational after railway connectivity. Construction of Railway Siding is being done by M/s RITES Ltd.
xx	3756 nos. of PAF's should be rehabilitated at cost of Rs 27012.66 Lakhs as per the approved Jharia Action Plan.	It is being followed as per the approved Jharia action plan.
xxi	Regular monitoring of groundwater level and quality of the study area shall be carried out by establishing a network of existing wells and construction of new piezometers. The monitoring for quantity shall be done four times a year in pre-monsoon (May), monsoon (August), post-monsoon (November) and winter (January) seasons and for quality including Arsenic and Fluoride during the month of May. Data thus collected shall be submitted to the Ministry of Environment & Forest and to the Central Pollution Control Board/SPCB quarterly within one month of monitoring. Rainwater harvesting measures shall be undertaken in case monitoring of water table indicates a declining trend.	Being Complied. The work of monitoring of ambient environment including ground water monitoring is being done by Central Mine Planning and Design institute (CMPDI). The Location and design of Piezometers to be installed have been finalized by CMPDI. Piezometer Installation: Construction for Piezometric well has been completed. Rainwater harvesting structures have been constructed at CISF Campus New Akashkinaree Colliery. (Ground Water report with photographs of rain water harvesting structure is attached as Annexure-X)
xxi	Regular monitoring of subsidence movement on the surface over and around	Shall be complied. At present there is no depillaring activity in Cluster-III.

i	the working area and 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 movement, appropriate effective corrective measures shall be taken to avoid loss of life and material. Cracks shall be effectively plugged with ballast and clayey soil/suitable material.	
xxi ii	Sufficient coal pillars shall be left un-extracted around the air shaft (within the Subsidence influence area) to protect from any damage from subsidence, if any.	Being Complied. Sufficient coal pillars have been left around air shafts as per the statutes and DGMS guidelines.
xxi v	High root density tree species shall be selected and planted over areas likely to be affected by subsidence.	It is being complied .
xx v	Depression due to subsidence resulting in water accumulating within the low lying areas shall be filled up or drained out by cutting drains.	It shall be complied . At present there is no depillaring activity in Cluster-III.
xx vi	Solid barriers shall be left below the roads falling within the blocks to avoid any damage to the roads.	It is being followed. Sufficient barriers are left for saving the surface Installation and infra structures as per the statute and DGMS guidelines.
xx vii	No depillaring operation shall be carried out below the township/colony.	It is being followed.
xx viii	A detailed CSR Action Plan shall be prepared for Cluster III group of mines. Specific activities shall be identified for CSR for the budget of Rs 139 Lakhs per year@ Rs 5/T of coal provided for CSR for 2012-2013 and Rs. 5/T of coal as recurring expenditure. The 491.91ha of area within Cluster III ML existing as waste land and not being acquired shall be put to productive use under CSR and developed with fruit bearing and other useful species for the local communities. Third party evaluation shall be got carried out regularly for the proper implementation of activities undertaken in the project area under CSR. Issue raised in the Public Hearing shall also be integrated with activities being taken up under CSR. The details of CSR undertaken along with budgetary provisions for the village-wise various activities and expenditure thereon shall be uploaded on the company website every year. The company must give priority to capacity building both within the company and to the local youth, who are motivated to carry out the work in future. The gap/space available between the entire mine area should be suitably planted with native species. Plantation should also be made in vacant area and along the road side so as to reduce dust pollution.	Being Complied. BCCL is implementing CSR activities. A separate CSR/Welfare committee has been formed at area level that will look after the works being executed under CSR. CSR dept. is established at the Headquarter level and area level for Executing the CSR Activities. All welfare/ CSR activities are also uploaded in Company web site https://www.bcclweb.in/?page_id=13446 . TISS has conducted survey to frame CSR policy for better implementation and monitoring of the CSR activities. CSR activities have not been dealt at cluster level. However, expenditure was allotted and made at corporate level, i.e. M/s BCCL level and cluster III is contributor for the same. Attached as Annexure-XI

xxi x	Central recreation park with herbal garden should be developed for use of all In habitants.	It is being complied . Herbal garden has been developed in cluster-III at Office of the General Manager. Recreational parks are being developed at Sinidih Water Treatment Plant, New Akashkinaree Colliery Biological reclamation site, and Maheshpur Colliery for use of local people.
xx x	The mine water should be treated properly before supply to the villager.	Being Complied . Mine water is being supplied to nearby villages for drinking and other purpose after being filtered through filter plants. Details of beneficiaries are attached as Annexure-XII .
xx xi	Details of transportation, CSR, R&R and implementation of environmental action plan for each of the clusters-III should be brought out in a booklet form Within a year and regularly updated.	Complied . CSR Booklet is being maintained at Cluster level.
xx xii	Central recreation park with herbal garden should be developed for use of all Inhabitants.	It is being complied . Herbal garden has been developed in cluster-III at Office of the General Manager. Recreational parks are being developed at Sinidih Water Treatment Plant, New Akashkinaree Colliery Biological reclamation site, and Maheshpur Colliery for use of local people.
xx xiii	The mine water should be treated properly before supply to the villager.	Being Complied . Mine water is being supplied to nearby villages for drinking and other purpose after being filtered through filter plants. Details of beneficiaries are attached as Annexure-XII .
xx xiv	Details of transportation, CSR, R&R and implementation of environmental action plan for each of the clusters-III should be brought out in a booklet form within a year and regularly updated.	Being Complied . CSR Booklet is being maintained at Cluster level.
xx xv	Mine discharge water shall be treated to meet standards prescribed before discharge into natural water courses/agriculture. The quality of the water discharged shall be monitored at the outlet points and proper records maintained thereof and uploaded regularly on the company website.	Being Complied . Monitoring is being done by Central Mine Planning and Design institute (CMPDIL). The quality of water is within prescribed standards. Monitoring reports of Air (including heavy metal analysis), Water (drinking, Surface, discharge) and Noise is attached as Annexure-XIII .
xx xvi	No groundwater shall be used for the mining activities. Additional water required, if any, shall be met from mine water or by recycling/reuse of the water from the existing activities and from rainwater harvesting measures. The project authorities shall meet water requirement of nearby village(s) in case the village wells go dry due to dewatering of mine.	Being Complied . No ground water is being utilized for the purposes of industrial use of the water. Mine water is being supplied to nearby villages for drinking and other purpose after being filtered through filter plants. Details of beneficiaries are attached as Annexure-XII .
xx xvi i	The void shall be converted into a water reservoir of a maximum depth of 15-20 m and shall be gently sloped and the upper benches of the reservoir shall be stabilized with plantation and the periphery of the reservoir fenced. The	Post mining requirement. Continuous process of the backfilling has been Adopted. A part of the void will be converted into the water body as specified in EC.

	abandoned pits and voids should be backfilled with OB and reclaimed with plantation and or may be used for pisciculture.	
xx xvi ii	Regular monitoring of groundwater level and quality of the study area shall be carried out by establishing a network of existing wells and construction of new piezometers. The monitoring for quantity shall be done four times a year in pre-monsoon (May), monsoon (August), post-monsoon (November) and winter (January) seasons and for quality including Arsenic and Fluoride during the month of May. Data thus collected shall be submitted to the Ministry of Environment & Forest and to the Central Pollution Control Board/SPCB quarterly within one month of monitoring. Rainwater harvesting measures shall be undertaken in case monitoring of water table indicates a declining trend.	Being Complied. The work of monitoring of ambient environment including ground water monitoring is being done by Central Mine Planning and Design institute (CMPDI). The Location and design of Piezometers to be installed have been finalized by CMPDI. Piezometer Installation: Construction for Piezometric well has been completed. Rainwater harvesting structures have been constructed at CISF Campus New Akashkinaree Colliery. (Ground Water report with photographs of rain water harvesting structure is attached as Annexure-X)
xx xix	ETP shall also be provided for workshop, and CHP, if any. Effluents shall be treated to conform to prescribe standards in case discharge into the natural water course.	It is being complied. Oil & grease trap has been provided at HEMM Workshop.
xi	The location of monitoring stations in the Jharia coalfield should be finalized in consultation with Jharkhand State Pollution Control Board.	It is being complied.
xli	For monitoring land use pattern and for post mining land use, a time series of land use maps, based on satellite imagery (on a scale of 1: 5000) of the core zone and buffer zone, from the start of the project until end of mine life shall be prepared once in 3 years (for any one particular season which is consistent in the time series), and the report submitted to MOEF and its Regional office at Bhubaneswar.	Being Complied. 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. Land use map report for cluster-III is attached as Annexure-XIV .
xlii	A Final Mine Closure Plan along with details of Corpus Fund shall be submitted to the Ministry of Environment & Forests five year before mine closure for approval. Habitat Restoration Plan of the mine area shall be carried out using a mix of native species found in the original ecosystem, which were conserved in-situ and ex-situ in an identified area within the lease for reintroduction in the mine during mine reclamation and at the post mining stage for habitat restoration.	Being complied. Mine closure plan as per the guidelines of Ministry of Coal has already been prepared by Central Mine planning and Design Institute, Dhanbad and approved by BCCL Board on 21.09.2013. The financial provisions required for the implementation of mine closure plan are being kept in accounts. Details of amount kept in escrow account and copy of mine closure plans are attached as Annexure-II .
xli v	A separate management structure for implementing environment policy and socio-economic issues and the capacity building required in this regard.	Being Complied. Environment Engineers are provided at Mine and Area level. 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. Community Development executives support capacity building.															
xlv	Corporate Environment Responsibility:	Being Complied.															
	a) The Company shall have a well laid down Environment Policy approved by the Board of Directors.	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. (http://www.bcclweb.in/environment/CEP_04.11.2019.pdf)															
	b) The Environment Policy shall prescribe for standard operating process/procedures to bring into focus any infringements/deviation/violation of the environmental or forest norms/conditions.	Complied.															
	c) The hierarchical system or Administrative Order of the company to deal with environmental issues and for ensuring compliance with the environmental clearance conditions shall be furnished.	A hierarchical system of the company to deal with environmental issues from corporate level to mine level already exists.															
	d) To have proper checks and balances, the company shall have a well laid down system of reporting of non-compliances/violations of environmental norms to the Board of Directors of the company and/or shareholders or Stakeholders at large.	Environment Management cell has been constituted at Area level with GM as Chairman. Internal Monitoring Mechanism is in place.															
B	EC Conditions (General):																
i	No change in mining technology and scope of working shall be made without prior approval of the Ministry of Environment and Forests.	Being Complied.															
ii	No change in the calendar plan of production for quantum of mineral coal shall be made.	Being Complied. Production is being done well within the peak production capacity as per EC. Details of production from cluster-III is given below: <table><tr><th colspan="2">EC capacity (MTY)</th><th colspan="3">Actual Production (MTe)</th></tr><tr><th>Normative</th><th>Peak</th><th>FY 2020-21</th><th>FY 2021-22</th><th>FY 2022-23</th></tr><tr><td>2.769</td><td>3.600</td><td>1.205</td><td>0.7861</td><td>0.850105</td></tr></table>	EC capacity (MTY)		Actual Production (MTe)			Normative	Peak	FY 2020-21	FY 2021-22	FY 2022-23	2.769	3.600	1.205	0.7861	0.850105
EC capacity (MTY)		Actual Production (MTe)															
Normative	Peak	FY 2020-21	FY 2021-22	FY 2022-23													
2.769	3.600	1.205	0.7861	0.850105													
iii	Four ambient air quality monitoring stations shall be established	Being Complied. Location of Four ambient air quality monitoring stations for															

	in the core zone as well as in the buffer zone for PM ₁₀ , PM _{2.5} , SO ₂ and NO _x monitoring. Location of the stations shall be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets in consultation with the State Pollution Control Board. Monitoring of heavy metals such as Hg, As, Ni, Cd, Cr, etc. carried out at least once in six months.	the cluster is approved by Jharkhand pollution control Board. The work for monitoring of ambient environment is being done by Central Mine Planning and Design institute (CMPDIL). Monitoring reports of Air (including heavy metal analysis), Water (drinking, surface) and Noise is attached as Annexure-XIII .						
iv	Data on ambient air quality (PM ₁₀ , PM _{2.5} , SO ₂ and NO _x) and heavy metals such as Hg, As, Ni, Cd, Cr and other monitoring data shall be regularly submitted to the Ministry including its Regional Office at Bhubaneswar and to the State Pollution Control Board and the Central Pollution Control Board once in six months. Random verification of samples through analysis from independent laboratories recognized under the EPA rules, 1986 shall be furnished as part of compliance report.	Being Complied. The work for monitoring of ambient environment is being done by Central Mine Planning and Design institute (CMPDIL). Monitoring reports of Air (including heavy metal analysis), Water (drinking, surface) and Noise is attached as Annexure-XIII . Random verification has been completed by IIT(ISM) Dhanbad.						
v	Adequate measures shall be taken for control of noise levels below 85 dBA in the work environment. Workers engaged in blasting and drilling operations, operation of HEMM, etc shall be provided with ear plugs/muffs.	Being Complied. Details of ear plugs/muffs and dust masks distributed is as below: <table border="1"> <thead> <tr> <th>Year</th><th>Dust masks (nos.)</th><th>Ear plugs (nos.)</th></tr> </thead> <tbody> <tr> <td>2022-23 (Up to 31.03.2023)</td><td>55</td><td>45</td></tr> </tbody> </table>	Year	Dust masks (nos.)	Ear plugs (nos.)	2022-23 (Up to 31.03.2023)	55	45
Year	Dust masks (nos.)	Ear plugs (nos.)						
2022-23 (Up to 31.03.2023)	55	45						
vi	Industrial wastewater (workshop and wastewater from the mine) shall be properly collected, treated so as to conform to the standards prescribed under GSR 422 (E) dated 19 th May 1993 and 31 st December 1993 or as amended from time to time before discharge. Oil and grease trap shall be installed before discharge of workshop effluents.	Being Complied. Discharge of water confirms to applicable standards. Oil & grease trap exists at Sinidih workshop and (Water quality report is attached as Annexure-XIII).						
vii	Vehicular emissions shall be kept under control and regularly monitored. Vehicles used for transporting the mineral shall be covered with tarpaulins and optimally loaded.	Being Complied. Regular maintenance of vehicles is being done. Vehicles with valid Pollution under control certificates are being used for coal transportation. Covered transportation is in practice.						
viii	Monitoring of environmental quality parameters shall be carried out through establishment of adequate number and type of pollution monitoring and analysis equipment in consultation with the State Pollution Control Board and data got analyzed through a laboratory recognized under EPA Rules, 1986.	Being Complied. The locations of monitoring stations are approved by Jharkhand Pollution Control Board. Monitoring is being done by CMPDI. Monitoring reports of Air (including heavy metal analysis), Water (drinking, surface) and Noise is attached as Annexure-XIII .						
ix	Personnel working in dusty areas shall wear protective respiratory devices and they shall also be provided with adequate training and information on safety	Being Complied. A separate full-fledged Human Resource Development Department Is conducting regular training programme on these issues. Apart						

	in the core zone as well as in the buffer zone for PM ₁₀ , PM _{2.5} , SO ₂ and NO _x monitoring. Location of the stations shall be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets in consultation with the State Pollution Control Board. Monitoring of heavy metals such as Hg, As, Ni, Cd, Cr, etc. carried out at least once in six months.	the cluster is approved by Jharkhand pollution control Board. The work for monitoring of ambient environment is being done by Central Mine Planning and Design institute (CMPDIL). Monitoring reports of Air (including heavy metal analysis), Water (drinking, surface) and Noise is attached as Annexure-XIII .						
iv	Data on ambient air quality (PM ₁₀ , PM _{2.5} , SO ₂ and NO _x) and heavy metals such as Hg, As, Ni, Cd, Cr and other monitoring data shall be regularly submitted to the Ministry including its Regional Office at Bhubaneswar and to the State Pollution Control Board and the Central Pollution Control Board once in six months. Random verification of samples through analysis from independent laboratories recognized under the EPA rules, 1986 shall be furnished as part of compliance report.	Being Complied. The work for monitoring of ambient environment is being done by Central Mine Planning and Design institute (CMPDIL). Monitoring reports of Air (including heavy metal analysis), Water (drinking, surface) and Noise is attached as Annexure-XIII . Random verification has been completed by IIT(ISM) Dhanbad.						
v	Adequate measures shall be taken for control of noise levels below 85 dBA in the work environment. Workers engaged in blasting and drilling operations, operation of HEMM, etc shall be provided with ear plugs/muffs.	Being Complied. Details of ear plugs/muffs and dust masks distributed is as below: <table border="1"> <thead> <tr> <th>Year</th><th>Dust masks (nos.)</th><th>Ear plugs (nos.)</th></tr> </thead> <tbody> <tr> <td>2021-22 (Up to 31.03.2022)</td><td>500</td><td>10</td></tr> </tbody> </table>	Year	Dust masks (nos.)	Ear plugs (nos.)	2021-22 (Up to 31.03.2022)	500	10
Year	Dust masks (nos.)	Ear plugs (nos.)						
2021-22 (Up to 31.03.2022)	500	10						
vi	Industrial wastewater (workshop and wastewater from the mine) shall be properly collected, treated so as to conform to the standards prescribed under GSR 422 (E) dated 19 th May 1993 and 31 st December 1993 or as amended from time to time before discharge. Oil and grease trap shall be installed before discharge of workshop effluents.	Being Complied. Discharge of water confirms to applicable standards. Oil & grease trap exists at Sinidih workshop and (Water quality report is attached as Annexure-XIII).						
vii	Vehicular emissions shall be kept under control and regularly monitored. Vehicles used for transporting the mineral shall be covered with tarpaulins and optimally loaded.	Being Complied. Regular maintenance of vehicles is being done. Vehicles with valid Pollution under control certificates are being used for coal transportation. Covered transportation is in practice.						
viii	Monitoring of environmental quality parameters shall be carried out through establishment of adequate number and type of pollution monitoring and analysis equipment in consultation with the State Pollution Control Board and data got analyzed through a laboratory recognized under EPA Rules, 1986.	Being Complied. The locations of monitoring stations are approved by Jharkhand Pollution Control Board. Monitoring is being done by CMPDI. Monitoring reports of Air (including heavy metal analysis), Water (drinking, surface) and Noise is attached as Annexure-XIII .						
ix	Personnel working in dusty areas shall wear protective respiratory devices and they shall also be provided with adequate training and information on safety	Being Complied. A separate full-fledged Human Resource Development Department Is conducting regular training programme on these issues. Apart						

	and health aspects.	from this Vocational Training Centers 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. Details of training conducted at VTC for FY 2022-23 (up to 31.03.2023) are given below: <table><tr><td></td><td></td></tr><tr><td>Type of Training</td><td>Number of Persons</td></tr><tr><td>Basic</td><td>07</td></tr><tr><td>Refresher</td><td>602</td></tr><tr><td>Safety Committee Recommendation</td><td>293</td></tr><tr><td>MVT training</td><td>164</td></tr><tr><td>Total</td><td>1066</td></tr></table> Details of protective devices distributed (Up to 31.03.2023) to workers engaged in mining activities are as below: <table><tr><td>Year</td><td>Dust masks</td><td>Ear plugs</td></tr><tr><td>FY 2022-23</td><td>55</td><td>45</td></tr></table>			Type of Training	Number of Persons	Basic	07	Refresher	602	Safety Committee Recommendation	293	MVT training	164	Total	1066	Year	Dust masks	Ear plugs	FY 2022-23	55	45
Type of Training	Number of Persons																					
Basic	07																					
Refresher	602																					
Safety Committee Recommendation	293																					
MVT training	164																					
Total	1066																					
Year	Dust masks	Ear plugs																				
FY 2022-23	55	45																				
x	Occupational health surveillance programme of the workers shall be undertaken periodically to observe any contractions due to exposure to dust and to take corrective measures, if needed and records maintained thereof. The quality of environment due to outsourcing and the health and safety issues of the outsourced manpower should be addressed by the company while outsourcing.	Being Complied. 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 of PME conducted for FY 2022-23 upto 31.03.2023 are: <table><tr><td>Name of Colliery</td><td>PME's conducted</td></tr><tr><td>New Akashkinaree Colliery</td><td>400</td></tr><tr><td>Block-IV/Kooridih Colliery</td><td>375</td></tr><tr><td>Maheshpur Colliery</td><td>175</td></tr><tr><td>Jogidih Colliery</td><td>125</td></tr></table>	Name of Colliery	PME's conducted	New Akashkinaree Colliery	400	Block-IV/Kooridih Colliery	375	Maheshpur Colliery	175	Jogidih Colliery	125										
Name of Colliery	PME's conducted																					
New Akashkinaree Colliery	400																					
Block-IV/Kooridih Colliery	375																					
Maheshpur Colliery	175																					
Jogidih Colliery	125																					
xi	A separate environmental management cell with suitable qualified personnel shall be set up under the control of a Senior Executive, who will report directly to the Head of the company.	Being Complied. Environment Engineer provided at Mine and Area level. 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.
xii	The funds earmarked for environmental protection measures shall be kept in separate account and shall not be diverted for other purpose. Year-wise expenditure shall be reported to this Ministry and its Regional Office at Bhubaneswar.	Being Complied. A separate fund under the environmental protection measures has already been allocated. Expenditure details as per EIA/EMP for FY 2022-23 are enclosed as Annexure-XV
xiii	The Project authorities shall advertise at least in two local newspapers widely circulated around the project, one of which shall be in the vernacular language of the locality concerned within seven days of the clearance letter informing that the project has been accorded environmental clearance and a copy of the clearance letter is available with the State Pollution control Board and may also be seen at the website of the ministry of Environment & Forests at http://envfor.nic.in .	Advertised timely, Complied. Advertisements published and EC letter circulated to concerned panchayats have been attached as Annexure-XVI .
xiv	A copy of the environmental clearance letter shall be marked to concern Panchayat/Zila Parishad, Municipal Corporation or Urban local body and local NGO, if any, from whom any suggestion/representation has been received while processing the proposal. A copy of the clearance letter shall also be displayed on company's website.	Complied. EC on receipt circulated to all concerned authorities (EC letter circulated to concerned panchayats have been attached as Annexure-XVI).
xv	A copy of the environmental clearance letter shall be shall also be displayed on the website of the concerned State Pollution Control Board. The EC letter shall also be displayed at the Regional Office, District Industry Sector and Collector's Office/Tehsildar's Office for 30 days.	Complied.
xvi	The clearance letter shall be uploaded on the company's website. The compliance status of the stipulated environmental clearance conditions shall also be uploaded by the project authorities on their website and updated at least once every six months so as to bring the same in public domain. The monitoring data of environmental quality parameter (air, water, noise and soil) and critical pollutant such as PM ₁₀ , PM _{2.5} , SO ₂ and NO _x (ambient) and critical sectoral parameters shall also be displayed at the entrance of the project premises and mine office and in corporate office and on company's website.	Complied. Environmental Clearance and Six monthly compliance of Environmental Clearance along with monitoring reports are uploaded on BCCL website.
xvi i	The project proponent shall submit six monthly compliance reports on status of compliance of the stipulated environmental clearance conditions (both in hard copy and in e-mail) to the respective Regional Office of the Ministry, respective Zonal Office s of CPCB and the SPCB.	Being complied.

xvi ii	The Regional Office of this Ministry located at Bhubaneswar shall monitor compliance of the stipulated conditions. The Project authorities shall extend full cooperation to the office(s) of the Regional Office by furnishing the requisite data/ information/monitoring reports.	Shall be complied .
xix	The Environmental statement for each financial year ending 31 March in Form –V is mandated to be submitted by the project proponent for the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall also be uploaded on the company's website along with the status of compliance of EC conditions and shall be sent to the respective Regional Offices of the MoEFCC by E-mail	Being Complied. Environmental Statement is regularly submitted.
C	EC Conditions (Other):	
i	The Ministry or any other competent authority may stipulate any further condition for environmental protection.	Conditions of CTO are being complied .
ii	Failure to comply with any of the conditions mentioned above may result in withdrawal of this clearance and attract the provisions of the Environment (Protection) Act, 1986.	All condition complied to avoid this condition.
iii	The above conditions will be enforced <i>inter-alia</i> , 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 and the Public Liability Insurance Act, 1991 along with their amendments and Rules. The proponent shall ensure to undertake and provide for the costs incurred for taking up remedial measures in case of soil contamination, contamination of groundwater and surface water, and occupational and other diseases due to the mining operations.	It is being complied . Conditions of CTO are being complied . The storage of material is below threshold attracting Public Liability Insurance Act, 1991.
iv	The Environmental Clearance is subject to the outcome of the Writ Petition filed by M/S Bharat Coking Coal Limited (BCCL) in response to the closure orders issued by the Jharkhand State Pollution Control Board which is pending in the Jharkhand High Court.	Agree.

**DELINEATION OF SURFACE COAL FIRE AND
LAND SUBSIDENCE IN THE JHARIA
COALFIELD, DHANBAD, JHARKHAND FROM
REMOTE SENSING DATA**

**GEOSCIENCES GROUP
REMOTE SENSING APPLICATIONS AREA
NATIONAL REMOTE SENSING CENTRE
INDIAN SPACE RESEARCH ORGANISATION
DEPT. OF SPACE, GOVT. OF INDIA
HYDERABAD-500 037**



JANUARY, 2018

**DELINEATION OF SURFACE COAL FIRE AND
LAND SUBSIDENCE IN THE JHARIA COALFIELD,
DHANBAD, JHARKHAND FROM REMOTE
SENSING DATA**

Report for

BHARAT COKING COAL LIMITED (BCCL)

(A SUBSIDIARY OF COAL INDIA LTD.)

**ENVIRONMENT DEPARTMENT, KOYLA BHAWAN
KOYLA NAGAR, DHANBAD – 826 005, JHARKHAND**

GEOSCIENCES GROUP

REMOTE SENSING APPLICATIONS AREA

NATIONAL REMOTE SENSING CENTRE

INDIAN SPACE RESEARCH ORGANISATION

DEPT. OF SPACE, GOVT. OF INDIA

HYDERABAD-500 037

JANUARY, 2018



1. **Dr. K VINOD KUMAR**, Group Head, Geosciences Group
Project formulation and coordination
2. **Dr. Tapas R. Martha**, Scientist 'SF'
Field survey and report preparation
3. **Shri Priyom Roy**, Scientist 'SD'
Image processing, interpretation, field survey, maps and report preparation

1. **Dr. K VINOD KUMAR**, Group Head, Geosciences Group
Project formulation and coordination
2. **Dr. Tapas R. Martha**, Scientist 'SF'
Field survey and report preparation
3. **Shri Priyom Roy**, Scientist 'SD'
Image processing, interpretation, field survey, maps and report preparation

CONTENTS

ACKNOWLEDGEMENTS	i
EXECUTIVE SUMMARY	ii
LIST OF FIGURES AND TABLES	iii
CHAPTER – I INTRODUCTION	1
1.1 BACKGROUND	2
1.2 OBJECTIVES	2
1.3 STUDY AREA	3
CHAPTER – II GENERAL DESCRIPTION OF THE STUDY AREA	4
2.1 LOCATION AND ACCESSIBILITY	4
2.2 PHYSIOGRAPHY, DRAINAGE AND CLIMATE	4
2.3 GENERAL GEOLOGY	4
CHAPTER – III DATA REQUIREMENTS	7
3.1 REMOTE SENSING DATA	7
3.2 ANCILLARY DATA	7
CHAPTER – IV REMOTE SENSING DATA ANALYSIS	8
4.1 METHODOLOGY	8
4.1.1 PROCESSING OF LANDSAT 8 DATA	8
4.1.2 THRESHOLDING OF RADIANT TEMPERATURE IMAGE	9
4.2 METHODOLOGY FOR SUBSIDENCE DETECTION	12
4.2.1 PROCESSING OF ALOS-PALSAR-2 DATA	12
CHAPTER – V FIELDWORK	17
CHAPTER – VI POST FIELD WORK ANALYSIS	19
CHAPTER – VII DISCUSSIONS AND CONCLUSIONS	20
7.1 DISCUSSION	20
7.2 CONCLUSIONS	22
CHAPTER – VIII LIMITATIONS	24
REFERENCES	26
Annexure – I	27
Annexure - II	29
Annexure - III	31
Annexure - IV	34

ACKNOWLEDGEMENTS

The project team is grateful to Dr. Y.V.N. Krishnamurthy, Director, NRSC, for his support at various stages during execution of this project. We are extremely grateful to Dr. P.V.N. Rao, Deputy Director (RSAA), NRSC for his overall guidance and encouragement. We thank Shri D. Gangopadhyay (Director, P&P), BCCL, for this project initiative and for providing Geosciences group, NRSC, the opportunity to carry out the task. We are thankful to Shri A. K. Singh (GM, I/C), BCCL for taking keen interest in the project work and for the support during our fieldwork. We also thank Shri Dipankar Maity, Surveyor (Mining) and Shri Mithilesh Kumar, Sr. Manager (Mining) for their support and fruitful discussion during the fieldwork. The support of all the BCCL officials in the various collieries visited during the course of the ground truth verification is duly acknowledged.

EXECUTIVE SUMMARY

Coal fire is a serious problem in Jharia coal field, where high ranking coals are gradually burnt due to these fires. The combined effect of surface and sub-surface fires and mining related subsidence has endangered the environmental stability of Jharia coal field. Coupled with the ecological changes instigated by open cast mining, the landscape in and around Jharia have changed drastically over the years. In the present study, delineation of coal fire and mining related land subsidence have been addressed. Thermal band of Landsat-8 (100m resolution) have been used to demarcate the coal mine fire areas from non fire areas. For this study, Landsat-8 data of May, 2017 have been used. The band 10 (10.60-11.19 μm) of Landsat-8 data is used to derive the relative radiant temperature. Further ALOS-PALSAR 2, L band microwave data has been used to delineate zone of probable land subsidence (using differential interferometry) due to mining. The study reflects that, compared to 2012, the eastern flanks (Lodna and Tisra) show a larger fire area. The western flank (Nadkhurkee and Shatabdi) and the northern flank (Katras and Gaslitand) show isolated fire pockets in active mines as well as OB dumps. Among all the colliery areas, Kusunda and Lodna area is most affected by coal mine fire. The current fire area mapped is 3.28 sq.km. Apart from this, five distinctive areas of land subsidence have been identified using interferometric method. These are primarily caused by older or active underground mining. The Moonidih Project is most affected by subsidence. The coal mine fire and subsidence areas are further verified on the ground. The final coal mine fire and subsidence map of Jharia coal field is prepared by using remote sensing data analysis with field validation.

LIST OF FIGURES AND TABLES

- Figure 1 : Study area map of Jharia Coalfield, Jharkhand
- Figure 2 : Geological map of Jharia coal field, Dhanbad, Jharkhand (published by CMPDIL)
- Figure 3 : False colour composite image of Jharia Coalfield (VNIR 3N,2,1) , with subset blocks (in red) to obtain temperature values (from radiant temperature image) within the Barakar formation across the Jharia coalfield.
- Figure 4 : Maximum temperature plotted against mean temperature for various locations; cluster separation observed around 39 °C (marked with arrow)
- Figure 5 : Coal mine fire map (May, 2017) of Jharia coal field, Dhanbad. The fire areas shown in this map have been verified in the field as per field points in figure 13.
- Figure 6 : DInSAR acquisition scheme
- Figure 7 : Work flow diagram for generating land subsidence map using DInSAR technique
- Figure 8 : ALOS-PALSAR - 2 Master-Slave pairs for short and long temporal base line processing
- Figure 9 : Fringe patterns generated from short baseline processing (e.g. Master: Oct, 16, Slave: Feb, 17)
- Figure 10 : Fringe patterns generated from long baseline processing (e.g. Master: Oct, 15, Slave: Feb, 17)
- Figure 11 : Subsidence map of Jharia coal field, Dhanbad
- Figure 12 : Total fire area statistics
- Figure 13 : Field data points for coal fire verification
- Figure 14 : Field data points for subsidence verification

Field Photographs

- Figure 15 : Fume cracks in Lodna-Tisra Area. (point 39 in figure 13 and table 4)
- Figure 16 : Burnt area near OB dump in Lodna area (point 41 in figure 13 and table 4).

- Figure 17 : Coalfries in active seams in Kusunda (point 23 in figure 13 and table 4)
- Figure 18 : Sagged area due to subsidence, south of Block II OCP. (point 1 in figure 14 and table 5).
- Figure 19 : Fire in OB dumps in Kusunda area. (point 24 in figure 13 and table 4).
- Figure 20 : Fume cracks in the Bhulanbarari area.

List of Tables

- Table 1 : Generalised stratigraphy of JCF
- Table 2 : List of satellite data used in the present study
- Table 3 : Threshold temperature for fire area estimation of individual mines.
- Table 4 : Coal Fire observations during fieldwork (see figure 13 for reference)
- Table 5 : Coal Fire observations during fieldwork (see figure 14 for reference)
- Table 6 : Colliery wise break-up of change in fire area from 2012 to 2017

CHAPTER I

INTRODUCTION

Coal fire is a perennial problem in Jharia coal field (JCF) covering 447 sq. km. area in the Dhanbad district of Jharkhand state. Subsurface and surface coal fires are a serious problem in many coal-producing countries. The severity and extent of mine fires in some of the Indian coalfields, particularly Jharia and Raniganj coalfields, are quite alarming. Combustion can occur either within coal or in coal dumps on the surface. Considerable economic loss and environmental problem arises due to the coal fire. Coal fire burns valuable coal and also creates difficulties in mining by increasing the cost of production or making existing operations difficult. Noxious gases like sulphur dioxide, nitrogen oxide, carbon monoxide, carbon dioxides, which are the result of coal burning processes, often affect the immediate surroundings of an active coal fire area (Gangopadhyay, 2003). These greenhouse gases not only affect local atmosphere but also play a crucial role in the damages, found associated with coal fire such as land surface subsidence and surface cracking. Coal fires are caused by oxidation of coal but the reaction involved in oxidation of coal is not understood till date. Broadly, the potential for spontaneous combustion lies in its ability to react with oxygen at ambient temperature. This occurs through the reaction of oxygen at the surface of the coal resulting in an exothermic reaction. As a consequence, the temperature of coal rises and if temperature reaches the threshold temperature, ranging between 80° to 120°C , a steady reaction starts, which produces carbon dioxide. Temperature keeps on increasing once CO_2 started to form and at 2300°C , the exothermic reaction becomes rapid. It is known that high grade coals (high carbon content) are more fire prone, though the reason behind this is not well understood. Another important parameter, which controls fire, is the size of the particles. Larger the effective area of coal (fire particles), more rapidly the reaction proceeds. Cracks, fissures play a role like positive catalysts to coal oxidation by slowly supplying oxygen / air through their conduits.

Coal mining in Jharia Coal Field (JCF) started way back in 1895. History of fire in Jharia Coal Field date back to 1916 when the first incidence of fire was reported from XIV seam of Bhowrah colliery. JCF was nationalised in 1972 and over the decades, the fire has spread or been contained but never extinguished. The combination of underground fire and subsidence have affected vast areas of JCF.

1.1 Background

Remote sensing technique in thermal band offers a cost-effective and time-saving technology for mapping various geoenvironmental / hazardous features such as coal fires, forest fires, oil well fires, volcanic eruptions etc. NRSC has carried out coal fire mapping projects in the past; conducting an airborne campaign in 1989 and using Landsat-5 TM data in 1995 (Bhattacharya *et. al.*, 1995), over Jharia coalfield, Jharkhand and using Landsat-5 TM data for 2001 over Raniganj coalfield, West Bengal. Further, projects were executed in 2006 and 2012 in which coal fires of the JCF were mapped using Landsat-7 ETM+ and ASTER data, respectively. Additionally, a R&D study was taken up in 2013 to delineate subsidence areas using differential interferometric (DInSAR) technique. In view of the past experiences, based on the letter (Ref. no. NRSC/16/76) from Director (Tech.), Operations, BCCL addressed to Director, NRSC on 01 February 2016, a project was formulated to take up Coal fire and Land Subsidence study of the Jharia Coal Field using space-borne remote sensing technique. The formal Memorandum of Understanding between BCCL and NRSC was signed on 23rd of Dec, 2016.

1.2 Objectives

The following objectives are formulated on the basis of the above mentioned background:

- I. To map Coal fire in the study area based on pixel integrated relative radiant temperature derived from latest available Landsat-8 data of 2016-17 time period.
- II. To compare the change in the coal fire distribution in the Jharia coalfield within the period of 2012 and 2016-17.
- III. To delineate probable subsidence areas in the region using differential interferometry method.

1.3 Study Area

Jharia Coalfield is located in the Dhanbad district of Jharkhand state (Figure 1) and it is named after the main coal mining town of Jharia. It is situated in the Damodar River valley and is about 250 km NW of Kolkata. The coalfield is contained roughly within latitudes $23^{\circ} 42' N$ and $23^{\circ} 50' N$ and longitudes $86^{\circ} 09' E$ and $86^{\circ} 30' E$.

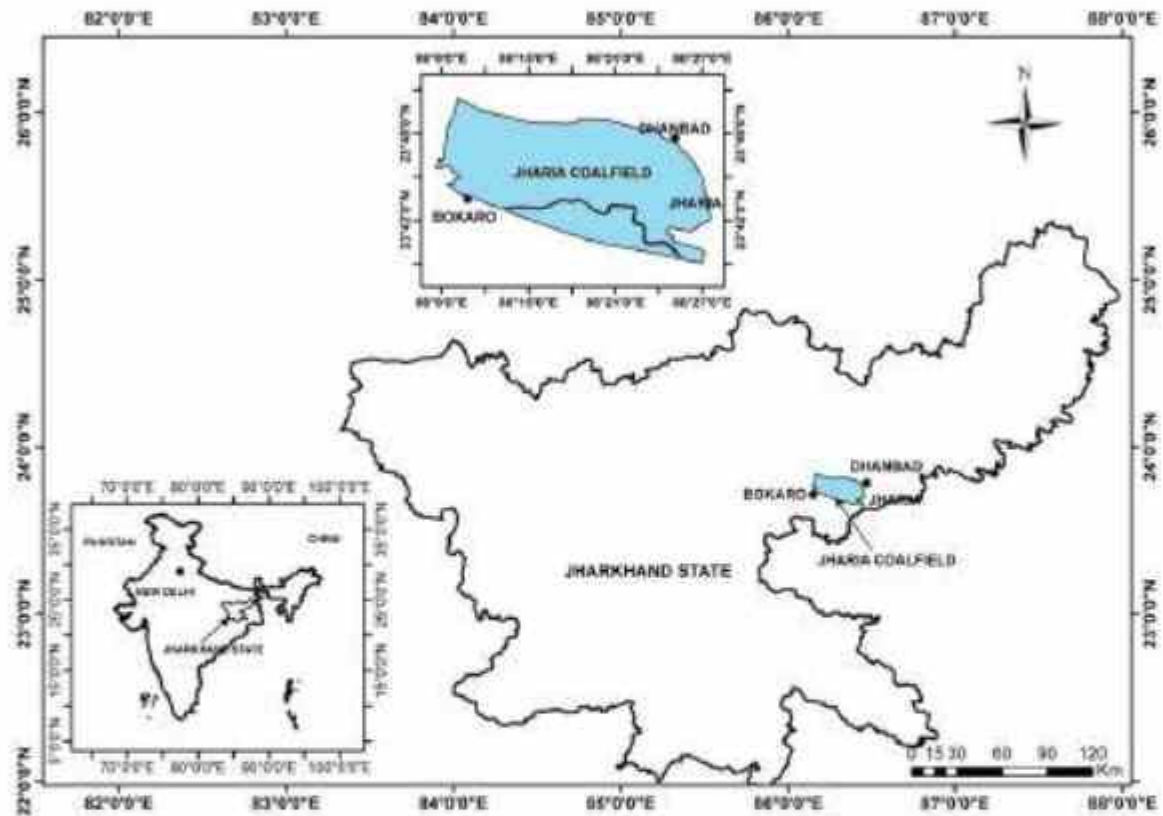


Figure 1: Study area map of Jharia Coalfield, Jharkhand

CHAPTER II

GENERAL DESCRIPTION OF THE STUDY AREA

2.1 Location and Accessibility

Jharia is an old mining town in the Dhanbad district of Jharkhand. This town is famous for its surrounding mines producing high grade coal and supplying mainly to the neighbouring industrial areas. Jharia is approximately 6 km in south western direction from Dhanbad town and connected by metal road. Dhanbad is well connected to Kolkata by road and rail.

2.2 Physiography, Drainage and Climate

Jharia coalfield is characterised by undulatory topography with very low rolling slope towards the eastern part of the area. The average height of the area is around 200 meters above the mean sea level. Damodar is the major river in the study area. The other tributaries to the Damodar River in this area are Jamuniya Nadi, Khudia Nadi, Khatri Nadi, Jarian Nala, Kari Jora and Domohani Nadi. Damodar River flows from west to east in this area. The minimum temperature is $<10^{\circ}\text{C}$ in the month of December – January and maximum temperature is $>50^{\circ}\text{C}$ in the month of May – June.

2.3 General Geology

Gondwana Super Groups of rocks of Up. Carboniferous to Lr. Cretaceous age (i.e. from 320 MY to 98 MY) are exposed here. Gondwana Super Group rocks unconformably overlie Archaean rocks. In Gondwana Rocks, Raniganj and Barakar Formations of Permian age have more potential as far as the coal production is concerned. Barakar Formation is exposed in north and north eastern part of the basin (Figure 2). Most of the coal mines are confined to the Barakar Formation in JCF. Barakars consists of coarse, medium grey and white sandstones, shales and coal seams. Raniganj consists of grey and greenish soft feldspathic sandstones, shales and coal seams. Faults are prevalent in this portion of basins (Figure 2). NW trending faults are conspicuous north to Jharia. Many lamprophyre and dolerite dykes are also exposed in this area in a criss-cross manner. The Raniganj Formation though coal bearing, has suffered much deformation due to faulting, thus causing difficulty for

mining in the area. The generalised stratigraphy of JCF is mentioned below (after Saraf, et al., 1995).

FORMATION	LITHOLOGY	MAXIMUM THICKNESS
Supra Panchet	Red and Grey sandstones and shales	300m
Panchet	Micaceous Yellow and Grey sandstones, Red and Greenish shales	600m
Raniganj	Grey and Greenish soft feldspathic sandstones, shales and coal seams	1050m
Ironstone Shales	Dark carbonaceous shales with ironstone bands	360m
Barakar	Coarse and medium Grey and white sandstones, shales and coal seams	630m
Talchir Boulder Bed	Coarse sandstones above and Greenish shales below	300m

Table 1: Generalised stratigraphy of JCF.

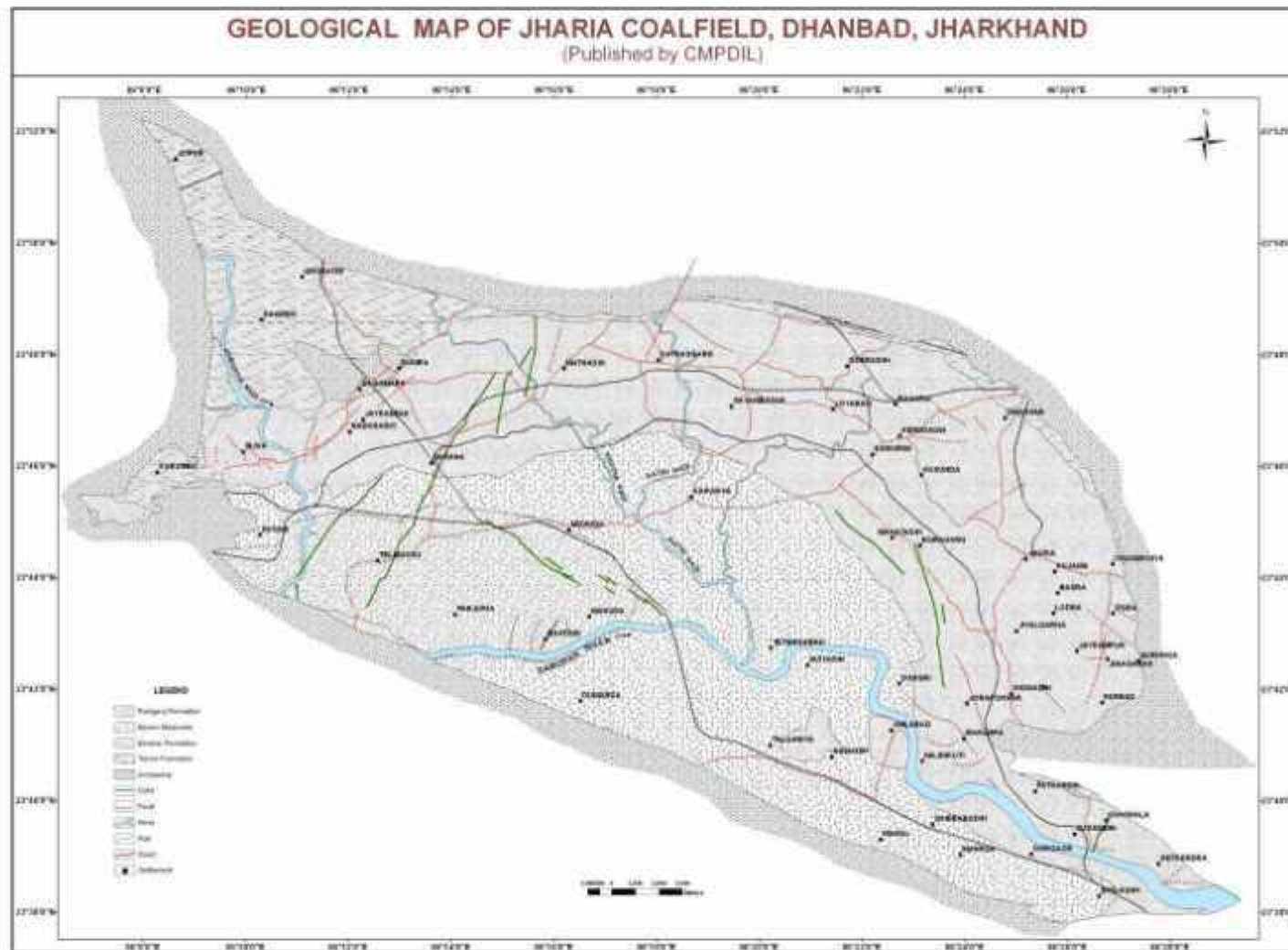


Figure 2 : Geological map of Jharia coal field, Dhanbad, Jharkhand (published by CMPIDL)

CHAPTER III

DATA REQUIREMENTS

3.1 Remote Sensing Data

The most recent available thermal satellite data was used in conjunction with the fieldwork for mapping coal fire in JCF. A coal fire map generated from the same, would serve as a reference for the fieldwork, as the observations can be verified in the field. For this purpose, a coal fire map was created from LANDSAT 8 TIRS data of 14-May 2017.

Further, the coal fire map of 2012 prepared by NRSC (NRSC, 2012) from ASTER data was used as a reference to identify the changes that has occurred in the extent and disposition of the fires from 2012 to 2017.

For the land subsidence study, L-band microwave data from ALOS-PALSAR satellite (JAXA) were used. Five scenes of "Fine mode" SLC data were taken from PALSAR-2 archives over a period from October, 2014 to February, 2017. This was done to identify long term terrain changes and differentiate the same from short term changes due to mining excavations and overburden dumping.

Table 2: List of satellite data used in the present study.

Sl. No	Satellite	Sensor	Time	Date	Data source
1	LANDSAT-8	TIRS	Daytime	14 May 2017	USGS, USA
2	ALOS-PALSAR-2 (Fine mode)	PALSAR-2	-	4 October, 2014	JAXA, Japan
3				3 October, 2015	
4				20 February, 2016	
5				01 October, 2016	
6				18 February, 2017	

3.2 Ancillary data

1. Geological map of Jharia coal field.
2. Mine surface plans as provided by BCCL.

CHAPTER IV**REMOTE SENSING DATA ANALYSIS****4.1 Methodology****4.1.1 Processing of Landsat 8 Data**

With the launch of the LANDSAT-8 mission in February, 2013; thermal space borne data is available from its thermal infrared sensor (TIRS). This has enabled monitoring of the earth with a spatial resolution of 100 m in the thermal domain with a repeat cycle of 16 days. The LANDSAT-8 has two channels (Band 10 and Band 11) in the thermal infrared region (Table 1) which ranges from 10.4 micrometer to 12.5 micrometer. In present study, band 10 of TIRS sensor (acquired on 14 May, 2017) has been used coal fire mapping (Gangopadhyay et al. 2012). The spectral domain of the band is known for its maximum transmittance (Chatterjee et al. 2007; Martha et al. 2010). The data are freely accessible through USGS portal (Landsat 8 download source: <http://landsatlook.usgs.gov>).

Landsat-8 data are available in GeoTiff format and the data are converted to top of the atmosphere spectral radiance using the radiance rescaling factors provided in the metadata file, using equation 1.

$$L_{\lambda} = M_L Q_{cal} + A_L \dots\dots\dots (1)$$

Where:

L_{λ} = Spectral radiance (Watts/ (m² * srad * μ m)).

M_L = Band-specific multiplicative rescaling factor from the metadata.

A_L = Band-specific additive rescaling factor from the metadata.

Q_{cal} = Quantized and calibrated standard product pixel values (DN).

Once the spectral radiance (L_{λ}) for ASTER Band 13 and Landsat-8 band 10 data is generated, it is possible to calculate radiant (brightness) temperature directly using equation 2. Planck's radiation function (Planck, 1914) forms the basis of radiant temperature derivation from spectral radiances and the theory is discussed in detail in existing literatures (Gupta, 2003).

$$T_R = K_2 / \ln ((K_1 / L_{\lambda}) + 1) \dots\dots\dots (2)$$

T_R = Radiant (brightness) temperature,

K_1 = Calibration constant (1260.56 K),

K_2 = Calibration constant (666.09 watts/ (m² *ster*μm)),

L_λ = Spectral radiance

4.1.2 Thresholding of radiant temperature image

Once the Landsat-8 data are converted to radiant temperature image, the next step was to segregate fire pixels from the background, which requires the estimation of the cut-off temperature (Roy et al. 2015). This has been attempted by the statistical analysis of sensor derived radiant temperature to delineate clusters (in the scatter-plot) indicative for fire and non-fire pixels. Mean and maximum radiant temperatures are derived from randomly sampled uniform sized pixel blocks distributed in entire spatial extent of Barakar formation (Figure 3) known for fire bearing coal seams. The pixel block sizes are chosen to adequately represent the overall areal extent of the coalfield and homogeneously encompass all the mining blocks (27x27 pixels for Landsat-8, Figure 3). The maximum temperature value recorded in each representative area, derived from each of the datasets, is plotted against the mean temperature. The maximum temperature represents that of fire (wherever present), whereas the mean temperature represents the average background temperature, for normalization. The fire and background populations show considerable variance, separating coal fire and background radiant temperatures. The cut-off temperature derived is the maximum temperature of the background cluster, above which all temperatures represent coal fires. In the case of the Landsat-8 data used in this study, the cut-off temperature was determined around 39°C (Figure 4). Based on this cut-offs, regional coal fire map was prepared (Figure 5).

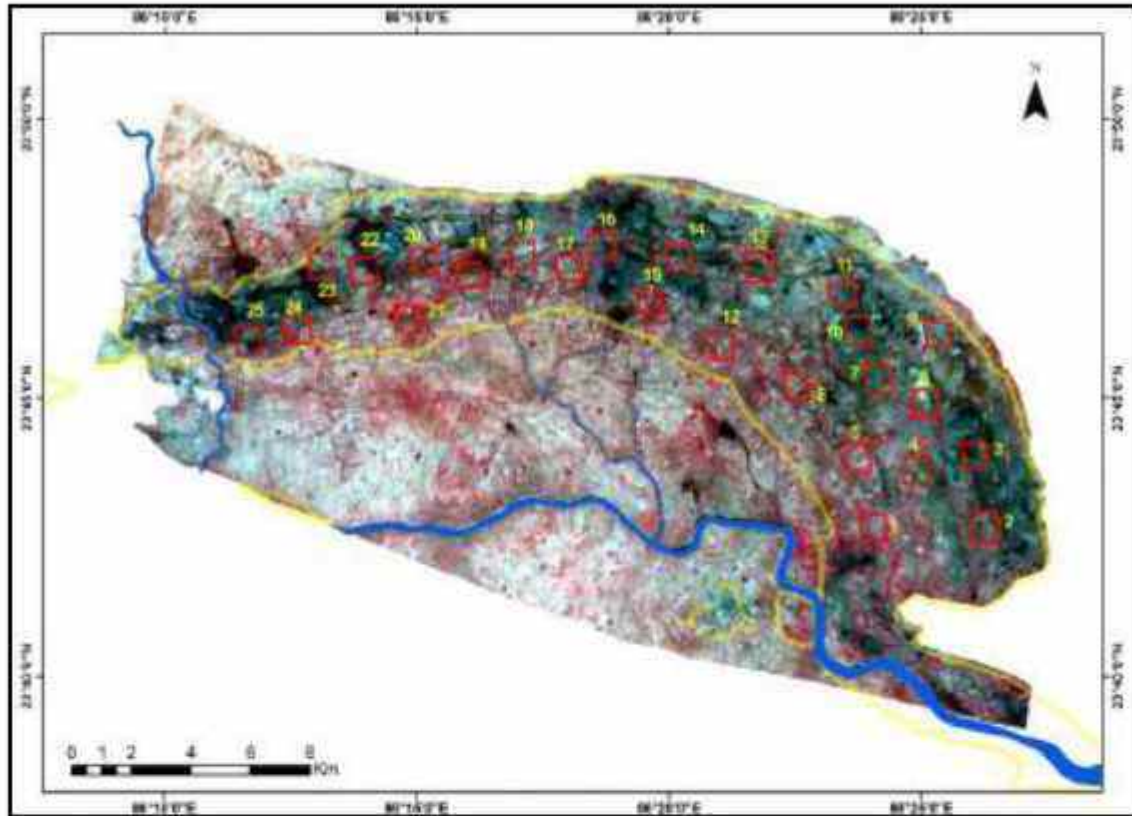


Figure 3. False colour composite image of Jharia Coalfield, with subset blocks (in red boxes) to obtain temperature values (from radiant temperature image) within the Barakar formation across the Jharia coalfield.

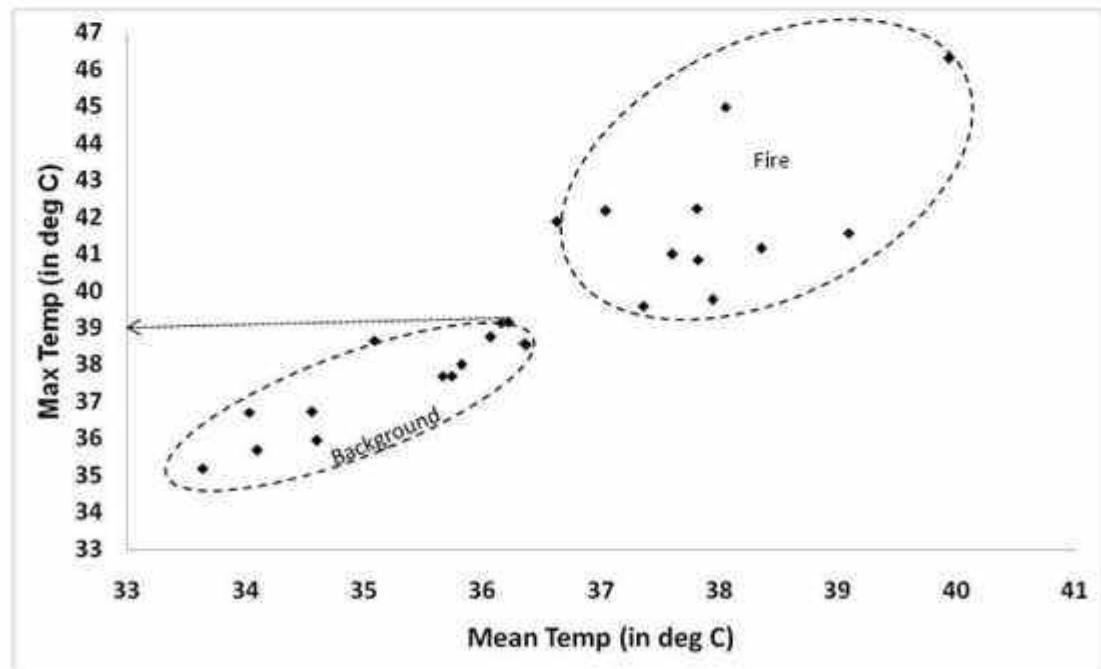


Figure 4. Maximum temperature plotted against mean temperature for various locations; cluster separation observed around 39 °C (marked with arrow)

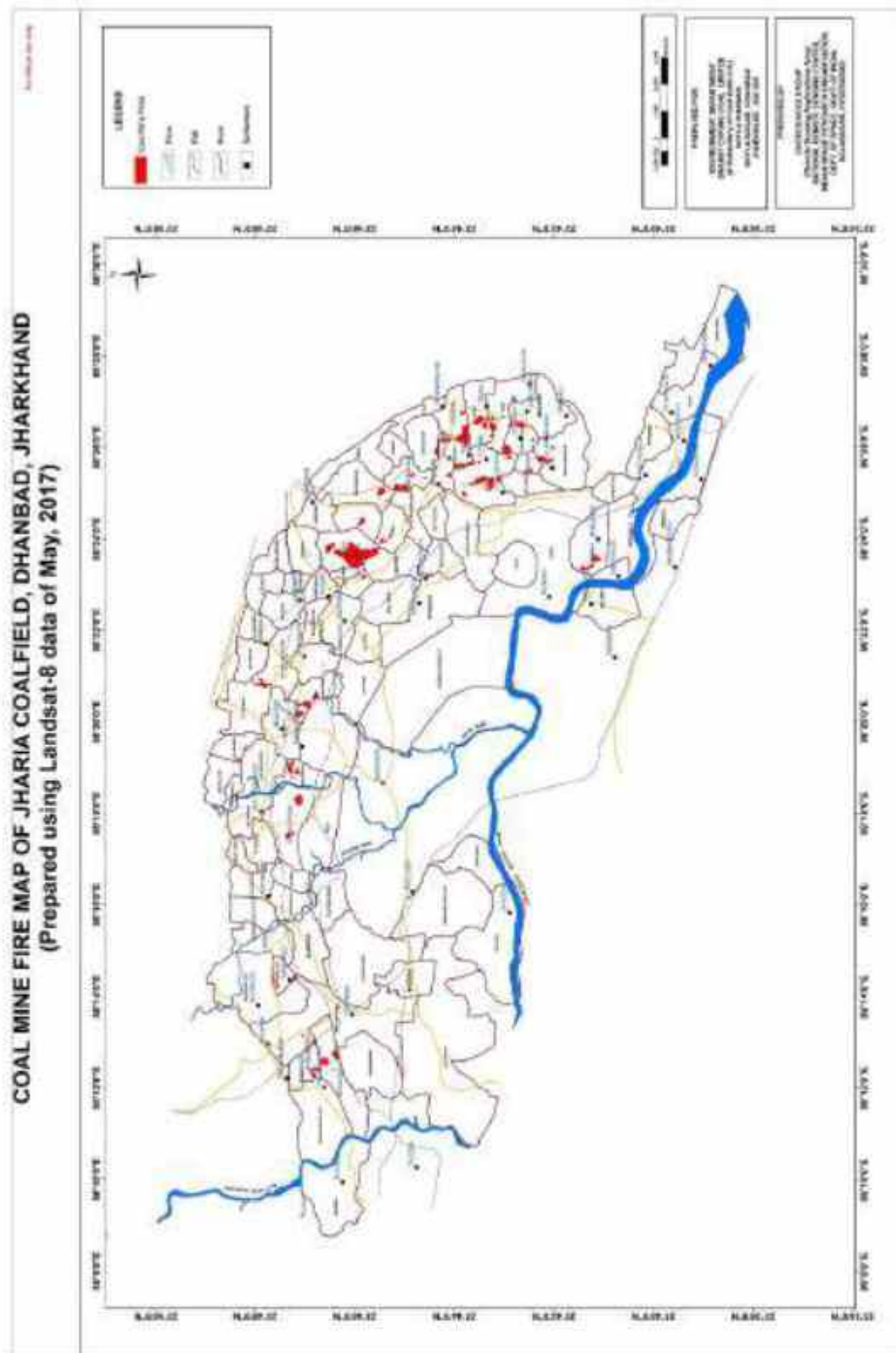


Figure 5: Coal mine fire map (May, 2017) of Jharia coal field, Dhanbad. The fire areas shown in this map have been verified in the field as per field points in figure 13.

4.2 Methodology For Subsidence Detection

4.2.1 Processing of ALOS-PALSAR 2 Data

Differential Interferometric SAR (DInSAR) techniques consist of combination of two SAR images of the same area acquired from slightly different positions (Figure 6).

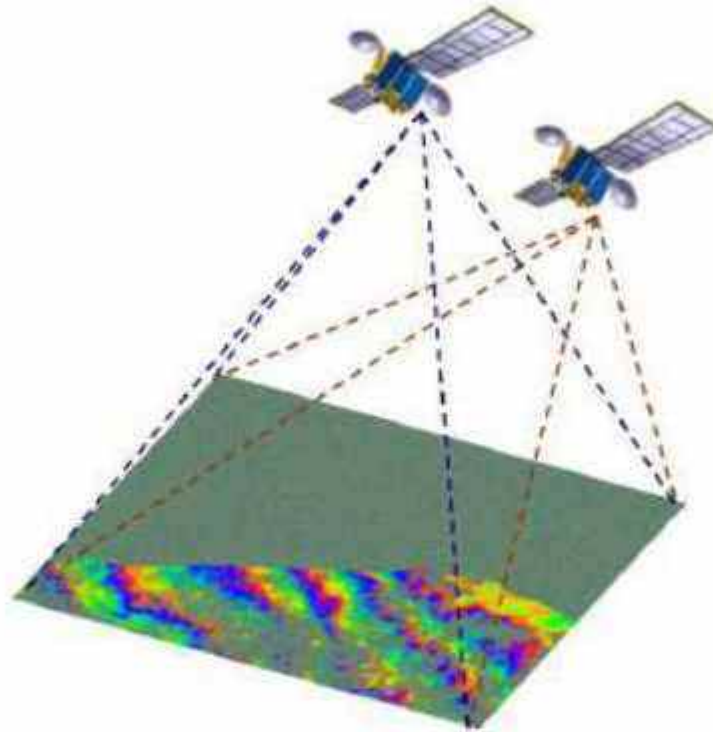


Figure 6. DInSAR acquisition scheme.

The result of this combination provides a new image, known as 'interferogram', whose phase component is formed by the following term:

$$\Delta\Phi_{Int} = \Phi_{Topo} + \Phi_{Mov} + \Phi_{Atm} + \Phi_{Noise} \quad (3)$$

where, Φ_{Topo} denotes the topographic component, Φ_{Mov} denotes the terrain deformation/ displacement component, Φ_{Atm} is the noise component and Φ_{Noise} is the thermal noise.

Topography, atmospheric effects and thermal noise needs to be removed or optimized to obtain precise measurements of terrain movement. When working with classical DInSAR interferograms (combination of two SAR images) the main problem is the presence of atmospheric artefacts, since there is no way to cancel them without a priori information. On the other hand, the term related with topography can be cancelled out using an external Digital Elevation Model (DEM) and the orbital ephemeris from the SAR acquisitions, considering no height errors on the DEM.

$$\Delta\Phi_{dif} = \Phi_{ErrorTopo} + \Phi_{Mov} + \Phi_{Atm} + \Phi_{Noise} \quad (ii)$$

Since the coal mine area is very dynamic in terms of its surfacial changes (open cast mine, abandoned mine, fire affected waste/reclaimed land, over burden dumps) over time, it is proposed to utilize an advanced DInSAR technique. It is a recent remarkable improvements in SAR differential interferometry that has led to an innovative approach based on the use of a large dataset of SAR images over the same area to overcome the intrinsic limitations of conventional DInSAR in terms of temporal and geometrical decorrelation as well as atmospheric disturbances (Ferretti et al 2001; Hooper et al 2004; Kampes, 2006; Lanari et al 2004; Mora et al 2003; Werner et al 2003).

Broad work flow diagram for generating land subsidence map using satellite based DInSAR technique is shown in Figure 7.

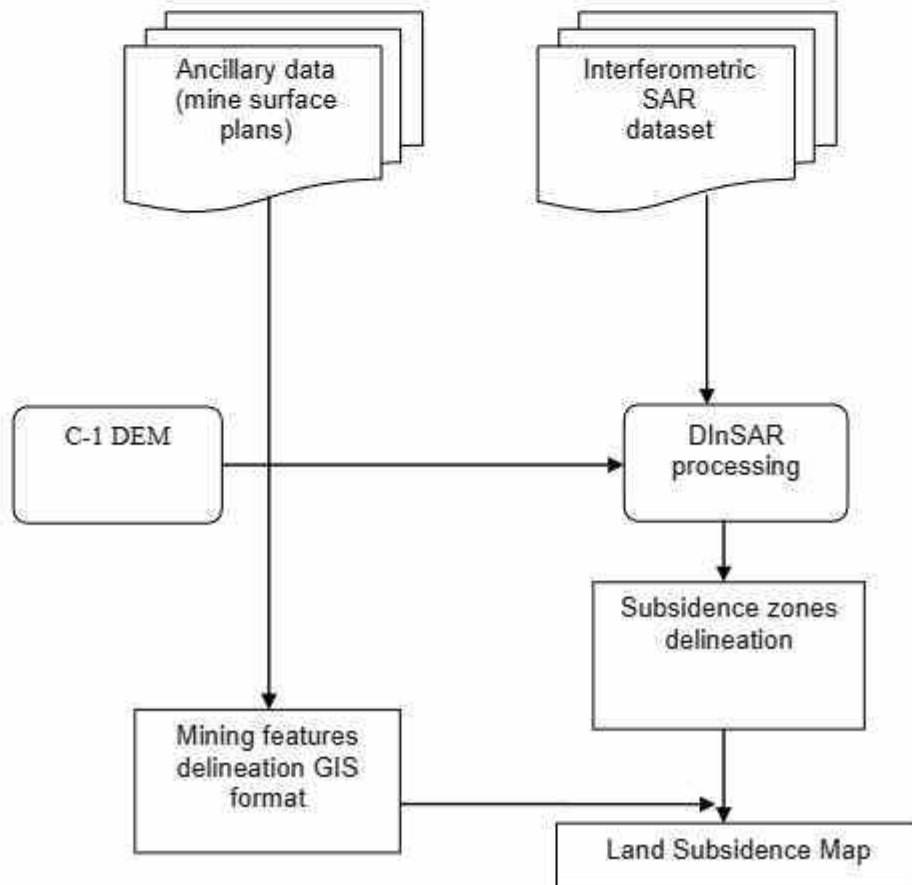


Figure 7. Work flow diagram for generating land subsidence map using DInSAR technique.

In the present study, 5 sets of ALOS-PALSAR L-band microwave data (as mentioned in table 1) were procured. The datasets were paired into master-slave pairs as per short and long temporal baselines. The short temporal baselines include master slave pairs of time difference of six months or less, whereas long temporal baselines include data pairs of time difference of one year or more. This has been illustrated in figure 8.

		SLAVE IMAGE				
		October, 2014	October, 2015	February, 2016	October, 2016	February, 2017
MASTER IMAGE	October, 2014					
	October, 2015					
	February, 2016					
	October, 2016					
	February, 2017					
		Short Temporal Baseline Pair (less than 1 year)				
		Long Temporal Baseline Pair (more than 1 year)				

Figure 8. ALOS-PALSAR - 2 Master-Slave pairs for short and long temporal baseline processing

The interferometric fringes generating from short baseline pairs will generally indicate terrain changes due to mining activity happening over a short period of time. This will include mining excavations and creation of new OB dumps adjacent to the mining area. Any incidences of slow land subsidence will not be demarcated in the results (figure 9).

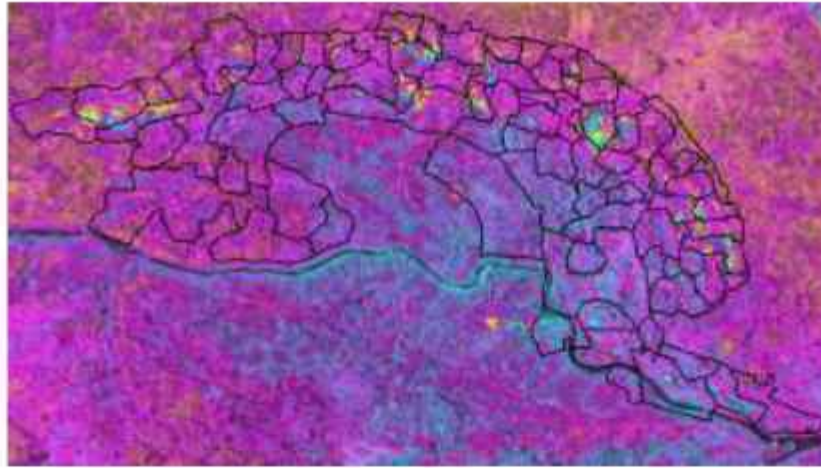


Figure 9. Fringe patterns generated from short baseline processing (e.g. Master: Oct, 16, Slave: Feb, 17).

On the other hand, master-slave pairs of long temporal baseline (one year or more, as shown in figure 8) will incorporate terrain changes due to mining activities as well, as long term ground subsidence from underground mining where ever present (figure 10).

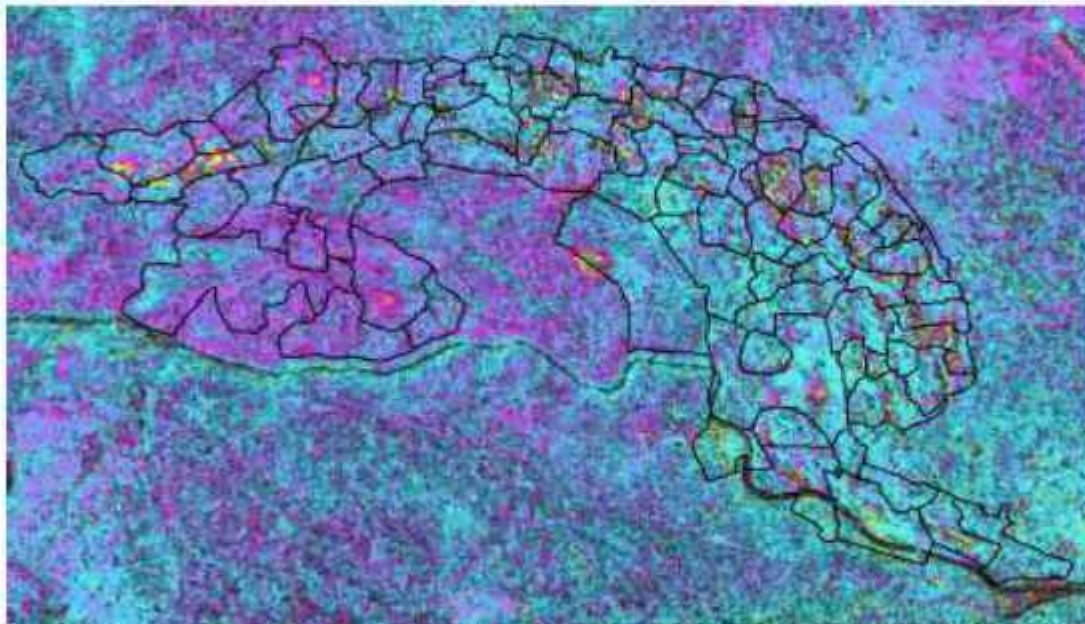


Figure 10. Fringe patterns generated from long baseline processing (e.g. Master: Oct, 15, Slave: Feb, 17).

The results from the long and short baseline processing can be compared and zone where fringes have been developed due to terrain changes due to mining excavation and dumping, can be systematically identified and demarcated. The remaining fringes from the long temporal baseline processing will then indicated towards zones where subsidence has taken place due to underground mining. Using this, a terrain change

map of the Jharia Coalfield was generated demarcating terrain changes due to mining activities and subsidence areas (Figure 11).

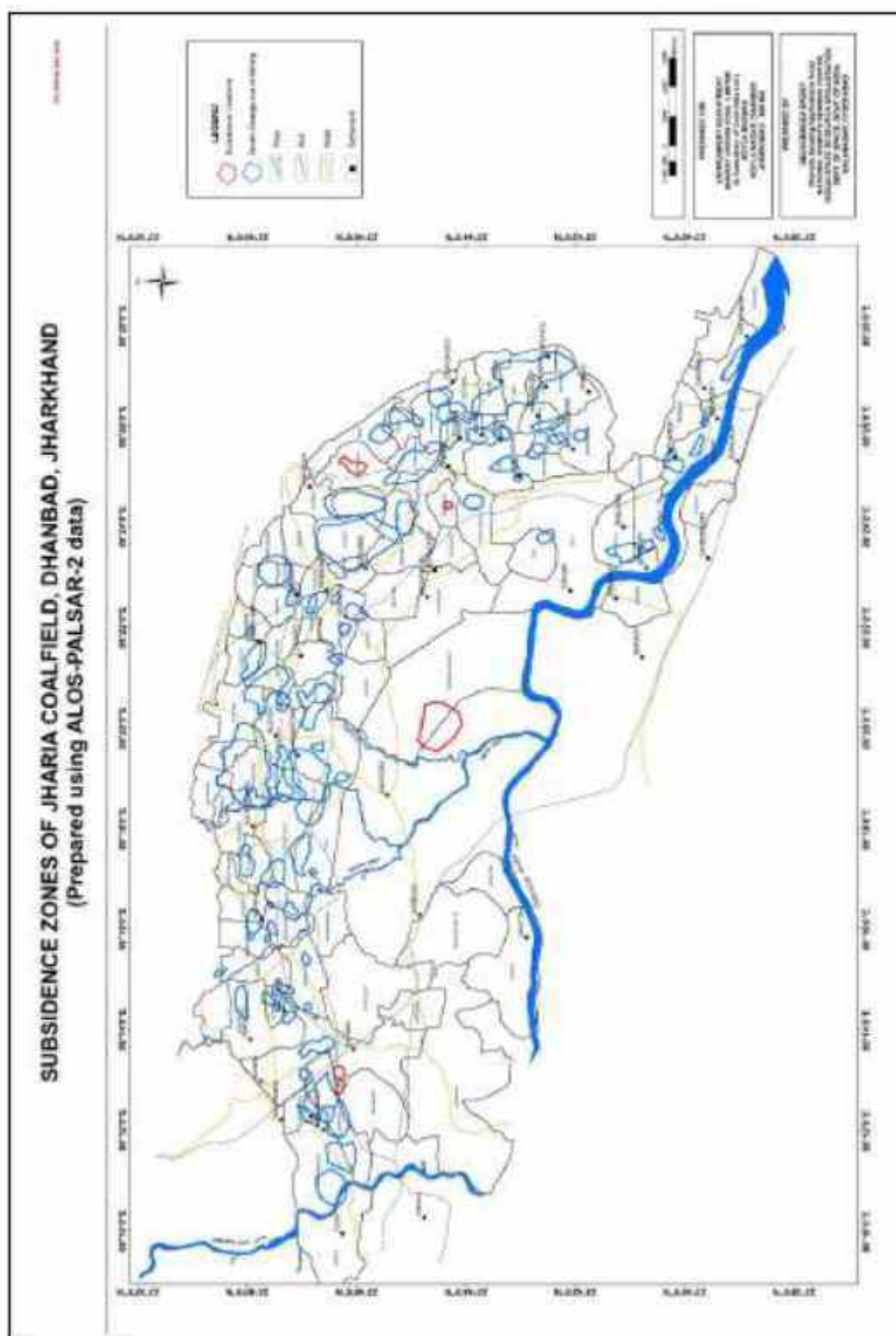


Figure 11: Subsidence map of Jharia coal field, Dhanbad.

CHAPTER V

FIELD WORK

A field work for verification of the coal fire locations and the subsidence zones as identified by the satellite data were taken up in December, 2017. A total of 53 coal fire points and 37 land subsidence locations were identified from the satellite data analysis. The locations of these points along with geographic coordinates were given to BCCL prior to the December, 2017 field work for their feedback on the status of these points. Out of the 53 coal fire locations identified, 52 points were confirmed to be fire bearing as per the present masterplan of the Jharia coalfield created by BCCL. Both the coal fire and the subsidence locations were further independently verified by NRSC during the fieldwork in December, 2017. The locations and the observations are coal fire and subsidence are provided in annexure 1 and annexure 2 of this report respectively.

The salient overview of the field observations are as follows:

Coal-fire observations:

1. The coal fires as observed identified by the Landsat-8 data are mostly accurately delineated. Fires have been identified in the western, northern and eastern flank of the coalfield with considerable accuracy in the spatial locations.
2. In the eastern flank, the main fire affected mines are Kusunda, Lodna and Tisra. Active fires area present in the mines and fumes can be seen from the OB dumps. The Bhowra and Bhulanbarari mines also show presence of fire, however, the extent of the fire area appears to be underestimated in the data. Similarly, the extent of fires in Lodna and Tisra appears to have been overestimated in the data. The largest extent of fire in the single mine block is that in Kusunda.
3. In the northern flank, the main fire bearing mines are Katras, Gaslitand and Mudidih. However, it is seen that in these areas, the fires appears in pockets and are not pervasively present. The spatial extent of the fires on the ground and as estimated in the data can be correlated.

4. In the western flank, the Block II OCP is the primary fire affected region. However, it is seen that the Shatabdi OCP also bears fire pockets along semi-vertical mine walls. This is not identified in the data.

Subsidence location observations:

1. Subsidence locations as identified by the data are difficult to verify in the field, unless there are tell-tale signatures like large cracks or fissures on the ground or damage to anthropogenic constructions like vertical cracks on building cracks etc.
2. Out of the 37 identified subsidence locations from the microwave data, it is seen that 32 are due to terrain changes resulting from mining activities like ongoing excavations or formation of new mining dump. These decrease or increase in elevations has resulted in forming of interferometric fringes in the data thus creating false positives.
3. Five areas were firmly established as subsidence zones. Out of these, the main area where subsidence is occurring in a pervasive scale, is that in the Moonidih Underground Project. The Moonidih Project is an underground long wall mine where excavations are going on for over decades. This may have resulted in pervasive subsidence in the region. The signatures of subsidence such as ground cracks are observed in the area.
4. Two adjacent locations are observed south of the Block II OCP and in Phularitand mining block. This may be resulted due to older underground mining in the area. Signatures such as sagging of ground is seen.
5. Another minor subsidence region was identified around the Simlabahal underground mining project. This is again due to active underground mining in the area. A similar region was also observed in the northern part of the Bastacolla mines where active underground mining is ongoing.

In lieu of the observations in field on the fire and subsidence locations, few post field work correction in the coal fire and subsidence maps was necessitated and has been discussed in the next chapter.

CHAPTER VI**POST FIELDWORK ANALYSIS**

As observed in the fieldwork, there were certain mine areas where the presence of fire was not detected by the satellite data. For example in Shatabdi and Bhulanbarari mine areas, the fire appears in small pockets on mine faces and was possibly not detected by the threshold temperature calculated for the entire mine area. On the other hand, in the Bhowra, Lodna and Tisra mine areas, the spatial extent of fire appears to have been overestimated by the regional threshold temperature use to separate the fire and the background areas.

Therefore, mine specific threshold temperature analysis was carried out for Shatabdi, Bhulanbarari, Bhowra, Lodna and Tisra mine areas to correctly depict the fire areas on the ground. The threshold temperature selected from each of these mine areas are given in Table 3.

Table 3: Threshold temperature for fire area estimation of individual mines.

Name of the Mine Block	Threshold Temperature (in °C)
Bhowra	38.5
Tisra (north and south)	North : 41; South : 40.5
Lodna	41
Bhulanbarari	38.5
Shatabdi	38

Using the threshold temperatures as mentioned in the table 3, the previously undetected fire areas in the Shatabdi and Bhulanbarari mines were detected. Further the spatial extent of the fire areas in Bhowra, Lodna and Tisra mines were changed to adequately represent the actual extent of the fire on the ground. These were incorporated in the coalfire map shown in figure 5.

DISCUSSIONS AND CONCLUSIONS

CHAPTER VII

7.1 Discussions

7.1.1 Coal fire analysis

The present study is aimed to provide the status of coal fire in the Jharia coal field for the period of 2017. Landsat-8 data of May, 2012 was used to prepare the coal mine fire map (Figure 5) for the year 2017. The data have 100 m spatial resolution in the thermal bands and is as on study date, the best thermal satellite data available. The Coal fire maps of 2017 when compared to map of 2012 (NRSC, 2014) depicts the dynamics of coal fire. Coal fire is difficult to mitigate because of its dynamic nature. But the understanding the trend in the shift of coal fire zones and over all distribution of coal fire will help in environmental and risk management related to coal mining activities.

The coal mine fire map for the year 2017 (Figure 5 illustrates the overall fire distribution in the area). The maps reveal that the coal fires are distributed across the Jharia coal field in pockets associated with major open cast mining activities. All most all the coal mine fires are restricted to the Barakar Formation where coal seams are exposed. In the eastern flank of the arcuate shaped mining extent, the collieries in Lodna and Tisra (North and South) is the highest fire affected mining blocks and Bhowra, Bhulanbarari, Kujama and Jharia are also affected by multiple smaller fire pockets. The fire in the areas is mostly manifested by high temperature fume cracks with occasional presence of active flames especially the the Lodna-Tisra area. Further, towards the north east, in Ena and Kusunda active fires are more prevalent and the area is extensively affected. The highest radiant temperatures (in order of ~50°C) are recorded by the satellite sensors in these areas. In the north, a large number of moderate to small fire pockets are seen in the areas around Shyambazar (Figure 5 & 6). These are related to the mining areas of Katras, Gaslitand, Mudidih and Kankanee. Mining activity, over the last few of years has exposed new, isolated and discontinuous fires in these regions.

In the western flank, three distinguishable fire affected zones are seen. Toward the western end of the mining area, the Benedih and Block II OCP are affected by smaller fires from isolated coal seams. These again are surfacialy manifested in the

form of fume cracks with smoke emanating from them. The Shatabdi OCP are also affected but fire is manifested in the along vertical mining wall sections.

Comparison of the 2017 coal fire map with that of 2012 (NRSC, 2014) indicated the dynamism in the spatial extent and distribution of the coal fires. The changes are highlighted as follows:

- i. In reference to the map generated in 2012, the 2017 map shows that the emergence/re-emergence of fires in the eastern flank, namely Kujama, Tisra, Lodna and Jharia etc. The entire zone has been affected by multiple fire occurrences. The spatial disposition of fires in Bastacolla, Jharia and Bhulanbarari appear to have a minor increase.
- ii. The areal extent of major fire zone around Kusunda/Kenduadih and Ena appears to remain the same, though here again the spatial location of the anomalies has changed. This is probably due to the mitigation and active mining in this region.
- iii. The fire zones in Benedih/Block II OCP and Shatabdi OCP have also changed/diminished in areal extent with presence of isolated smaller anomalies. There has been a considerable reduction in fire areas in and around the Shatabdi OCP.
- iv. The spatial disposition of fire areas around Katras, Gaslitand and Mudidih show minor change. In 2012, a number of small fire pockets were seen, however presently those fire pockets have given away to a few fire zones of moderate disposition.
- v. It needs to be noted that the 2012 study was carried out using ASTER data whereas the present study is carried out using Landsat-8 data. Therefore, the difference of sensor sensitivities will have a influence on the way the fires are sensed on the ground. Difference of sensor sensitivities will influence the number of fires identified as well as the areal extent of the fires in the data.

In summary, there is a change in the areal disposition of the fires from 2012 to 2017. Observations suggest the emergence/re-emergence of new areas in the eastern flanks in areas around Lodna and Tisra. Concurrently, there is a decrease in extent of fire areas Shatabdi, Nadkhurkee area in the western flank from 2012 to 2017. A quantitative comparison of the 2012 and 2017 data was carried out. As compared

2012, when the total fire affected extent of about 2.18 km²; in 2017 total fire affected extent is about 3.28 km². The colliery wise break-up of change in fire area from 2012 to 2017 is given in Annexure III.

7.1.2 Subsidence analysis

An attempt to identify subsidence zones in the Jharia Coalfield was also carried out using ALOS-PALSAR-2 L band microwave data using differential interferometric technique. 5 scenes of PALSAR-2 data spanning over a period of 2014 to 2017 were used to delineate the subsidence if any in the region and separately identify them from the terrain changes due to mining. Verification of the subsidence zones as seen from data is difficult as it requires visible signatures of subsidence in the form of cracks on the ground and damage to anthropogenic structures. In this study, data analysis and consequent field verification resulted in identification of 5 prominent subsidence areas. Of these, the major area where considerable ground subsidence is occurring is the Moonidih UG project. Long term underground mining has resulted in continuous subsidence in the area. Apart from this, the other four areas are south of Block II OCP, Simlabahal and Bastacolla. No quantitative estimates of the subsidence has been carried out in the study.

7.2 Conclusions

The following conclusions can be made:

1. As of the date of study in the year 2017 and in comparison with the previous study done in 2012, there has been a change in areal extent and disposition of the fire affected areas.
2. Compared to 2012, the eastern flanks (Lodna, Tisra areas) show considerable increase in fire disposition and the western flank (Shatabdi and Block II area) show diminished fire presence.
3. The major new fire areas are observed in the northern flank in the areas around Lodna and Tisra etc. These areas were not mapped as fire in the 2012 study.
4. The mines in Kenduadih and Lodna remain to be the worst affected with maximum presence of active fires.
5. There is an increase in areal extent of the fire (Figure 12) from 2012 to 2017.

Note: Estimations of fire extent (in terms of sq.km.) both in 2012 and in the present 2017 study are pixel based. They do not represent the actual ground area under fire. These estimations are made for comparative purpose only, to indicate the increase or decrease of areal disposition of fire. Hence, they should not be quoted as fire area on the ground.

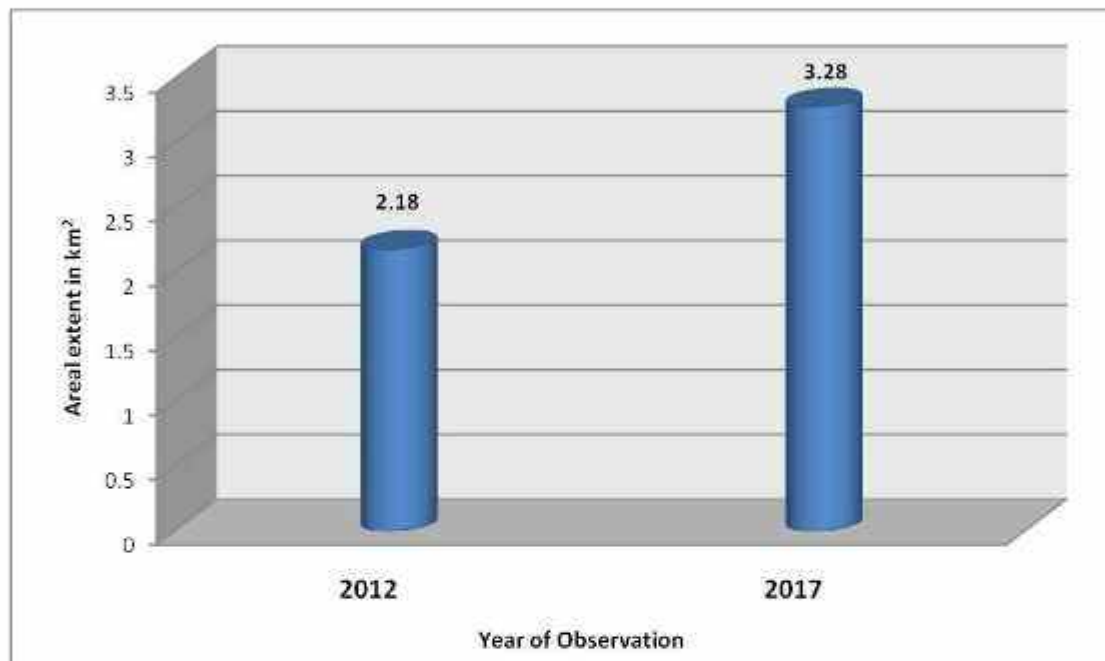


Figure 12: Total fire area statistics

CHAPTER VIII

LIMITATIONS

Delineation and mapping of coal fire from thermal data of remote sensing platforms carries with it some inherent limitations which needs to be understood in order to decipher the results obtained from it. This will assist in deducing the correct information and remove any ambiguity associated with the results. The key limitations of the data and the results obtained are as follows:

- 1) An anomalous pixel from LANDSAT data represents an area of 30m x 30m (resampled from spatial resolution of 100m) on the ground whose temperature is considerably higher than its surroundings. This can be attributed to two circumstances, namely the area has a very high intensity fire located within a smaller pocket or there are a number of low intensity fires spread across it. In both the mentioned cases the actual areal extent of the fire on the surface differs, but appears as a single anomalous pixel in the data. Hence, representation of fire affected ground area by means of pixel area is ambiguous and hence should be considered with caution.
- 2) There are locations as observed during the fieldwork, where coal seams are affected by active fires along vertical/semi-vertical sections of open cast mines (see cover page). In such cases, the actual areal expression of the fire affected area as seen by the sensor changes considerably and the representation from the same is not accurate.
- 3) As discussed in section 4.2.1, thresholding the data to separate the fires from the non fire areas, is a statistical technique. However, this method is dependent on how the temperature of non-fire background area is distinctive from the fire temperature.
- 4) The background temperatures vary with the time of the day when the data is collected, topography, and season of the year when the data is acquired. Night-time data has lower background temperature as compared to day-time. Similarly a data collected in October-November will have a considerably lower background temperature than that collected in May-June due to seasonal temperature variations. Hence, identification of the background temperature range becomes essential in

estimation of threshold temperature and the same varies depending upon the discussed controlling factors.

5) Generally, a constant threshold temperature is estimated over the entire study area, and the same is applied to delineate the fire areas from those of non-fire. However, it is seen that the application of such global thresholding may mask fires which are in turn seen in the field and that the threshold temperature value may vary locally. In the current scenario, it is seen that the fire locations as verified in the fieldwork at Bhulanbarari and Shatabdi were not identified in the data on application of a global threshold of 39°C. However, a subset of the data within the Bulanbarari area only, is analyzed with a lower threshold of 38.5°C, the fire pixels are manifested in the data. Hence, the appropriateness of a singular thresholding temperature value may need to be relooked upon. Future studies can be carried out using colliery wise statistical local thresholding to create a composite coal fire map.

6) Due to the mitigation measures taking place in various mines, it is seen that in a number of places the fire affected seam is excavated and dumped as overburden. However, these overburden dumps retains the excavated burning coals and thus are seen to have active fires occasionally. There lies a possibility that the same will be identified as anomalous pixels and hence, although the fire is not a part of any active coal seam, it will be included as a fire affected area in the final map.

7) Verification of the subsidence zones as detected from the interferometric technique is sometimes difficult due to lack in observable signatures of subsidence such as cracks on the ground and damage to anthropogenic structures.

Therefore, in quantitative estimation of fire affected areas and areas denoted as subsidence, the above mentioned limitations needs to be taken into account diligently, as it is inevitable that the area estimate will not define the actual fire/subsidence affected area on the ground. However, the areal extent estimated from the data can be "like to like" compared to earlier estimates of similar studies to understand the change and dynamism of the fire in terms of area affected and spatial disposition.

References

1. Gangopadhyay, P.K., Lahiri-dutt, K., Saha, K. (2005): "Application of remote Sensing to identify coal fires in the Raniganj coal belt, India." *Int. Jour of Applied Earth Observation and Geoinformation*.
2. Gangopadhyay, P.K., Malthuis.B, Van Dink (2005): "Aster Derived emissivity and coal-fire related surface temperature anomaly a case study in Wuda, North China," *Int. Jour. of Remote Sensing*, vol-26, No.-24, pp-5555-5571.
3. Schmugge, T., French, Ritchie, J.C., Rango, A., Pelgrum, H. (2002): "Temperature and emissivity separation from multispectral thermal infrared observation," *Remote Sensing of Environment*, 79, pp-189-198.
4. Saraf A.K., Prakash A., Sengupta, S., Gupta, R.P (1995): "Landsat-TM data for estimating ground temperature and depth of sub-surface coal fire in the Jharia coalfield, India," *Int. Jour. Remote sensing vol-16, no-12*, 2111-2124.
5. Gangopadhyay P.K., (2003): "Coalfire detection and monitoring in Wuda, North China, A multispectral and multi-sensor approach:-Ph.D. Thesis, ITC Netherland.
6. Gupta, R.P. (2003): "Remote Sensing Geology", *Springer-Verlag.Third ed*.pp-183-216.
7. Kealey, P.S and Hook S.J(1993): "Separating temperature and emissivity in thermal infrared Multispectral Scanner Data: Implication for recovering land surface temperatures", *IEE Transaction on Geoscience and Remote Sensing*,vol,31,no-6,pp-1155-1164
8. Zhang, J., Wagner, W., Prakash, A., Mehl,H. and Voigt,S.(2004): "Detecting coal fires using remote sensing techniques," *Int. Jour. Remote sensing*, vol-25, no-6, pp3193-3220.
9. Bhattacharya, A. and Reddy, C.S.S. (1995): Inventory and monitoring of underground and surface coal mine fire in Jharia coalfield, Bihar using thematic mapper thermal IR data: *Geosciences Group, Official report, NRSA*.
10. Coal mine fire delineation and surface features mapping using satellite data in Jharia coal field, Dhanbad, Jharkhand. Geology and Geophysics division. *Official report, NRSA, 2006*
11. Coal mine fire delineation and surface features mapping using satellite data in Jharia coal field, Dhanbad, Jharkhand. Geosciences Group. *Official report, NRSC, 2014*

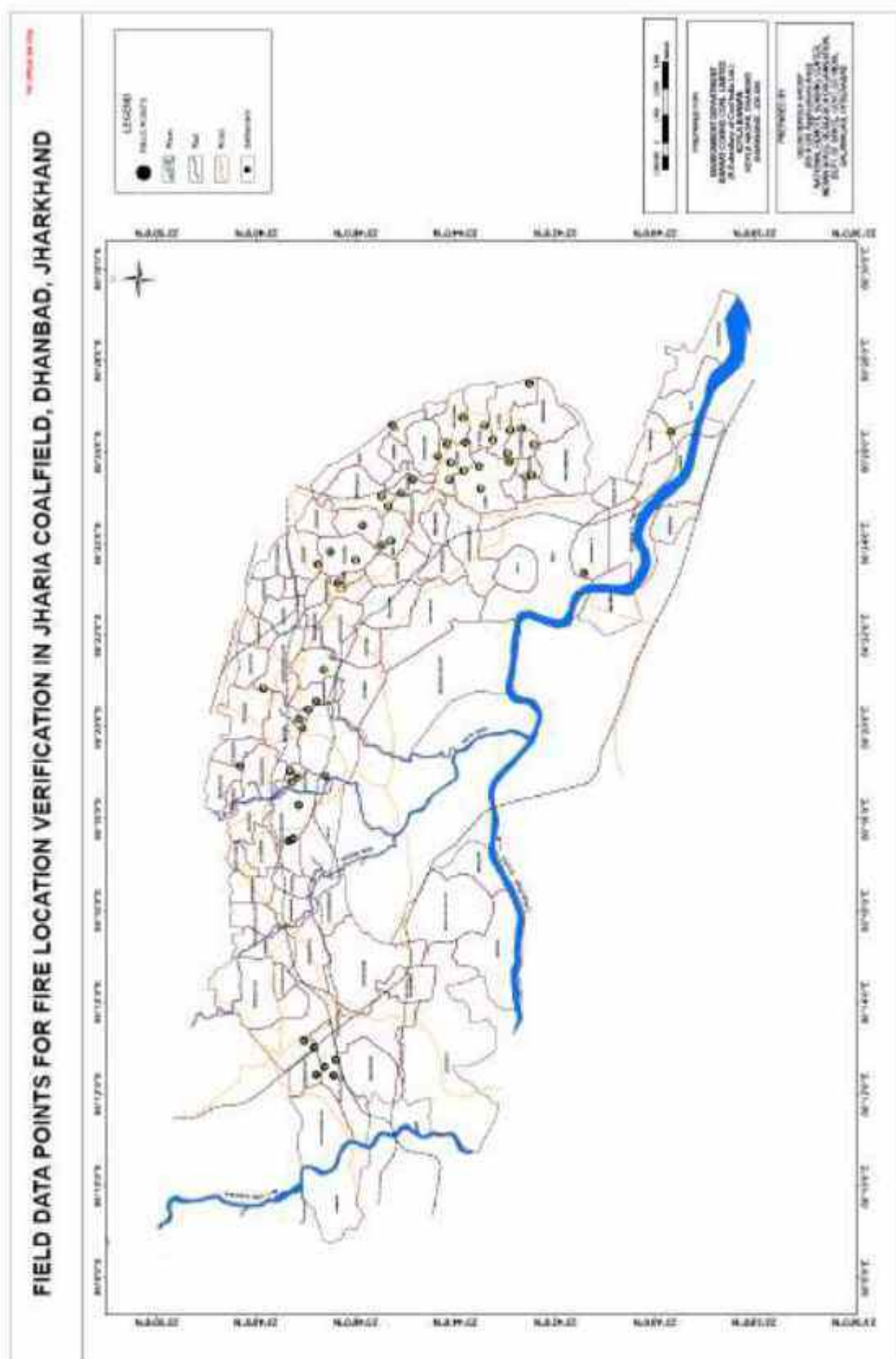


Figure 13. Field data points for coal fire verification

Table – 4: Coal Fire observations during fieldwork (see figure 13 for reference)

SL No.	Point of Observations		Comments		
	Latitude	Longitude	Type of Mining Activity	Presence of Coal Fire	Mine name and Any other Comments
1	23.7801	86.2068	OB Dump	Fire	ABOCP
2	23.7771	86.2097	Active Mine	Fire	ABOCP
3	23.7739	86.2066	Active Mine	Fire	ABOCP
4	23.7733	86.2124	OB Dump	Fire	ABOCP
5	23.7806	86.2168	No Working	Fire	ABOCP
6	23.7841	86.2192	No Working	Fire	Phularitand
7	23.7893	86.2919	No Working	Fire	Katras Chatudih
8	23.7875	86.2926	No Working	Fire	Katras Chatudih
9	23.7857	86.3049	Working	Fire	Gaslitand
10	23.7768	86.3157	Outside Jharia Mines		Tata
11	23.7887	86.3170	OB Dump	Fire	Gaslitand
12	23.7862	86.3151	OB Dump	Fire	Gaslitand
13	23.7880	86.3133	OB Dump	Fire	Gaslitand
14	23.8054	86.3191	Working	Fire	AKWMC
15	23.7855	86.3363	OB Dump	Fire	Mudidih
16	23.7826	86.3397	Working	Fire	Kankanee
17	23.7800	86.3427	Working	Fire	Kankanee
18	23.7848	86.3327	OB Dump	Fire	Mudidih
19	23.7977	86.3473	OB Dump	Fire	Sendra Bansjora
20	23.7775	86.3540	OB Dump	Fire	Loyabad
21	23.7793	86.3924	No Working	No fire	Kusunda (Domestic coal burning)
22	23.7753	86.3970	Working	Fire	Kusunda
23	23.7724	86.3858	Working	Fire	Kusunda
24	23.7669	86.3940	OB Dump	Fire	Kusunda
25	23.7578	86.3993	OB Dump	Fire	Ena
26	23.7550	86.4009	OB Dump	Fire	Ena
27	23.7645	86.4065	Working	Fire	ADIC
28	23.7580	86.4172	Old Quarry	Fire	ROCP
29	23.7515	86.4184	OB Dump	Fire	ROCP
30	23.7559	86.4137	OB Dump	Fire	ROCP
31	23.7476	86.4232	Working	Fire	ROCP
32	23.7543	86.4431	Outside Jharia Mines		Unknown site (Out side of Kuya)
33	23.7394	86.4317	Active Mine	Fire	Ghanoodih
34	23.7360	86.4362	OB dump	Fire	Goluckdih
35	23.7349	86.4293	OB Dump	Fire	Kujama
36	23.7354	86.4232	No Working	Fire	Kujama
37	23.7301	86.4369	Working	Fire	NT-ST
38	23.7305	86.4265	OB dump	Fire	Kujama
39	23.7249	86.4200	No Working	Fire	Lodna
40	23.7159	86.4327	Working	Fire	Joyrampur
41	23.7254	86.4280	No Working	No fire	Lodna
42	23.7209	86.4376	Working	Fire	NT-ST
43	23.7154	86.4296	Working	Fire	Lodna
44	23.7238	86.4427	Working	Fire	NT-ST
45	23.7309	86.4457	OB dump	Fire	NT-ST
46	23.7151	86.4412	Active Mine	Yes	NT-ST
47	23.7114	86.4419	OB Dump	Fire	NT-ST
48	23.7073	86.4360	Active Mine	Fire	Joyrampur
49	23.7097	86.4243	Working	Fire	Bagdigi/Joyrampur
50	23.7079	86.4249	Active Mine	Fire	Bagdigi/Joyrampur
51	23.7086	86.4582	Outside Jharia Mines		Unknown site (Out side of NT-ST)
52	23.6614	86.4404	Outside Jharia Mines		Chasnala
53	23.6906	86.3892	OB dump	Fire	Bhowrah (North)

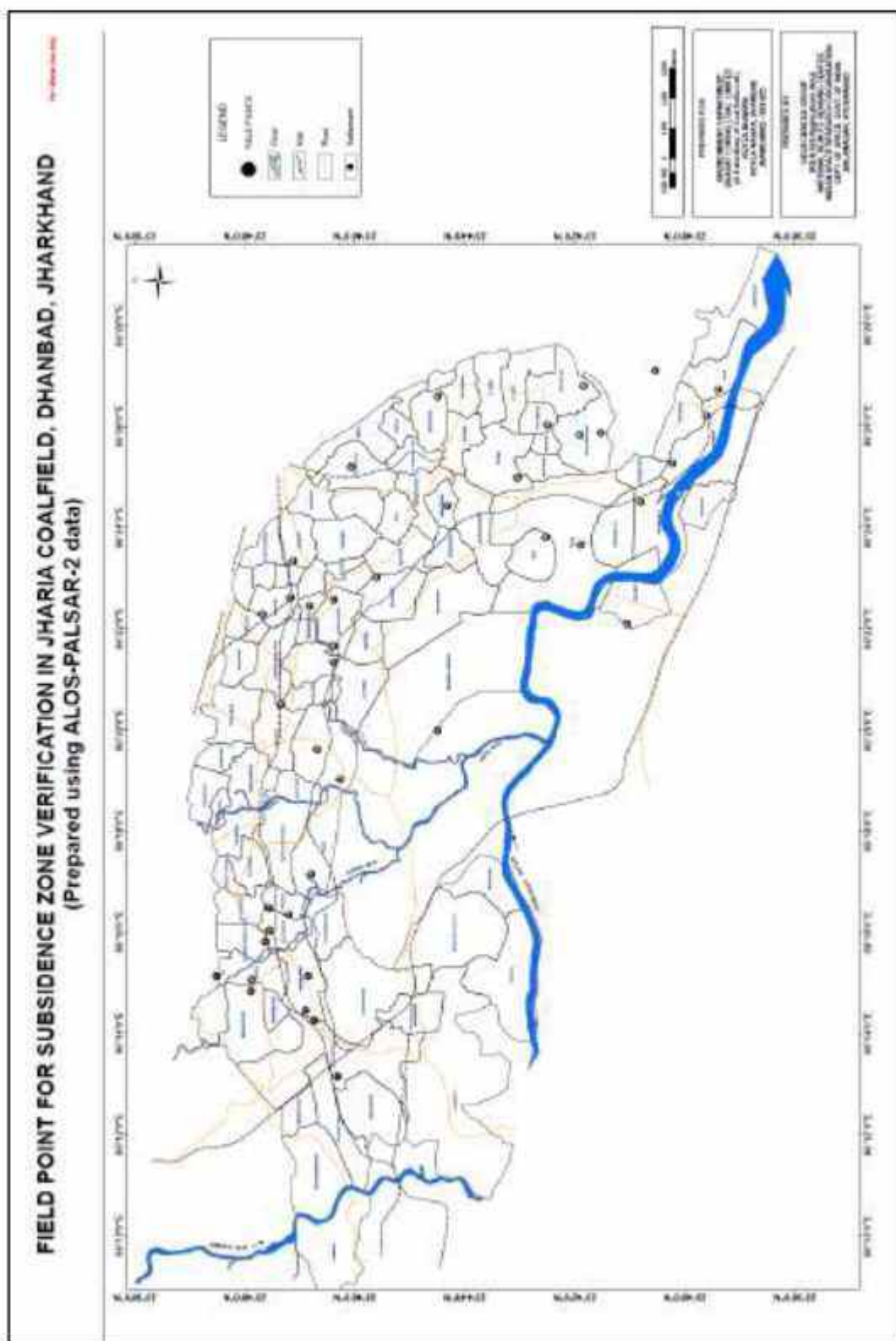


Figure 14. Field data points for subsidence verification

Table – 5: Coal Fire observations during fieldwork (see figure 14 for reference)

Sr. no.	Point of Observations		Comments	
	Latitude	Longitude	Mine name and Any other Comments	Signs of Subsidence (crack on building/ground crack etc.)
0	23.7416	86.3338	Moonidih UG Project	Sagged area, Building damage
1	23.7722	86.2192	South of Block II (2 areas)	Cracks on the ground
2	23.7817	86.2409		Terrain Change due to mining
3	23.7811	86.2521		Terrain Change due to mining
4	23.7792	86.2376		Terrain Change due to mining
5	23.7983	86.2473		Terrain Change due to mining
6	23.7981	86.2510		Terrain Change due to mining
7	23.8088	86.2521		Terrain Change due to mining
8	23.7941	86.2636		Terrain Change due to mining
9	23.7926	86.2671		Terrain Change due to mining
10	23.7868	86.2724		Terrain Change due to mining
11	23.7928	86.2746		Terrain Change due to mining
12	23.7800	86.2857		Terrain Change due to mining
13	23.7713	86.3171		Terrain Change due to mining
14	23.7783	86.3270		Terrain Change due to mining
15	23.7893	86.3419		Terrain Change due to mining
16	23.7734	86.3556		Terrain Change due to mining
17	23.7734	86.3762		Terrain Change due to mining
18	23.7804	86.3742		Terrain Change due to mining
19	23.7865	86.3769		Terrain Change due to mining
20	23.7855	86.3890		Terrain Change due to mining
21	23.7679	86.4199	Bastacolla	Sagged areas
22	23.7390	86.4071	Simlabahal UG	Sagged areas
23	23.7417	86.4431		Terrain Change due to mining
24	23.7176	86.4163		Terrain Change due to mining
25	23.7085	86.4339		Terrain Change due to mining
26	23.6986	86.4304		Terrain Change due to mining
27	23.6923	86.4312		Terrain Change due to mining
28	23.6977	86.4466		Terrain Change due to mining
29	23.7092	86.3967		Terrain Change due to mining
30	23.6985	86.3942		Terrain Change due to mining
31	23.6845	86.3681		Terrain Change due to mining
32	23.6804	86.4083		Terrain Change due to mining
33	23.6685	86.4110		Terrain Change due to mining
34	23.6706	86.4211		Terrain Change due to mining
35	23.6603	86.4366		Terrain Change due to mining
36	23.6568	86.4454		Terrain Change due to mining
37	23.6760	86.4516		Terrain Change due to mining
38	23.7603	86.3836		Terrain Change due to mining
39	23.7734	86.3609		Terrain Change due to mining
40	23.7948	86.3715		Terrain Change due to mining

Annexure –III

SL. NO.	COLLIERY AREA NAME	FIRE AREA 2012 (SQ. KM.)	FIRE AREA 2017 (SQ. KM.)	AREA CHANGE (SQ. KM.)	Increase/Decrease
1	DAMODA	0.0000	0.0000	0.000	NO FIRE
2	TISCO (west)	0.0000	0.0000	0.000	NO FIRE
3	IISCO	0.0000	0.0000	0.000	NO FIRE
4	TISCO (north)	0.0885	0.0153	-0.073	DECREASE
5	NUDKHURKEE OCP	0.0000	0.0000	0.000	NO FIRE
6	BENEDIH OCP	0.0530	0.0453	-0.008	DECREASE
7	BLOCK-II OCP	0.0530	0.1353	0.082	INCREASE
8	MURAIH OCP	0.1478	0.0022	-0.146	DECREASE
9	SHATABDI OCP	0.0378	0.0361	-0.002	DECREASE
10	TETURIA	0.0000	0.0000	0.000	NO FIRE
11	S.GOVINDPUR	0.0000	0.0000	0.000	NO FIRE
12	KORIDIH BLOCK-IV OCP	0.0000	0.0000	0.000	NO FIRE
13	JOGIDIH	0.0000	0.0000	0.000	NO FIRE
14	DHARAMABAND	0.0000	0.0000	0.000	NO FIRE
15	MAHESHPUR	0.0000	0.0000	0.000	NO FIRE
16	PHULARITAND	0.0133	0.0205	0.007	INCREASE
17	MADHUBAND	0.0000	0.0000	0.000	NO FIRE
18	AKASH KINARI	0.0000	0.0000	0.000	NO FIRE
19	GOVINDPUR	0.0000	0.0000	0.000	NO FIRE
20	E. KATRAS	0.0133	0.0000	-0.013	DECREASE
21	KATRAS-CHOITUDIH	0.1021	0.1368	0.035	INCREASE
22	KESHALPUR	0.0000	0.0013	0.001	INCREASE
23	RAMKANALI	0.0000	0.0000	0.000	NO FIRE
24	NICHITPUR	0.0000	0.0000	0.000	NO FIRE
25	E. BASURIA	0.0000	0.0000	0.000	NO FIRE
26	KHAS KUSUNDA	0.0000	0.0000	0.000	NO FIRE
27	GONDUDIH	0.0000	0.0000	0.000	NO FIRE
28	W. GODHAR	0.0012	0.0000	-0.001	DECREASE
29	BASURIA	0.0000	0.0000	0.000	NO FIRE
30	TETULMARI	0.0223	0.0220	0.000	DECREASE
31	DHANSAR	0.0000	0.0000	0.000	NO FIRE
32	GODHAR	0.1073	0.0000	-0.107	DECREASE
33	INDUSTRY	0.0119	0.0513	0.039	INCREASE
34	KUSUNDA	0.4243	0.7398	0.315	INCREASE
35	SENDRA-BANSJORA	0.0796	0.0275	-0.052	DECREASE
36	BASTACOLLA	0.0663	0.0810	0.015	INCREASE
37	BERA	0.0000	0.0000	0.000	NO FIRE
38	KUYA	0.0000	0.0000	0.000	NO FIRE
39	GOLUCKDIH	0.0301	0.1122	0.082	INCREASE
40	KUJAMA	0.0398	0.2404	0.201	INCREASE

41	S. JHARIA-R. OCP	0.0244	0.1118	0.087	INCREASE
42	DOBARI	0.0000	0.0000	0.000	NO FIRE
43	GONHOODIH	0.0398	0.0322	-0.008	DECREASE
44	SIMLABAHAL	0.0000	0.0000	0.000	NO FIRE
45	HURRILADIH&STD	0.0000	0.0000	0.000	NO FIRE
46	ENA	0.0918	0.0432	-0.049	DECREASE
47	BURRAGARH	0.0000	0.0000	0.000	NO FIRE
48	N. TISRA	0.0098	0.1802	0.170	INCREASE
49	LODNA	0.0000	0.3527	0.353	INCREASE
50	S. TISRA	0.0000	0.1015	0.102	INCREASE
51	BARAREE	0.1037	0.1074	0.004	INCREASE
52	AMLABAD	0.0000	0.0000	0.000	NO FIRE
53	PATHERDIH	0.0000	0.0000	0.000	NO FIRE
54	SUDAMDIH	0.0000	0.0000	0.000	NO FIRE
55	SITANALA	0.0000	0.0000	0.000	NO FIRE
56	MURULIDIH 20/21 PIT	0.0000	0.0000	0.000	NO FIRE
57	MURULIDIH	0.0000	0.0000	0.000	NO FIRE
58	BHATDIH	0.0000	0.0000	0.000	NO FIRE
59	LOHAPATTY	0.0000	0.0000	0.000	NO FIRE
60	IISCO	0.0000	0.0000	0.000	NO FIRE
61	TASRA-IISCO	0.0000	0.0000	0.000	NO FIRE
62	KENDUADIH	0.0610	0.0000	-0.061	DECREASE
63	BULLIHARY	0.0000	0.0000	0.000	NO FIRE
64	GOPALICHUCK	0.0000	0.0000	0.000	NO FIRE
65	FOOTKEE	0.0000	0.0000	0.000	NO FIRE
66	BHURUNGIA	0.0000	0.0000	0.000	NO FIRE
67	KHARKHAREE	0.0000	0.0000	0.000	NO FIRE
68	GASLITAND	0.1194	0.1215	0.002	INCREASE
69	KANKANEE	0.0530	0.0525	-0.001	DECREASE
70	MUDIDIH	0.1141	0.1104	-0.004	DECREASE
71	W. MUDIDIH	0.0171	0.0000	-0.017	DECREASE
72	LOYABAD	0.0133	0.0063	-0.007	DECREASE
73	BHAGABAND	0.0000	0.0000	0.000	NO FIRE
74	MOONIDIH PROJECT	0.0000	0.0000	0.000	NO FIRE
75	E.BHUGGATDIH	0.0022	0.0214	0.019	INCREASE
76	ALKUSHA	0.0326	0.0294	-0.003	DECREASE
77	KUSTORE	0.0524	0.0463	-0.006	DECREASE
78	ANGARAPATRA	0.1331	0.0149	-0.118	DECREASE
79	SALANPUR	0.0000	0.0000	0.000	NO FIRE
80	BHOWRAH. N	0.0133	0.0980	0.085	INCREASE
81	BHOWRAH. S	0.0000	0.0000	0.000	NO FIRE
82	BAGDIGI	0.0000	0.0209	0.021	INCREASE
83	JEALGORA	0.0000	0.0067	0.007	INCREASE
84	JEENAGORA	0.0000	0.0470	0.047	NO FIRE

85	JOYRAMPUR	0.0099	0.1042	0.094	INCREASE
86	CHANDAN OCP	0.0000	0.0000	0.000	NO FIRE
87	BANSDEOPUR	0.0000	0.0000	0.000	NO FIRE
	TOTAL AREA	2.18	3.28	1.10	INCREASE

Table 6: Colliery wise break-up of change in fire area from 2012 to 2017

Note:

- 1) "NO FIRE" implicates that the fire has not been identified satellite data (*either absent or below sensor resolution*)
- 2) "INCREASE" implies, increase in fire area OR emergence of fire areas not identified in 2012 study.
- 3) "DECREASE" implies, decrease in fire area OR fire areas of 2012, which are not identified in present study (*either absent or below sensor resolution*).
- 4) Estimations of fire extent (in terms of sq.km.) both 2012 and in present 2017 study are pixel based. They do not represent the actual ground area under fire. These estimations are made for comparative purpose only, to indicate the increase or decrease of areal disposition of fire. Hence, they should not be quoted as fire area on the ground.

Annexure –IV



Figure 15: Fume cracks in Lodna-Tisra Area. (point 39 in figure 13 and table 4)



Figure 16: Burnt area near OB dump in Lodna area (point 41 in figure 13 and table 4)



Figure 17: Coalfries in active seams in Kusunda (point 23 in figure 13 and table 4)



Figure 18: Sagged area due to subsidence, south of Block II OCP. (point 1 in figure 14 and table 5)



Figure 19: Fire in OB dumps in Kusunda area. (point 24 in figure 13 and table 4)



Figure 20: Fume cracks in the Bhulanbarari area.

Annexure-IV



Biological Reclamation on stabilized OB dumps at Chaitudih, New Akashkinaree Colliery (Plantation year 2021-22, area 23 Ha)





Biological Reclamation on stabilized OB dumps at Block-IV Colliery (Plantation year 2020-21, area 4.5 Ha)



Biological Reclamation on stabilized OB dumps at NAK Colliery (Plantation year 2020-21, area 5 Ha)





Biological reclamation of stabilized OB dumps in New Akashkinaree Colliery (Plantation year FY 2014-15 to 2017-18)

Annexure-III



Stone Pitching along the water body

Annexure-V

Details of OB generated

Colliery Name	OB generated (Lakh cum)									
	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-22	FY 2022-23
New Akashkinaree Colliery	10.01014	28.10951	59.42051	36.15412	38.11560	17.26961	27.54293	13.04	10.94	9.50461
Block-IV/Kooridih Colliery	17.25116	18.37296	17.80795	43.19287	34.79501	20.72033	27.89974	27.96	3.73	8.24221

Details of Backfilling

Colliery Name	Backfilled Area (Ha)									
	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-22	FY 2022-23
New Akashkinaree Colliery	3.6	3.8	13	8	4	4	5	2.53	2.5	1.46
Block-IV/Kooridih Colliery	7.38	5.23	7.54	2.5	3.7	2.7	4.9	6	1.5	4.0

Annexure-VI

Proposed Coal Production, OB generation, and plantation for FY 2023-24

FY 2023-24	New Akashkinaree Colliery (Mixed)	Block-IV Colliery (Mixed)	Maheshpur Colliery (UG)	Jogidih Colliery (UG)
Coal Production (Te)	0.95 MTe (OCP); 0.035 MTe(UG)	0.50 MTe	40000 Te	30000 Te
OB (cum)	41,00,000	25,00,000	NA	NA

Details of plantation done (Bamboo Gabion) for FY 2022-23

Sl. No	Name of Colliery	Nos.
1.	Maheshpur	200
2.	Kharkharee	450
3.	Jogidih	1000
5.	Block-IV	328
Total		1978

Proposed Plantation for FY 2023-24

Type of Plantation	Nos.	Executing Agency
Bamboo Gabion Plantation	150	DFO, Dhanbad

Annexure-VII

Details of Block Plantation/Biological Reclamation done up to 31.03.2023

Year of Plantation	Total Area Covered (Ha)	Species	Survival Rate
FY 2014-15	4	Gamhar, Siris, Subabool, Bel, Kachnar, Kher, Amaltas, Mehandi, Sheesham, Chakundi etc.	80 %
FY 2015-16	4.5		
FY 2016-17	5		
FY 2017-18	4		
FY 2018-19	5		
FY 2019-20	1		
FY 2020-21	9.5		
FY 2021-22	23		

Details of Avenue/Block Plantation/Biological Reclamation done up to 31.03.2023

Year of Plantation	Type of Plantation	Nos.	Executing Agency
FY 2020-21	Block	388 Nos.	DFO, Dhanbad
FY 2022-23	Avenue/ Block	1978 Nos.	DFO, Dhanbad

Annexure-VIII





Sedimentation ponds and settling tanks for mine water utilization



Roads constructed within colliery premises



Bamboo gabion plantations along roads.

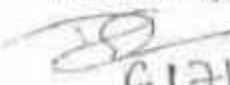


Trolley mounted fog cannon at railway siding



Water Sprinkling on Haul roads within mines through Mist type water tanker (28 KL Capacity)

The locations of monitoring stations are approved by Jharkhand Pollution Control Board. BCCL has awarded the work order for the Project "Source apportionment of ambient air particulate matter in Jharia coalfields region, Jharkhand" to CSIR-NEERI, Nagpur vide Ref no. BCCL/AGM/Envr/SOURCE APPORTIONMENT(MoU)/NEERI/2018/Dated 12.05.2018. NEERI, Nagpur and had submitted the final report on the Source apportionment study and the mineralogical composition study in the Jharia Coalfields on 27.04.2022 (report is attached).

		Ph: 0326-2204933
झारखण्ड राज्य प्रदूषण नियंत्रण पर्वद Jharkhand State Pollution Control Board HIG-1, Housing Colony, Dhanbad-826001		
Letter No. <u>2650</u>		Dated <u>6/2/13</u>
From, Regional Officer, Dhanbad		
To, HOD (Envr.), M/s. B.C.C.I., Koyla Bhawan, Koyla Nagar, Dhanbad.		
Sub: Fixing up monitoring station/Sampling location of Air, Water & Noise.		
Sir, With reference to you letter no. GM(Envr)/F-JSPCB/2013/783, dt. 06.07.2013 We have approved Air, Water & Noise monitoring Station/Sampling location after verification and return a copy of the map.		
Encl-A/a.		
Your's faithfully,  (Dinesh Prasad Singh) Regional Officer.		
Memo.....		Dhanbad, dated.....
Copy to: The Member Secretary, Jharkhand State Pollution Control Board for information & enclose a copy of the map for necessary action.		
Encl-A/a.		
(Dinesh Pd. Singh) Regional Officer.		

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

Sponsor

Bharat Coking Coal Limited (BCCL)



CSIR-National Environmental Engineering
Research Institute, Nagpur



April 2022

Principal Investigator

Dr. Rajesh Biniwale
Senior Principal Scientist
CSIR-National Environmental
Engineering Research Institute
Nagpur-440020, Maharashtra
rb_biniwale@neeri.res.in

Scientific Team

Dr. Yogesh Pakade
Er. S.A. Praveen
Dr. Rakesh Kadaverugu
Dr. Anirban Middey
Dr. A. D. Bhanarkar

Project Team

Mr. Pankaj Kaware
Mr. Ariz Ahmed
Ms. Anshu Pandey
Ms. Samiksha Ashtikar
Ms. Shruti Pande
Ms. Punam Bagde
Ms. Pratiksha Thombre
Mr. Mohit Mahurkar
Mr. Rahul Pawar
Ms. Smita Aditya
Mr. Ankush Rai
Mr. Vijay Selvaraj

Contents

List of Tables	6
Chapter 1 Introduction	7
1.1. Climate	8
1.2. Land use & Land cover	8
1.3. Population	9
1.4. Purpose of Study	9
1.5. Approach of study	11
Chapter 2 Emission Inventory	12
2.1. Inventory of Point Sources	12
2.2. Inventory of Area Sources	12
2.3. Inventory of Line Sources	12
2.4. Methodology	14
2.5. Results	15
2.5.1. Industrial Emission	15
2.5.2. Area/Distributed source	16
➤ Emission load from mining activities	17
➤ Cooking operations in non-slum household	17
➤ Cooking operations in slum households	18
➤ Emissions from crematorium	18
➤ Emissions from bakeries	18
➤ Emissions from hotels and restaurants	18
➤ Emission from open eat-outs	19
2.5.3. Grid wise emission inventory	19
Chapter 3 Air Quality Monitoring and Receptor modelling	22
3.1. Sampling Method and Schedule	24
3.2. Chemical Analysis	26
3.2.1. Gravimetric analysis	26
3.2.2. Elemental analysis	26
3.2.3. Analysis of SO ₂ and NO ₂	26
3.2.4. Ion analysis	27
3.2.5. Polycyclic Aromatic Hydrocarbons (PAH) analysis	27
3.2.6. EC & OC analysis	27
3.3. Results	28
3.3.1. Mass concentration of PM ₁₀ and PM _{2.5}	28
3.3.2. Elemental concentration of PM ₁₀ and PM _{2.5} in summer	30
3.3.3. Elemental Concentration of PM ₁₀ and PM _{2.5} in Winter	31

3.3.4. SO ₂ and NO ₂ concentration in ambient air in the Summer season.....	33
3.3.5. SO ₂ and NO ₂ concentration in ambient air in Winter season.....	33
3.3.6. Carbonaceous Aerosol/EC & OC in Summer.....	34
3.3.7. Carbonaceous Aerosol/EC & OC in winter.....	34
3.3.8. Ionic composition of PM ₁₀ and PM _{2.5} in Summer season.....	36
3.3.9. Ionic composition of PM ₁₀ and PM _{2.5} in Winter season.....	36
Chapter 4 Receptor modelling.....	40
4.1. Source Apportionment.....	40
4.1.1. Chemical Mass Balance (CMB).....	40
4.1.2. Source profiling.....	42
4.1.3. Ambient profiling.....	42
4.2. Results of the Chemical Mass Balance.....	43
4.2.1. Domestic combustion.....	43
4.2.2. Industrial Emission.....	44
4.2.3. Coal Mining.....	44
4.2.4. Transportation.....	44
4.2.5. Secondary Inorganic Aerosol.....	44
4.2.6. Agriculture.....	45
4.2.7. Open burning.....	45
4.2.8. Road Resuspension dust.....	45
4.2.9. Other emission Contribution.....	45
Chapter 5 Dispersion Modelling.....	52
5.1. Wind data analysis.....	52
5.2. Dispersion of Particulate matter.....	54
Chapter 6 Recommendation.....	59
6.1. Mine industries.....	59
6.2. Area Sources.....	59
6.3. Line Source.....	60
6.4. Others.....	61

List of Figures

Figure 1.1: Geographical location of Jharia Coalfield in India	7
Figure 1.2: Land Use land cover map of Jharia coal field area	8
Figure 1.3: Air quality Monitoring & emission source apportionment studies	11
Figure 2.1 Percentage of different types of vehicle surveyed on the road network during the field survey	14
Figure 2.2 PM ₁₀ emission load for different categories of vehicle	15
Figure 2.3 Grid-wise emission inventory of PM ₁₀ in tons/year over the study area	20
Figure 2.4 Grid-wise emission inventory of PM _{2.5} in tons/year over the study area	20
Figure 2.5 (a) and (b) represents emission load from various sectors over JCF region for PM ₁₀ and PM _{2.5} respectively	21
Figure 3.1: Air monitoring sites under 30 km buffer area	23
Figure 3.2: Average concentration of PM ₁₀ and PM _{2.5} in JCF region in summer compared to NAAQS (2009)	29
Figure 3.3: Average concentration of PM ₁₀ and PM _{2.5} in JCF region during Winter compared to NAAQS (2009)	30
Figure 3.4: Metal concentration of PM ₁₀ in the summer season	31
Figure 3.5: Metal concentration of PM _{2.5} in the summer season	31
Figure 3.6: Metal concentration of PM ₁₀ in winter season	32
Figure 3.7: Metal concentration of PM 2.5 in winter season	32
Figure 3.8: NO ₂ and SO ₂ Concentration of all monitoring sites in summer season	33
Figure 3.9: NO ₂ and SO ₂ Concentration of all monitoring sites in Winter season	34
Figure 3.10: EC & OC concentration in PM ₁₀ and PM _{2.5} in Summer season	35
Figure 3.11: EC & OC concentration in PM ₁₀ and PM _{2.5} in Winter Season	36
Figure 3.12: Anion and Cation concentration in PM ₁₀ in summer	37
Figure 3.13: Anion and Cation concentration in PM _{2.5} in summer	38
Figure 3.14: Anion and Cation concentration in PM ₁₀ in winter	38
Figure 3.15: Anion and Cation concentration in PM _{2.5} in winter	39
Figure 4.1: General methodology followed in the source apportionment studies	43
Figure 4.2: Source contribution at receptor locations of PM ₁₀ and PM _{2.5} in summer	47
Figure 4.3: Source contribution at receptor locations of PM ₁₀ and PM _{2.5} in winter	47
Figure 5.1: Methodology followed in the study.	52
Figure 5.2: Windrose of the study area during March-June, 2019 (wind direction blowing towards the center)	53
Figure 5.3: Windrose of the study area during November-December 2019 (wind direction blowing towards the centre)	54
Figure 5.4: AERMOD grid covering the Jharia Coal Fields (JCF). The line, area, and point sources covered in the study are indicated in red color. The UTM coordinates of the left bottom point are x=406111 and y=2603492, and the coordinates of the right top point are x=456248 and y=2653417.	56
Figure 5.5: Windrose diagram for the summer (left) and winter seasons (right) at Jharia Coal Fields during the sampling period. Wind direction is flowing towards the centre.	56
Figure 5.6: 24-hour average maximum ground level concentration of PM contours in the study area simulated during the study periods in summer (left) and winter (right) seasons (a) PM ₁₀ (µg/m ³) and (b) PM _{2.5} (µg/m ³)	57

List of Tables

Table 1.1: LULC classification of Dhanbad study area	9
Table 1.2: Population in the study area as per 2011 census	9
Table 2.1: Daily average vehicle activity on different road network considered during the field survey	13
Table 2.2: Utilization Factors for different types of vehicle	14
Table 2.3: Emission estimate for road transport	14
Table 2.4: Emission rate for the paved and unpaved road	15
Table 2.5: Emission factor for coal mining activities	16
Table 2.6: Emission load from Industrial sector in Dhanbad	16
Table 2.7: Emission load from coal mine activities in Jharia coalfield region	17
Table 2.8: Emissions from the use of LPG in non-slum households in Dhanbad	18
Table 2.9: Emission from coal as fuel	18
Table 2.10: Emission from Crematoria using Wood as fuel	18
Table 2.11: Emission from Bakeries using Coal as fuel	18
Table 2.12: Emission from Hotel & Restaurants using Coal	19
Table 2.13: Emission from Hotel & Restaurants using LPG	19
Table 2.14: Emission loads from open eat-outs	19
Table 3.3.1: The details of mine cluster in Jharia Coalfield	22
Table 3.3.2: Frequency of Air pollutants sampling in Jharia Coalfields	24
Table 3.3.3: Ambient Air Quality Sampling/Analysis Methodology for Target Pollutants	24
Table 3.3.4: National Ambient Air Quality Standards (2009)	25
Table 3.3.5 Standards for Coal Mines (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)	26
Table 4.1: Summary of relevant air quality studies from major Indian cities.	48
Table 5.1 Performance Stimulation Metric	58

Chapter 1 Introduction

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

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

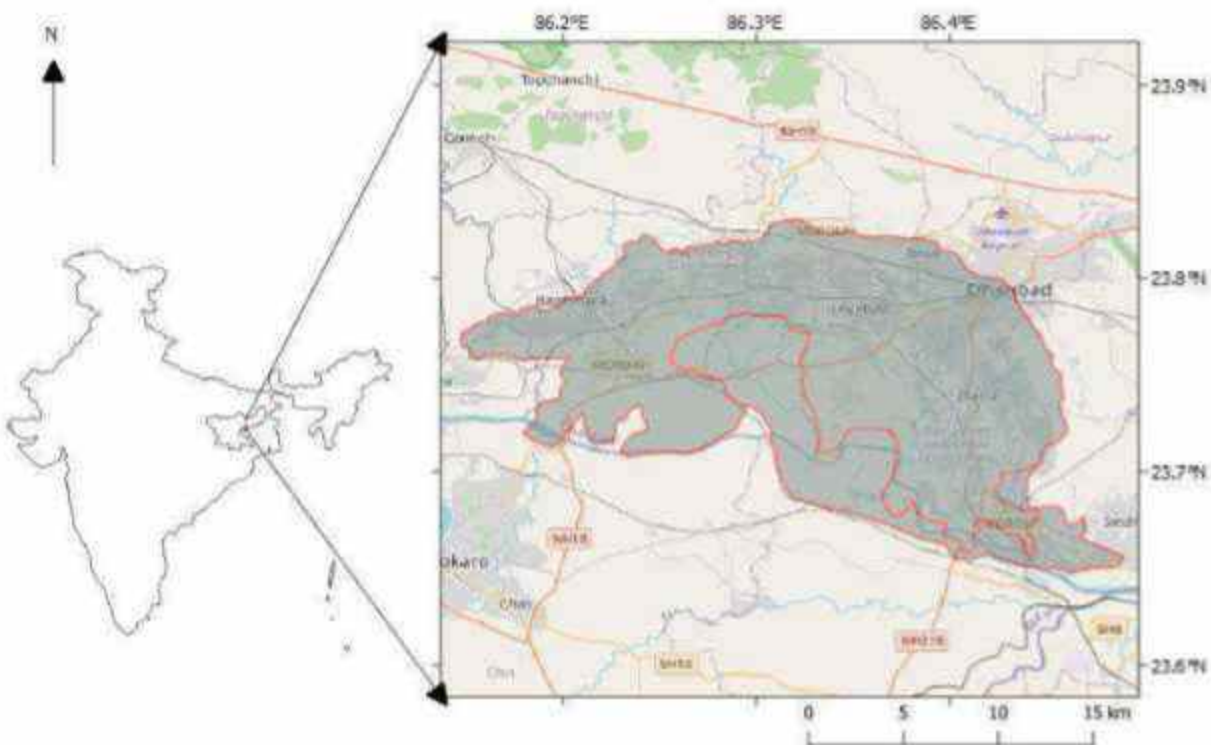


Figure 1.1: Geographical location of Jharia Coalfield in India

1.1. Climate

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

1.2. Land use & Land cover

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

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

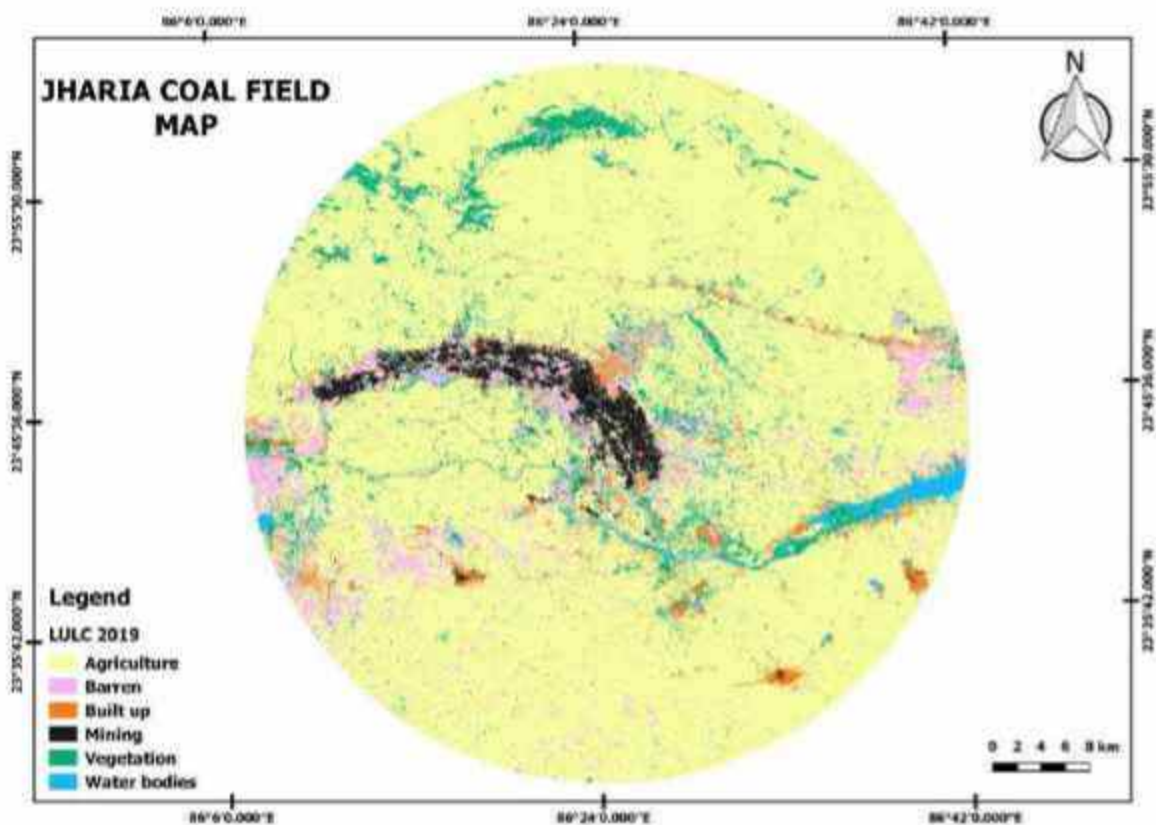


Figure 1.2: Land Use land cover map of Jharia coal field area

Table 1.1: LULC classification of Dhanbad study area

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

1.3. Population

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

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

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

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

1.4. Purpose of Study

Urban air pollution is a notable concern across the world. Inferring to the rapid rates of industrialization and urbanization in Indian cities, polluted air quality is considered a key factor in crumbling the quality of life with an adverse effect on the human being. Hence air quality gained a significant role in recent decades since it is worsened by emission from major pollutants including particulate matter (PM₁₀ and PM_{2.5}), NO₂, SO₂ and O₃ were found to exceed the national ambient air quality standard (NAAQS) limits.

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

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

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

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

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

The detailed objectives are as follows:

i. Ambient Air Monitoring

- Monitoring of ambient air quality at selected receptor locations for pollutants including PM₁₀, PM_{2.5}(limited), SO_x, NO_x, PAHs to establish the status of the air quality in Jharia Coalfields and an area up to 10 K.M from the periphery/boundary of BCCL mines. Also, review of the available air quality monitoring data from Central Pollution Control Board (CPCB) /Jharkhand State Pollution Control Board (JSPCB).
- To validate dispersion modelling predictions using measured air quality parameters
- To draw supportive data through the specific site-related monitoring regarding impact causing sources such as kerbside monitoring
- To establish the impact of meteorological conditions on a few select indicator pollutants in different micrometeorological conditions of the Jharia Coalfields

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

1.5. Approach of study

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

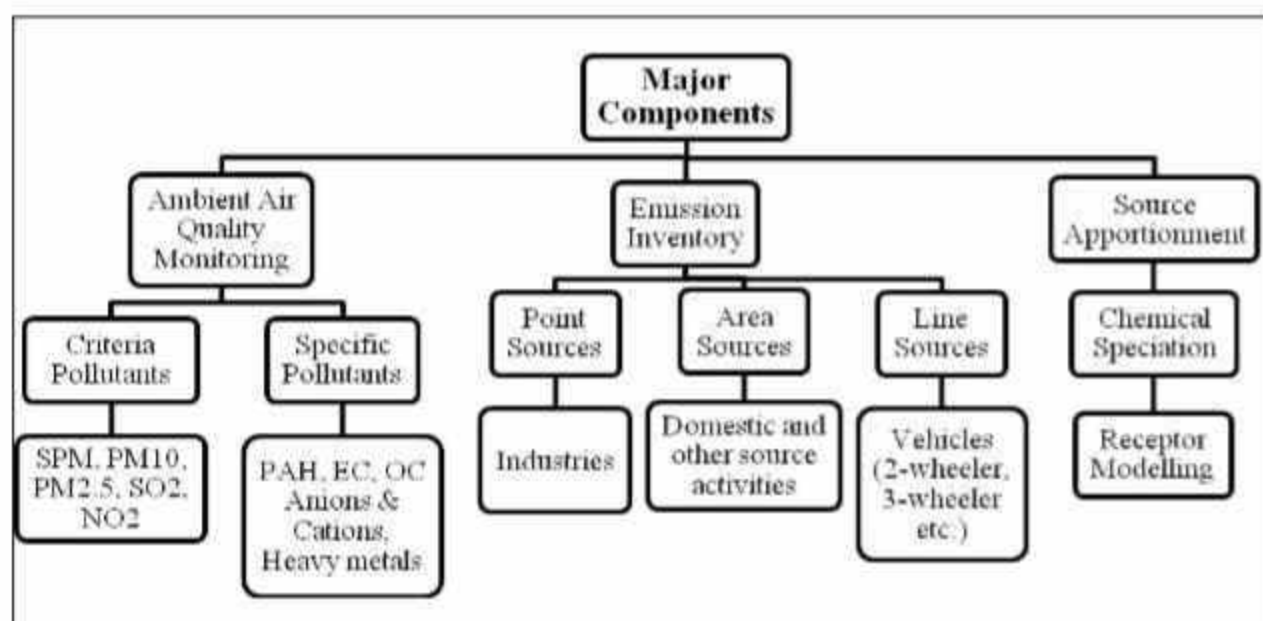


Figure 1.3: Air quality Monitoring & emission source apportionment studies

Chapter 2 Emission Inventory

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

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

2.1. Inventory of Point Sources

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

2.2. Inventory of Area Sources

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

2.3. Inventory of Line Sources

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

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

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

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

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

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

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

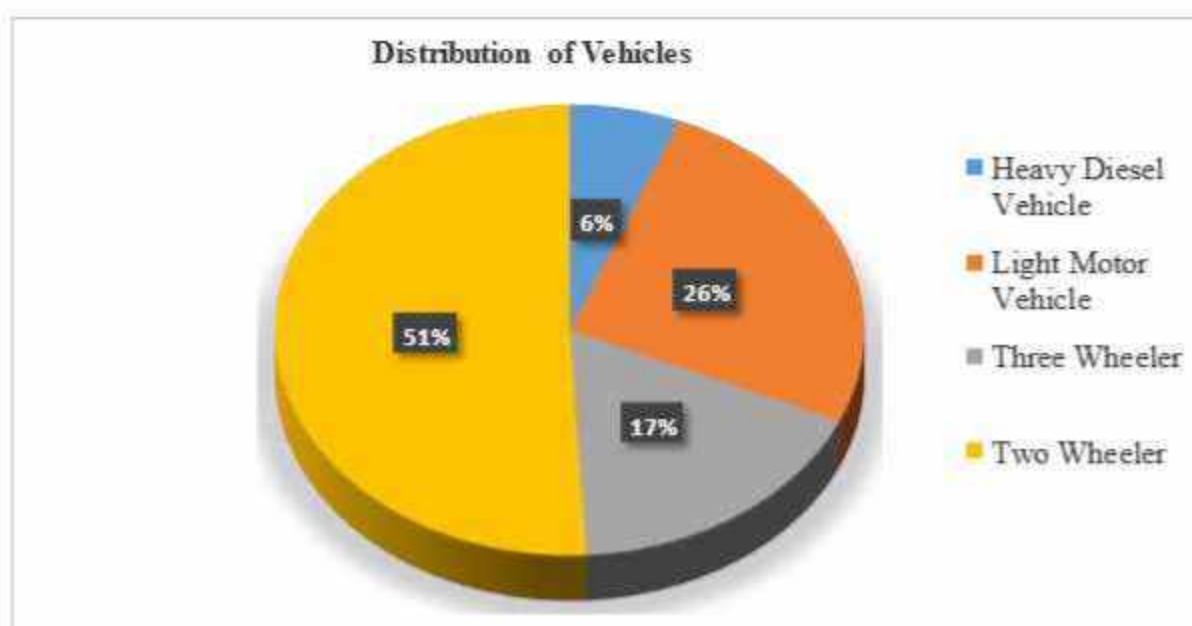


Figure 2.1 Percentage of different types of vehicle surveyed on the road network during the field survey

Table 2.2: Utilization Factors for different types of vehicle

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

2.4. Methodology

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

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

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

N_v is the number of vehicles of a particular type

VKT is the vehicle km travelled

E_f , km is the emission factor for a specific vehicle

Table 2.3: Emission estimate for road transport

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

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

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

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

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

S_L is silt load (g/m^2);

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

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

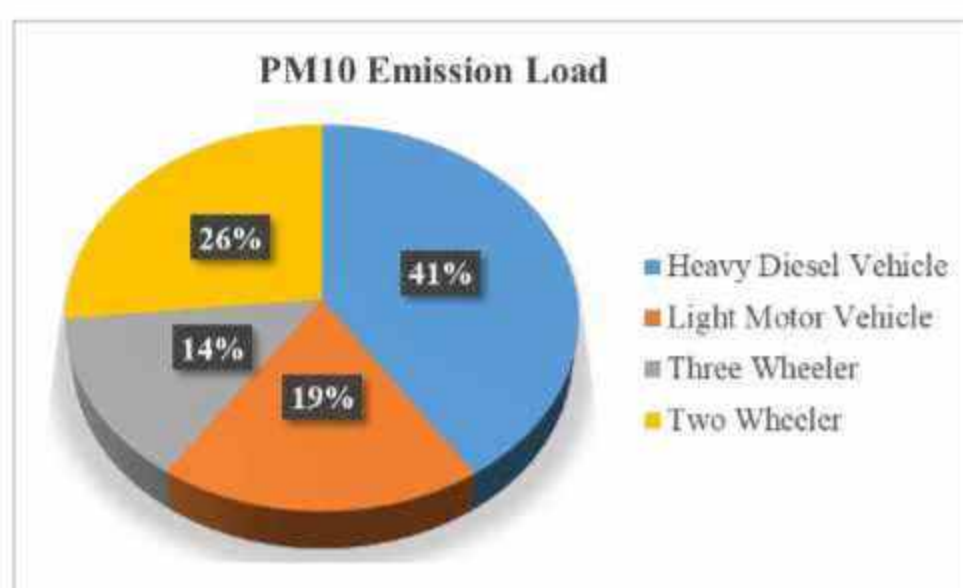


Figure 2.2 PM₁₀ emission load for different categories of vehicle

It is observed that 41% of PM₁₀ emission is contributed by the Heavy-duty diesel vehicles followed by two-wheelers (26%), Light motor vehicles (19%) and three-wheelers (14%) in the considered road network during the study period.

Table 2.4: Emission rate for the paved and unpaved road

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

2.5. Results

2.5.1. Industrial Emission

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

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

Table 2.5: Emission factor for coal mining activities

EF	TSP	PM ₁₀	PM _{2.5}	SO ₂	NO ₂
g/Mg Coal	1914	1864	1176	420	820

Table 2.6: Emission load from Industrial sector in Dhanbad

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

2.5.2. Area/Distributed source

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

Area sources considered for emission inventory for Dhanbad city are:

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

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

➤ Emission load from mining activities

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

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

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

➤ Cooking operations in non-slum household

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

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

LPG Pollutant	PM ₁₀	SO ₂	NO ₂	CO	HC
Emission Factor (g/kg)	2.1	0.4	1.8	0.25	0.07
Emission (T/Year)	0.00575	0.0011	0.0049	0.0007	0.0002

➤ Cooking operations in slum households

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

Table 2.9: Emission from coal as fuel

Pollutant	SPM	SO ₂	NO ₂	CO	HC
Emission Factor (g/kg)	20	13.3	3.99	24.92	0.5
Emission (T/Year)	28.354	18.856	5.657	35.330	0.709

➤ Emissions from crematorium

In order to calculate emission from crematoria data were obtained from crematoriums in Dhanbad. Emission from the burning of bodies using woods mainly produces PM₁₀, CO and HC majorly as depicted in Table 2.10.

Table 2.10: Emission from Crematoria using Wood as fuel

Pollutant	PM ₁₀	SO ₂	NO ₂	CO	HC
Emission Factor (g/Kg)	17.3	0.2	1.3	126.3	114.5
Emission (kg/day)	7.178	0.083	0.537	52.183	47.308

➤ Emissions from bakeries

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

Table 2.11: Emission from Bakeries using Coal as fuel

Pollutant	SPM	SO ₂	NO ₂	CO	HC
Emission Factor (g/kg)	20	13.3	3.99	24.92	0.5
Emission (T/Year)	6.26	4.16	1.25	7.80	0.16

➤ Emissions from hotels and restaurants

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

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

Table 2.12: Emission from Hotel & Restaurants using Coal

Pollutant	SPM	SO ₂	NO ₂	CO	HC
Emission Factor (g/kg)	20	13.3	3.99	24.92	0.5
Emission (T/Year)	8.110	5.393	1.618	10.105	0.203

Table 2.13: Emission from Hotel & Restaurants using LPG

Pollutant	PM ₁₀	SO ₂	NO ₂	CO	HC
Emission Factor (g/kg)	2.1	0.4	0.8	0.25	0.07
Emission (T/Year)	0.136	0.026	0.117	0.016	0.005

➤ Emission from open eat-outs

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

Table 2.14: Emission loads from open eat-outs

Pollutant	SPM	SO ₂	NO ₂	CO	HC
Emission Factor (g/kg)	20	13.3	3.99	24.92	0.5
Emission (T/Year)	14.07	9.36	2.81	17.54	0.35

2.5.3. Grid wise emission inventory

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

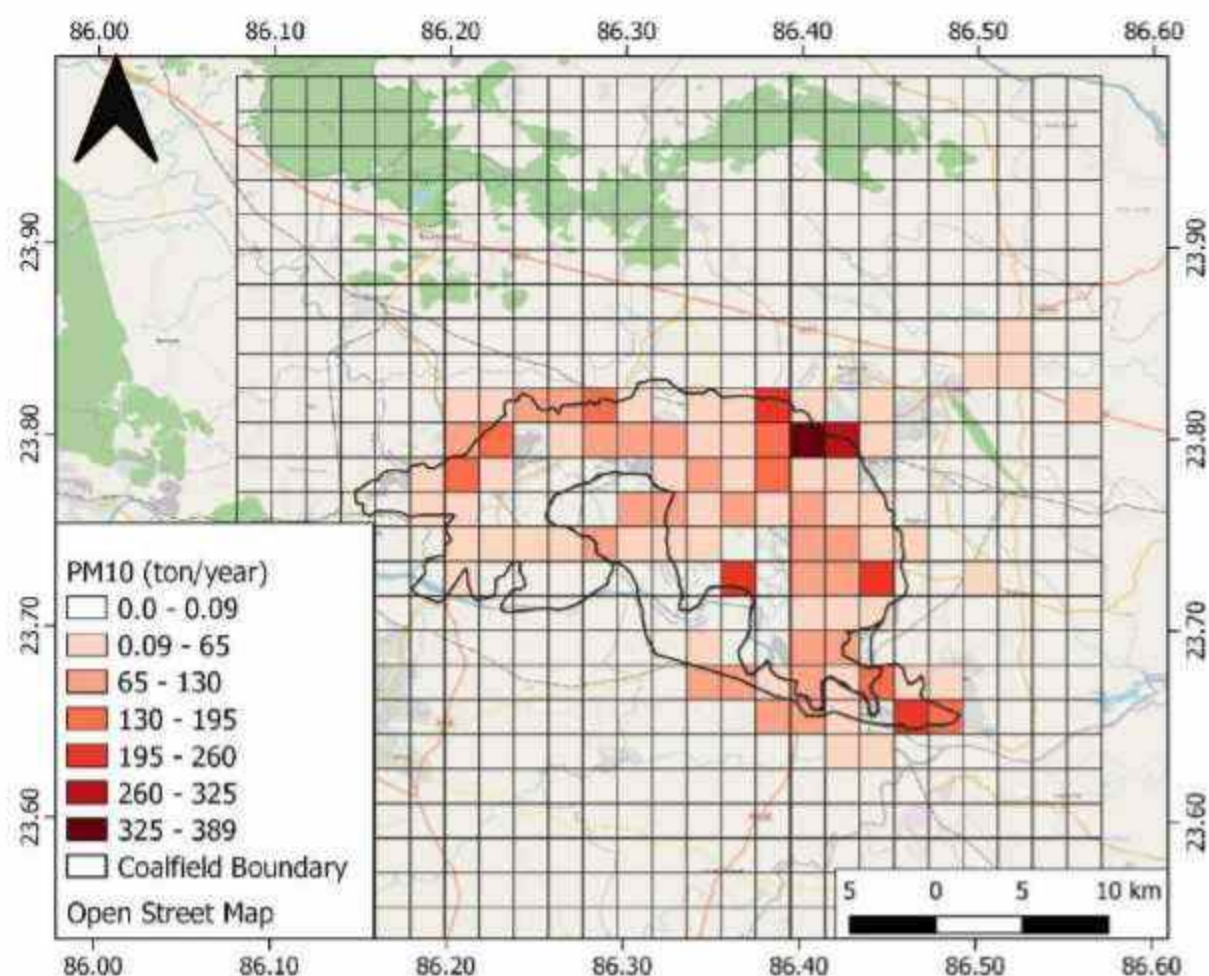


Figure 2.3 Grid-wise emission inventory of PM₁₀ in tons/year over the study area

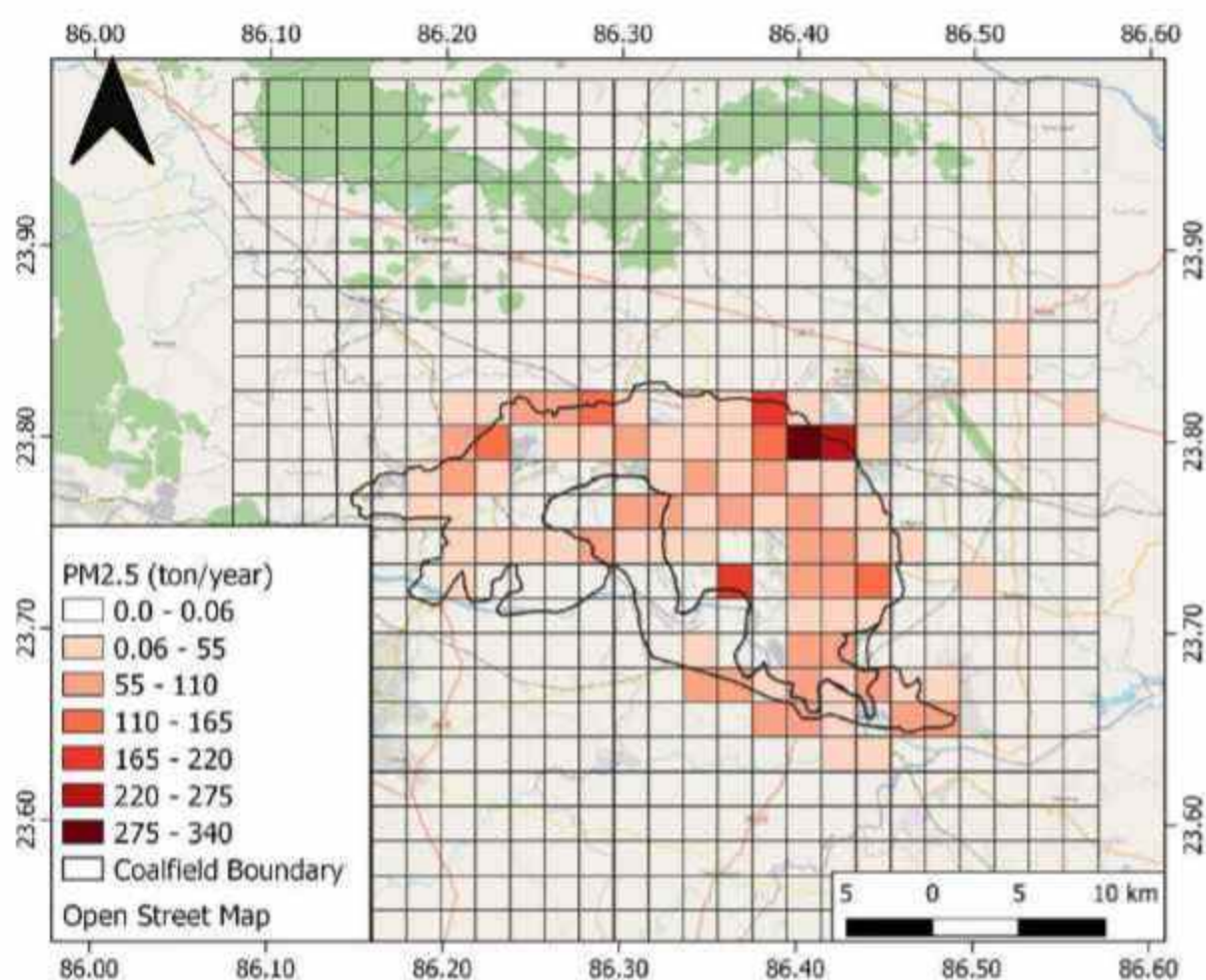


Figure 2.4 Grid-wise emission inventory of PM_{2.5} in tons/year over the study area

The respective share of various emission sources is represented through pie diagrams shown in Figure 2.5. Data shows that PM₁₀ emissions are contributed mostly from vehicular emissions

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



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

References

- Automotive Research Association of India (ARAI), CPCB/MoEF. (2007). EF development for Indian vehicles, as a part of ambient air quality monitoring and emission source apportionment studies. AFL/2006-07/IOCL/Emission Factor Project/Final Rep. [https://www.cpcb.nic.in/DRAFT REPORT-on-efdiv .pdf](https://www.cpcb.nic.in/DRAFT%20REPORT-on-efdiv.pdf)
- Central Pollution Control Board, Delhi, India. (2008–2010). Air quality monitoring, emission inventory and source apportionment studies for Indian cities. <https://cpcb.nic.in>
- Apoorva Pandey, Chandra Venkataraman, Estimating emissions from the Indian transport sector with on-road fleet composition and traffic volume, *Atmospheric Environment*, Volume 98, 2014, Pages 123-133, ISSN 1352-2310, <https://doi.org/10.1016/j.atmosenv.2014.08.039>.
- Roy, D., Singh, G., Sinha, S., Park, J., & Seo, Y. C. (2021). Emission inventory of PM_{10} in Dhanbad/Jharia coalfield (JCF), India: an intricate coal mining sector. *Environment, Development and Sustainability*, 23(3), 3048-3061. <https://doi.org/10.1007/s10668-020-00702-4>.

Chapter 3 Air Quality Monitoring and Receptor modelling

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

Table 3.3.1: The details of mine cluster in Jharia Coalfield

	Day 1: Cluster I, II, III, IV, XII, XIII, XV and XIV
	Day 2: Cluster V, VI, VII, and VIII
	Day 3: Cluster IX, X and XI

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

- **Core Zone**

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

- **Buffer Zone**

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

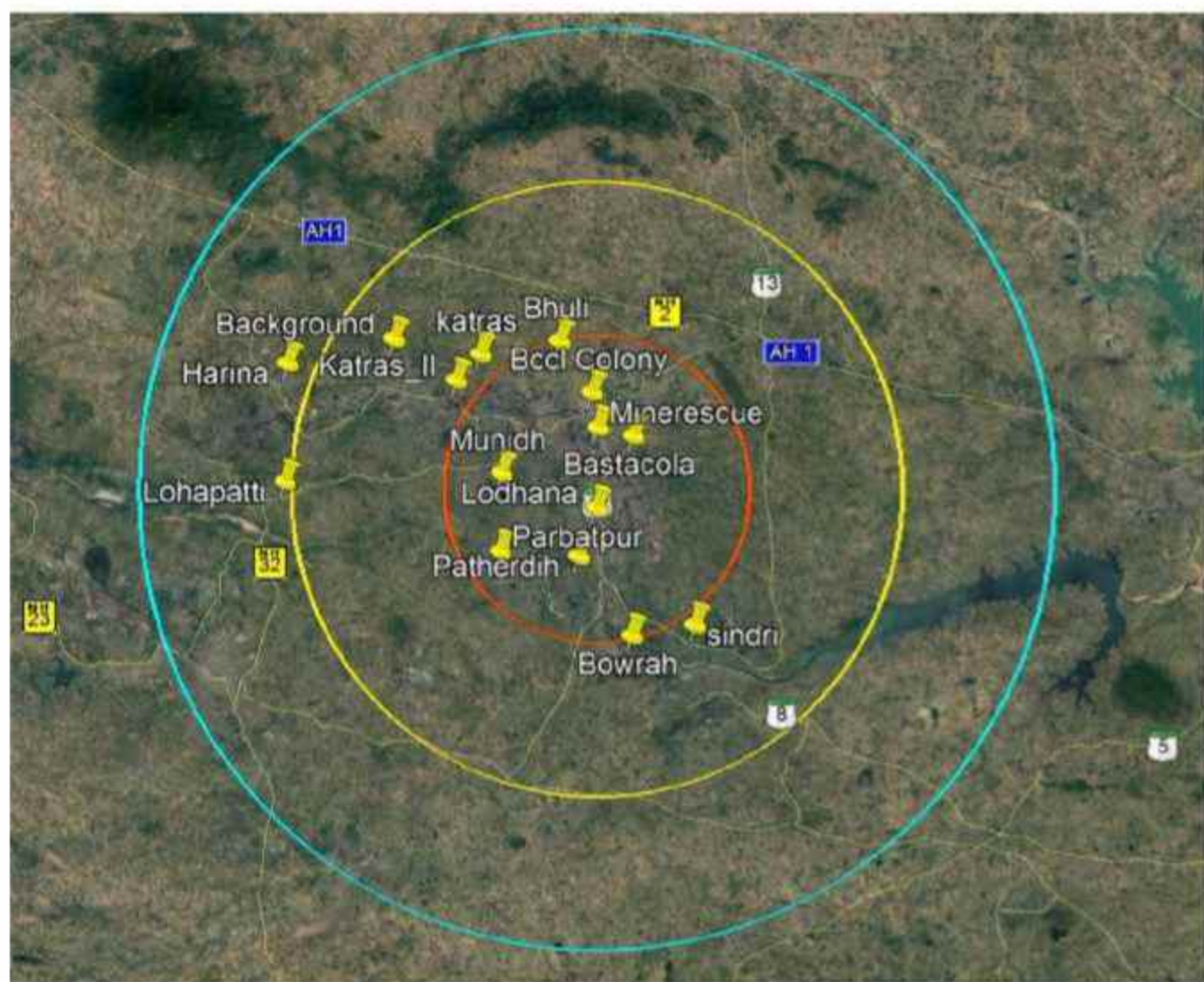


Figure 3.1: Air monitoring sites under 30 km buffer area

3.1. Sampling Method and Schedule

The PM₁₀ and PM_{2.5} sampling for Jharia Coalfields was done at all the 13 sampling sites for the period of 24 h using low volume respirable suspended particulate matter samplers (Instrumax, ARA and Envirotech) on Quartz and polytetrafluoroethylene (PTFE) filter paper of 47 mm diameter. Samplers at a flow rate of 16.67 LPM were used. The filter papers were desiccated before and after sampling for 24h at a temperature of $27 \pm 3^\circ\text{C}$ and at a relative humidity (RH) of $55 \pm 2\%$ to remove the moisture present in them. The PM₁₀ and PM_{2.5} field samples were collected periodically throughout the sampling period. The sampling frequency and types of equipment used for monitoring are described in Table 3.3.2 and 3.3.3. The national Ambient quality and Standards for Coal Mines (Stipulated by Ministry of Environment and Forests are depicted in Table 3.3.4. and Table 3.3.5.

Table 3.3.2: Frequency of Air pollutants sampling in Jharia Coalfields

Parameter	Number of Days	Change of Filter/ absorbing media	Reporting
PM ₁₀	10	24 hourly, Teflon: 5 Days Quartz: 5 Days	24 hourly
PM _{2.5}	10	24 hourly Teflon: 5 Days Quartz: 5 Days	24 hourly
NO ₂	10	8 hourly	8 hourly
SO ₂	10	8 hourly	8 hourly

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

Particulars	Parameters			
	PM ₁₀	PM _{2.5}	NO ₂	SO ₂
Sampling Instrument	INSTUMEX and ARA-N-FRM Sampler	INSTUMEX and ARA-N-FRM Sampler	APM sampler	APM sampler
Sampling Principle	Cyclonic Flow Technique	Cyclonic Flow Technique	Chemical absorption in suitable media	Chemical absorption in suitable media
Flow rate	16.7 LPM	16.7 LPM	0.5 LPM	0.5 LPM
Sampling Period	24 hourly	24 hourly	8 hourly	8 hourly
Sampling Frequency	7 days continuous, Teflon and quartz on alternate days	7 days continuous, Teflon and quartz on alternate days	7 days continuous	7 days continuous
Analytical Instrument	Electronic Micro Balance	Electronic Micro Balance	Spectrophotometer	Spectrophotometer
Analytical Method	Gravimetric	Gravimetric	Modified Jacob and Hochheiser method	Colorimetric Improved West & Gaeke Method
Minimum reportable value	5 $\mu\text{g}/\text{m}^3$	5 $\mu\text{g}/\text{m}^3$	9 $\mu\text{g}/\text{m}^3$	4 $\mu\text{g}/\text{m}^3$

Table 3.3.4: National Ambient Air Quality Standards (2009)

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

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

Pollutant	Time weighted Average	Concentration in Ambient Air	
		New Coal Mines (commenced after 25.09.2000)	Existing Coal Mines (commenced prior to 25.09.2000)
Suspended Particulates Matter (SPM)	Annual Average	360µg/m ³	430µg/m ³
	24 hours	500µg/m ³	600µg/m ³
Respirable Particulate Matter (size less than 10 µm) (RPM)	Annual Average	180µg/m ³	215µg/m ³
	24 hours	250µg/m ³	300µg/m ³
Sulphur Dioxide (SO ₂)	Annual Average	80µg/m ³	80µg/m ³
	24 hours	120µg/m ³	120µg/m ³
Oxides of Nitrogen as NO ₂	Annual Average	80µg/m ³	80µg/m ³
	24 hours	120µg/m ³	120µg/m ³

3.2. Chemical Analysis

3.2.1. Gravimetric analysis

The exposed filters were analysed by gravimetric technique using a weighing balance for PM₁₀ particles and using a microbalance for PM_{2.5} particles with a precision of 5µg with automatic (internal) calibration.

3.2.2. Elemental analysis

PM₁₀ samples collected on glass fibre filters were digested in a microwave digester. The samples were made up to 50ml using deionized distilled water. Similarly, the exposed filters containing PM_{2.5} particles were cut equally into 2 halves. A part of the exposed filter was used for ions analysis. Whereas, the other half was cut into tiny fragments and digested and made up to 15mL using distilled deionized water. The obtained samples (both PM₁₀ and PM_{2.5}) after digestion were stored in vials and refrigerated at 4°C until further analysis. These samples were later subjected to estimate the elemental composition using ICP-OES (Thermo Scientific, USA).

3.2.3. Analysis of SO₂ and NO₂

SO₂ analysis: Modified West and Gaeke method was followed for sampling and analysis of Sulfur dioxide in ambient air. SO₂ from the air is absorbed in a solution of potassium tetracholo-mercute (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air was formed. Once formed, that complex was stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex was made to react with pararosaniline and formaldehyde to form the intensely colored pararosaniline methylsulphonic acid. The absorbance of the solution was measured by means of a suitable spectrophotometer.

NO₂ analysis: Modified Jacobs and Hochheiser method was followed for sampling and analysis of NO₂ in ambient air. Ambient NO₂ was collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion produced during sampling was determined calorimetrically by the nitrite ion reaction with phosphoric acid, sulphanilamide, and N-(1-naphthyl)-ethylenediamine di-hydrochloride (NEDA) and the absorbance of the highly colored azo dye was measured at 540nm.

3.2.4. Ion analysis

The filter papers containing both PM₁₀ and PM_{2.5} samples were extracted and subjected to ion analysis as per standards. The filter papers were divided into tiny fragments and moistened with isopropanol slightly before extraction since the filters are hydrophobic. Further 25 mL of deionized distilled water was added and sonicated using an ultrasonic bath for 60 min at 60°C. The samples were then kept overnight after sonication. Furthermore, the samples were then filtered using nylon filter discs (25mm, 0.45mm) and were refrigerated at 4°C until further analysis. The extracted samples were subjected to IC to analyse the ions (anions and cations) present in them.

3.2.5. Polycyclic Aromatic Hydrocarbons (PAH) analysis

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

3.2.6. EC & OC analysis

This is a thermal/optical-transmittance (TOT) method that speciates carbon in particulate matter collected on a quartz-fiber filter into OC, EC, and CC. In the first (or non-oxidizing) heating stage, organic and carbonate carbon is thermally desorbed from the filter under a flow of helium with controlled temperature ramps. The oven is then partially cooled, and the original flow of helium is switched to an oxidizing carrier gas (He/O₂). In the second (or oxidizing) heating stage, the original elemental carbon component plus pyrolyzed organic carbon formed during the first heating stage are oxidized/desorbed from the filter with another series of controlled temperature ramps. All carbon evolved from the sample is converted to CO₂ in an oxidizing oven immediately downstream from the desorption oven, and the CO₂ is converted to methane (CH₄) by a methanator oven before being measured with a flame ionization detector (FID). (<https://www3.epa.gov/ttnamtl1/files/ambient/pm25/spec/RTIOCECSOP.pdf>)

3.3. Results

3.3.1. Mass concentration of PM₁₀ and PM_{2.5}

In summer monitoring, the mean mass concentrations of PM₁₀ particles in all 13 sampling sites were found to be in the range of 74-184 $\mu\text{g}/\text{m}^3$ with the highest concentration of 184 $\mu\text{g}/\text{m}^3$ at mine rescue site and lowest concentration of 74 $\mu\text{g}/\text{m}^3$ at Bastacola site. Also, the mean mass concentration of PM_{2.5} particles was found in the range of 49-117 $\mu\text{g}/\text{m}^3$ with the highest concentration of 117 $\mu\text{g}/\text{m}^3$ and the lowest concentration of 49 $\mu\text{g}/\text{m}^3$ recorded at Harina and Lohapatti site respectively.

The average concentrations of PM₁₀ and PM_{2.5} in two seasons are described in Table 3.6 and 3.7. Results revealed that the average concentrations of PM₁₀ are within the prescribed limits of MoEF notification guidelines for coal mine areas. In the case of PM_{2.5}, there is no Govt. notified standard for mining areas but in the case of buffer zones, National Ambient Air Quality Standard, NAAQS, 2009 may be applicable. The highest PM₁₀ and PM_{2.5} concentrations were found in Mine rescue and Harina (Figure 3.2 and 3.3).

Table 3.6: Average concentration of PM₁₀ and PM_{2.5} in Summer of Jharia Coalfield

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

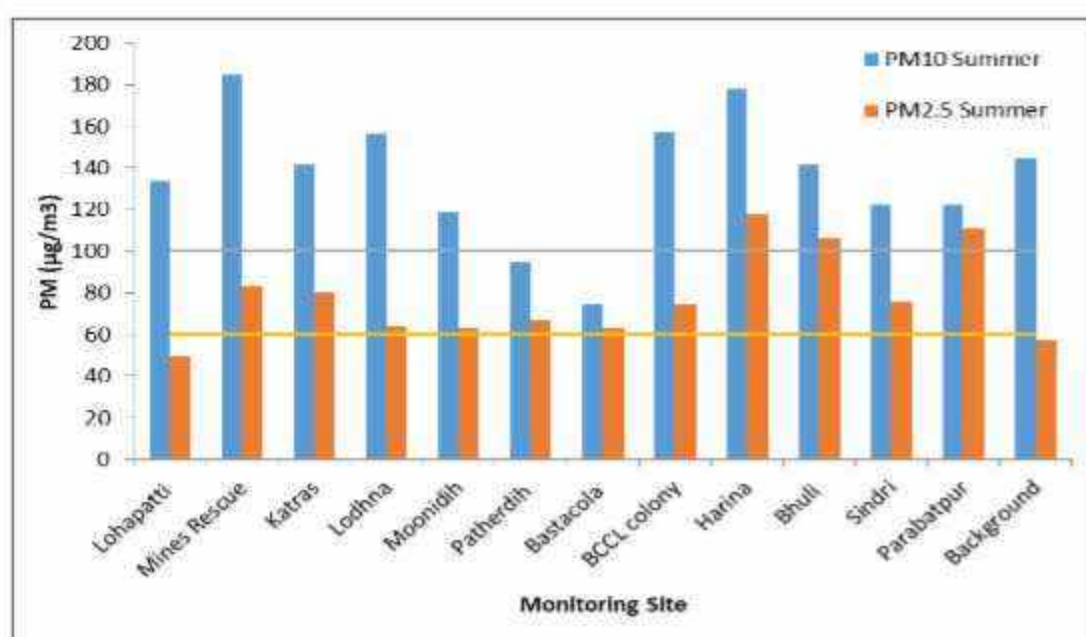


Figure 3.2: Average concentration of PM₁₀ and PM_{2.5} in JCF region in summer compared to NAAQS (2009)

Table 3.7: Average concentration of PM₁₀ and PM_{2.5} in winter of Jharia Coalfield.

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

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

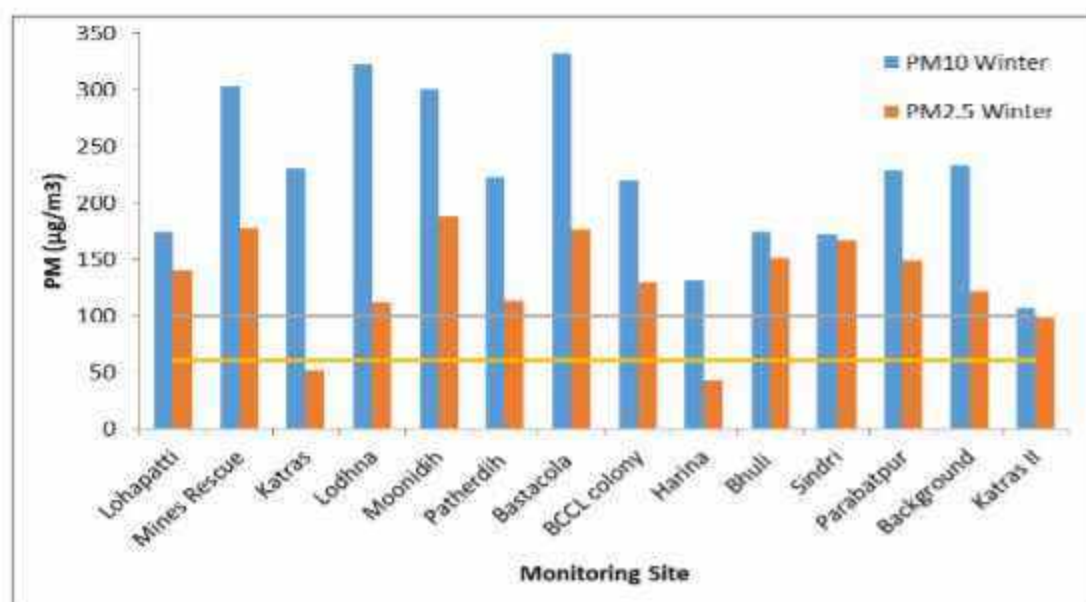
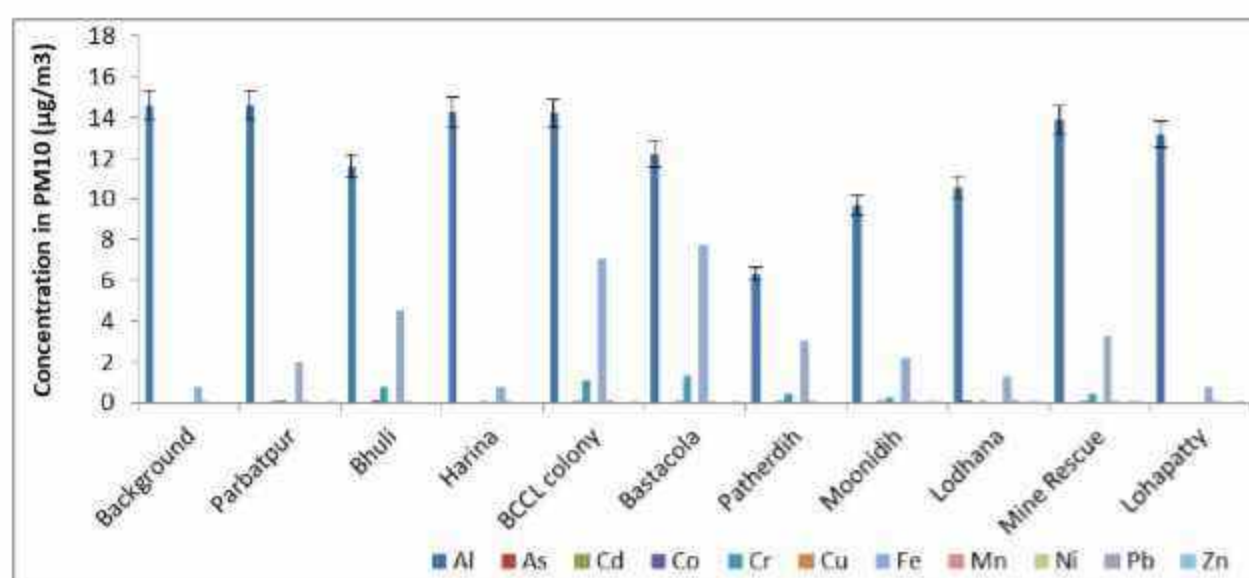
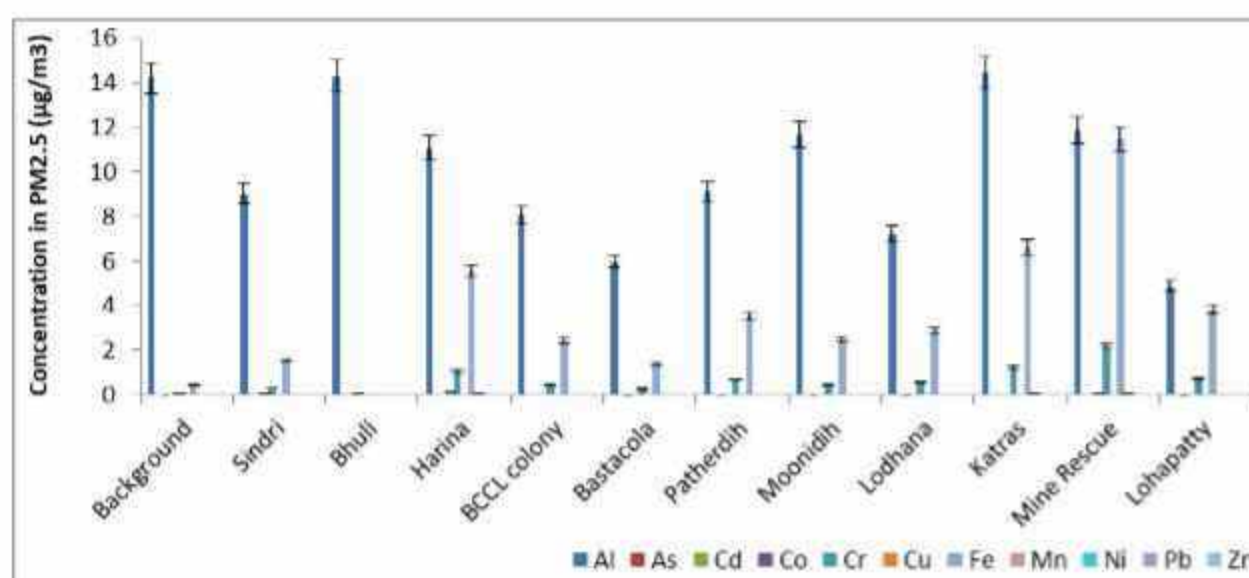


Figure 3.3: Average concentration of PM_{10} and $PM_{2.5}$ in JCF region during Winter compared to NAAQS (2009)

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

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

Figure 3.4: Metal concentration of PM₁₀ in the summer seasonFigure 3.5: Metal concentration of PM_{2.5} in the summer season

3.3.3. Elemental Concentration of PM₁₀ and PM_{2.5} in Winter

The elemental analysis was performed using inductively coupled plasma optical emission spectroscopy (ICP-OES). For the air quality assessment, the concentrations of 11 elements i.e. Al, As, Cd, Cr, Cu, Fe, K, Mn, Ni, Pb, and Zn in PM₁₀ and PM_{2.5} samples, were measured. Among all the elements, Al, Fe, and K concentrations were found considerably higher for PM₁₀ samples in the winter season. Al was observed in the range of 2.02-10.77 µg/m³ followed by Fe (0.79-9.26 µg/m³) and K (0.90-4.19 µg/m³). Maximum Al concentration (10.77 µg/m³) was observed at the BCCL colony, followed by Lodhna (10.29 µg/m³). The Highest Fe concentration (9.26 µg/m³) was observed at Bastacola while K (4.19 µg/m³) at the Lodhna site. This may be due to vehicular emissions, paved roads, construction dust, coal combustion, soil dust, etc. The concentration of As, Ni, Pb was found within the limits of CPCB standards. The remaining elements i.e. Cd, Cr, Cu, Mn, and Zn were found very low (Figure 3.6).

Similarly, in the case of PM_{2.5} samples concentrations of Al, Fe and K were detected higher than other elements. The concentration of Al, Fe, and K was obtained as 0.11-2.91 µg/m³, 0.05-1.93 µg/m³ and 0.08-2.12 µg/m³. For PM_{2.5} particles, maximum Al and K were found at the Munidih site, which were 2.91 µg/m³ and 2.12 µg/m³ respectively. The highest concentration of

Fe i.e. $1.93\mu\text{g}/\text{m}^3$ was detected at Lodhna site. The concentrations of all other analysed elements were low (Figure 3.7).

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

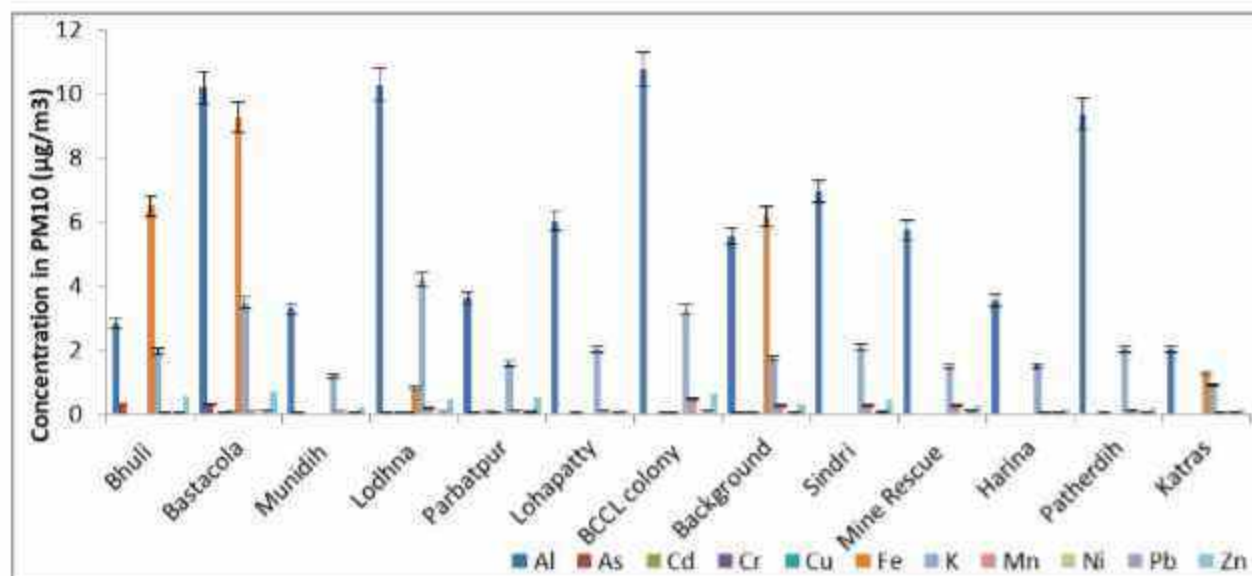


Figure 3.6: Metal concentration of PM₁₀ in winter season

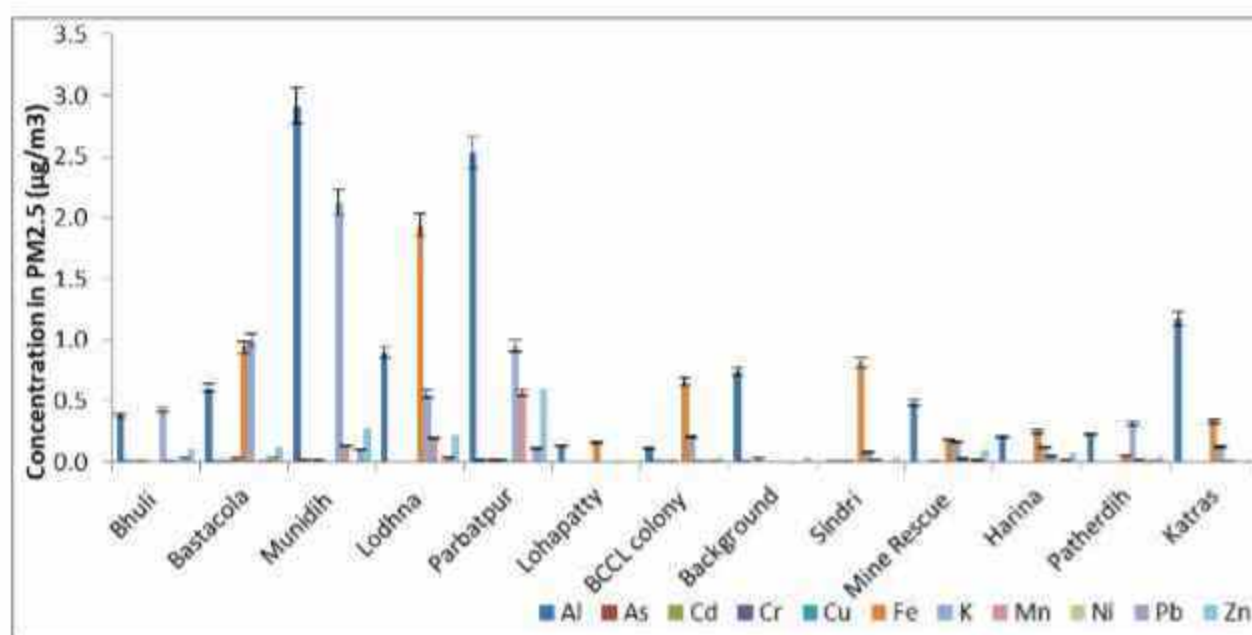


Figure 3.7: Metal concentration of PM 2.5 in winter season

3.3.4. SO₂ and NO₂ concentration in ambient air in the Summer season

The mean average SO₂ concentration in the summer season among all the monitoring stations ranged between 11 µg/m³ (Harina & Bastacola) and 24.5 µg/m³ (Moonidih), being well below the threshold limits of 80 µg/m³ (residential or industrial). The 8-hour average NO₂ concentrations were between 10.3 µg/m³ (Background) and 40.9 µg/m³ (Lodhana), well within the standard limits of 80 µg/m³ (residential or industrial) Figure 3.8. The SO₂ in the residential areas may be received from the open burning of raw coal and other domestic and commercial activities.

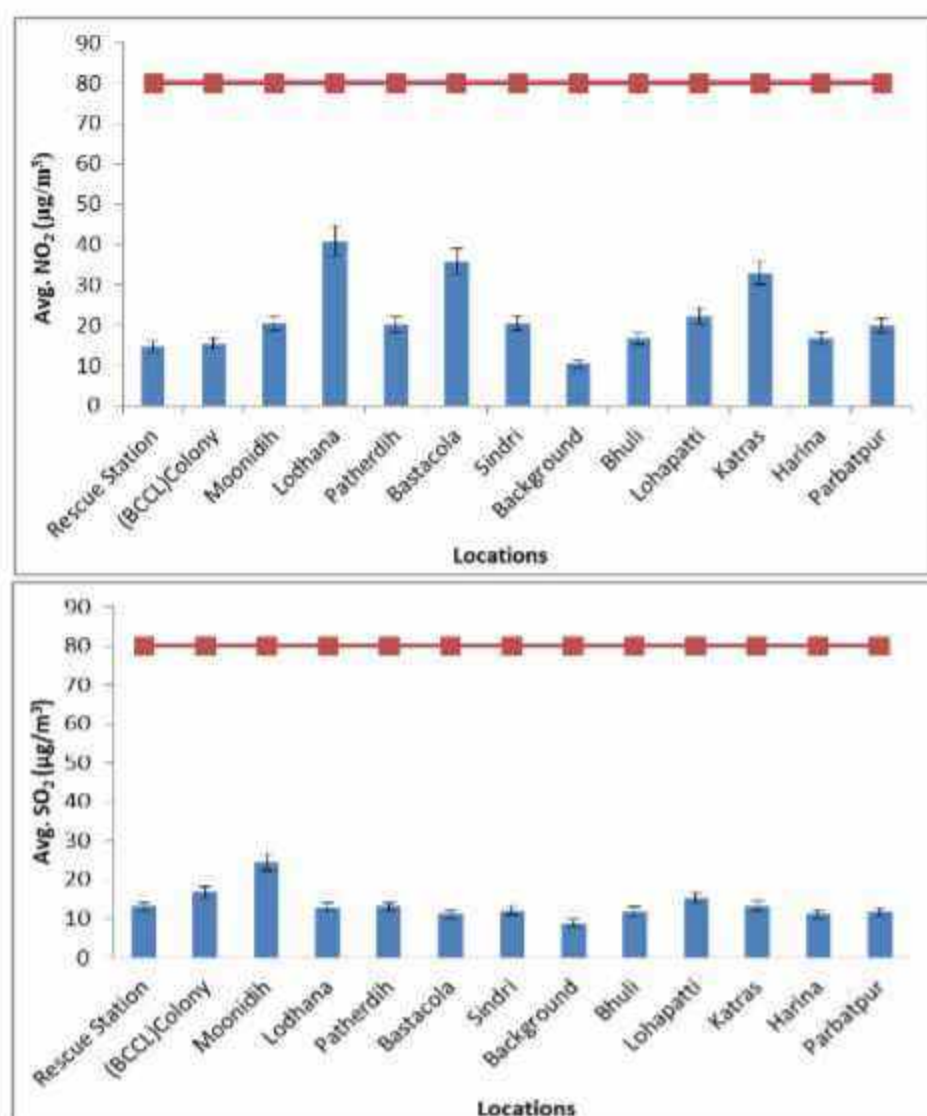


Figure 3.8: NO₂ and SO₂ Concentration of all monitoring sites in summer season

3.3.5. SO₂ and NO₂ concentration in ambient air in Winter season

The mean concentration of NO₂ and SO₂ in the winter season was found below the threshold limit i.e. 80 µg/m³. The concentration of SO₂ was below 10 µg/m³ in Katra, BCCL colony, Mine Rescue, Bastacola, Lodhana and Munidih. Bastacola and Bhuli site has a NO₂ concentration above 10 µg/m³ (Figure 3.9). It has been observed that the concentration of NO₂ and SO₂ in the winter and summer seasons were below the standard limit. But the average concentration of NO₂ and SO₂ in the summer season was higher than in the winter season.

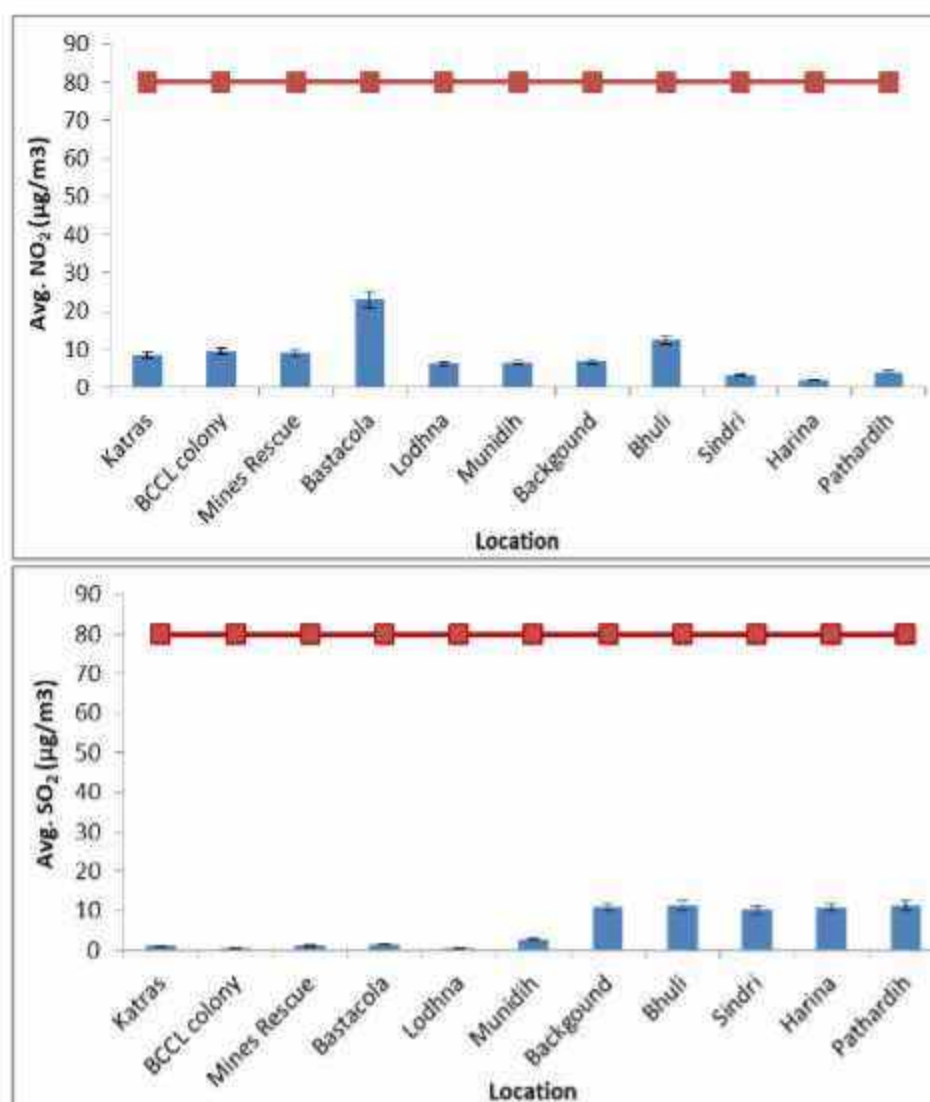


Figure 3.9: NO₂ and SO₂ Concentration of all monitoring sites in Winter season

3.3.6. Carbonaceous Aerosol/EC & OC in Summer

Data were obtained for four OC fractions (OC1, OC2, OC3 and OC4 in He atmosphere at 140, 280, 480 and 580°C, respectively) and three EC fractions (EC1, EC2, and EC3 in a 2% O₂/98% He atmosphere at 580, 740 and 840°C, respectively). The IMPROV protocol defines OC as OC1 + OC2 + OC3 + OC4 and EC as EC1 + EC2 + EC3. The mass concentration of organic matter (OM) in the atmosphere was estimated by multiplying OC by 1.6 (conversion factor for urban aerosol). The total carbonaceous aerosol (TCA) was calculated as the sum of OM and EC. The highest concentration of OC and EC in PM_{2.5} was found in the BCCL colony site i.e. 37.85 and 42.33 µg/m³, respectively, and the lowest OC concentration was 15.36 µg/m³ and EC was 13.08 µg/m³ in Sindri site. In comparison, the concentration of OC (67.35 µg/m³) and EC (81.67 µg/m³) in PM₁₀ were higher in the BCCL colony among all the sites. The lowest OC concentration as 17.95 µg/m³ was in Bastacola and EC in Parbatpur i.e. 15.44 µg/m³ (Figure 3.10).

3.3.7. Carbonaceous Aerosol/EC & OC in winter

The mass concentration of EC and OC in PM₁₀ and PM_{2.5} are more significant than 100 µg/m³ and 70 µg/m³, respectively in Bastacola, Katras, Mine Rescue, Background, and Sindri. The highest concentration of EC in PM₁₀ and PM_{2.5} was observed in the Sindri site, whereas OC was found higher in Sindri and Bastacola. OC contributing to PM₁₀ mass concentration was lowest in

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

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

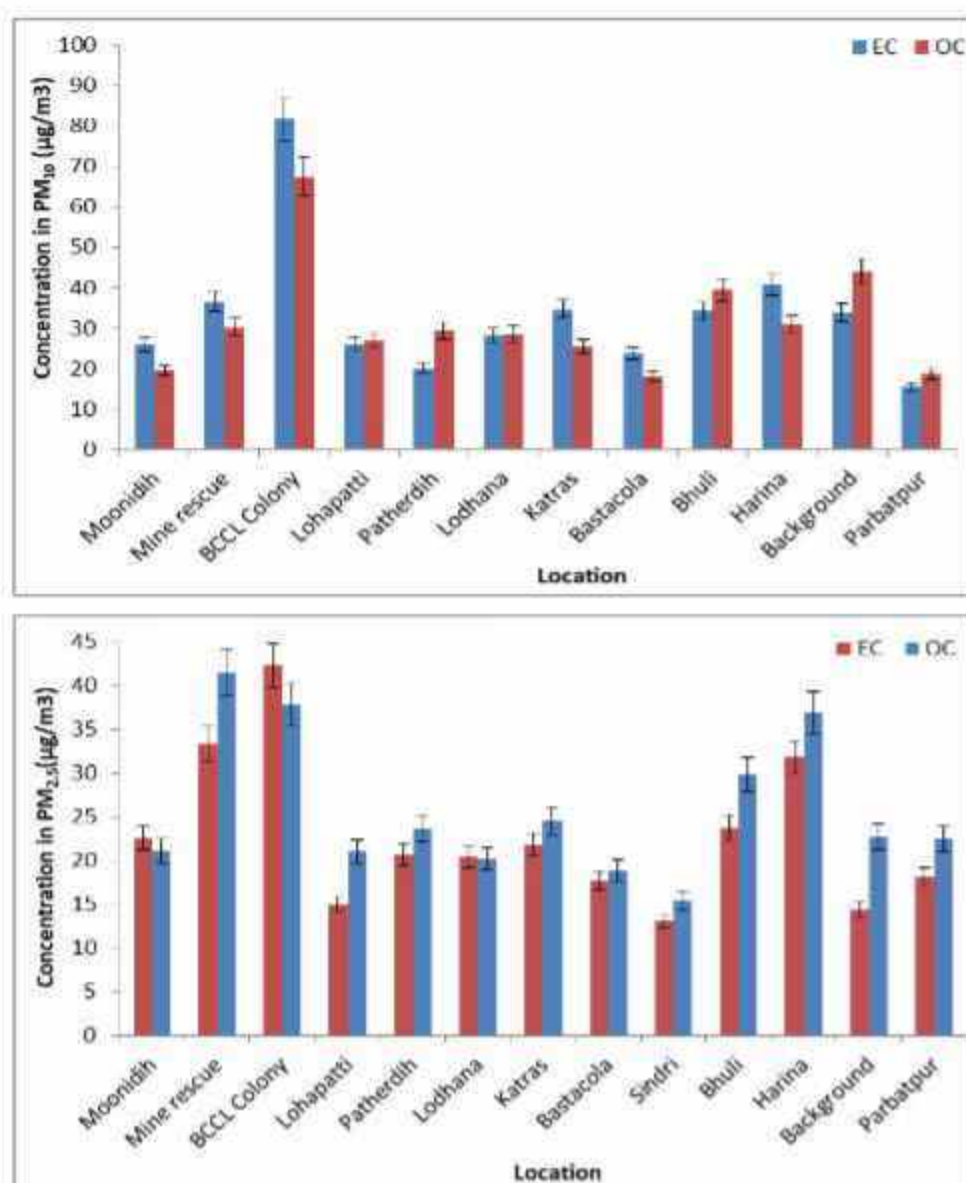


Figure 3.10: EC & OC concentration in PM_{10} and $PM_{2.5}$ in Summer season

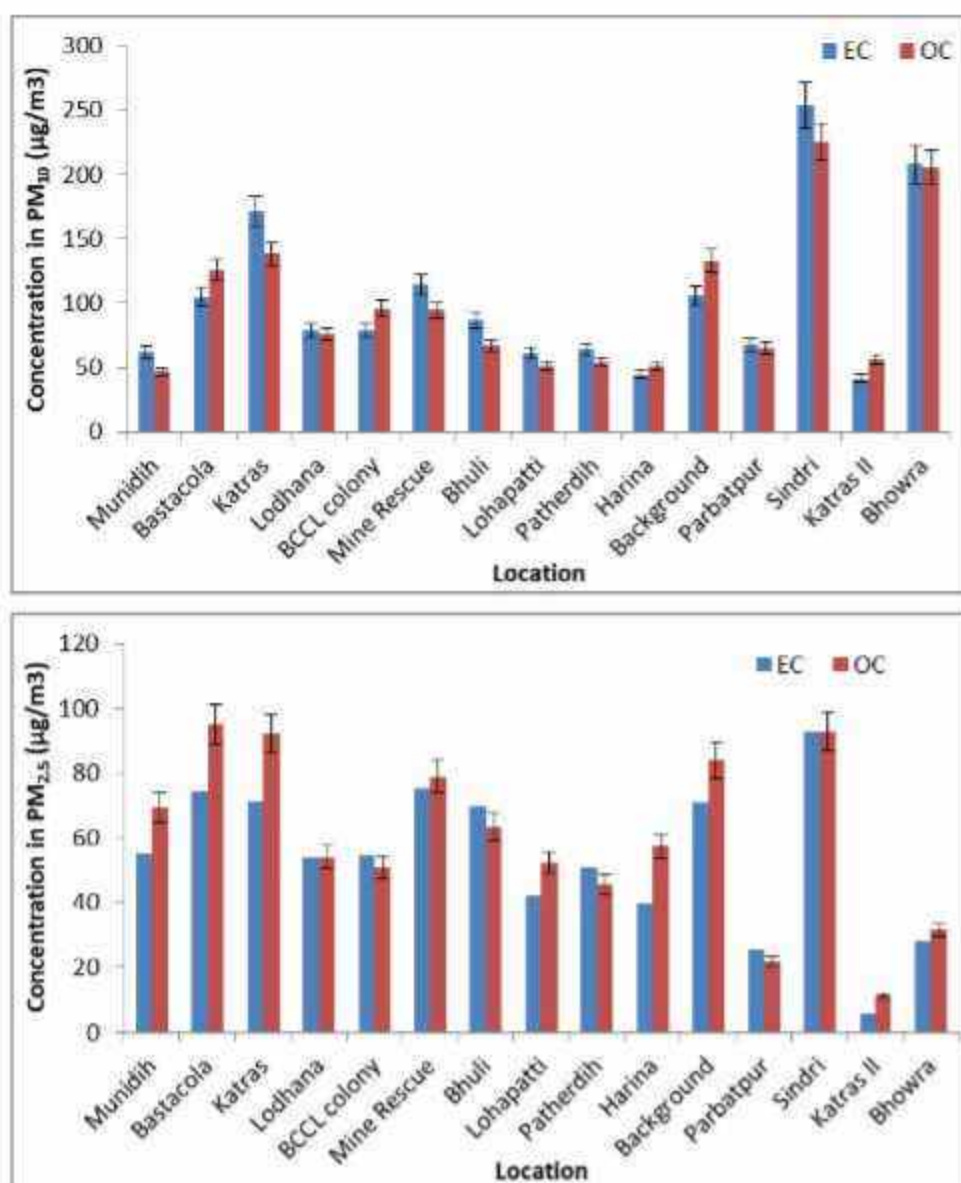


Figure 3.11: EC & OC concentration in PM₁₀ and PM_{2.5} in Winter Season

3.3.8. Ionic composition of PM₁₀ and PM_{2.5} in Summer season

The anions (SO_4^{2-} , NO_3^- and Cl^-) and cations (NH_4^+ , Na^+ , Ca^{2+} , K^+) are the water-soluble inorganic ions found in abundance. In summer, the mass concentration of SO_4^{2-} in PM₁₀ was in the range of $1.06\text{--}20.17\mu\text{g}/\text{m}^3$ where a higher concentration was observed in Harina, BCCL colony, and Lodhana sites. Likewise, NO_3^- was in the range of $0.32\text{--}19.2\mu\text{g}/\text{m}^3$ with the highest in the Harina site. PO_4^{3-} and Cl^- concentration was highest in Harina and $< 2\mu\text{g}/\text{m}^3$ in other locations. NH_4^+ was in the range of $0.75\text{--}16.24\mu\text{g}/\text{m}^3$, Harina with the highest concentration, and Bastacola with the lowest concentration. Na^+ concentration ($0.18\text{--}8.6\mu\text{g}/\text{m}^3$) was highest in Harina followed by BCCL colony and less than $2\mu\text{g}/\text{m}^3$ in remaining sites. Ca^{2+} concentration ($1.5\text{--}11.77\mu\text{g}/\text{m}^3$) was highest in Lohapatti and BCCL colony while lowest in Katras. K^+ ion was also observed in the Harina site with a concentration of $5.85\mu\text{g}/\text{m}^3$ (Figure 3.12).

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

3.3.9. Ionic composition of PM₁₀ and PM_{2.5} in Winter season

PM₁₀ ions concentration in Bastacola and Background were highest among all the monitoring

sites which followed the increasing order of $\text{Na}^+ < \text{Mg}^{2+} < \text{F}^- < \text{K}^+ < \text{Ca}^{2+} < \text{Cl}^- < \text{NH}_4^+ < \text{SO}_4^{2-} < \text{NO}_3^-$. It has been observed that SO_4^{2-} , NO_3^- and NH_4^+ ions were present in abundant in PM_{10} mass concentration, and concentration of NO_3^- in these sites contributes majorly to PM_{10} . Ions concentration in Katras, Lohapatti, and Bhuli sites were observed having lower ionic concentration Figure 3.14.

The ionic composition of $\text{PM}_{2.5}$ comprises mainly of SO_4^{2-} , NO_3^- , Cl^- , NH_4^+ , Ca^{2+} and K^+ ions. Locations such as Bastacola and Parbatpur have higher concentration of ions compared to remaining sites in following order: $\text{Mg}^{2+} < \text{Na}^+ < \text{Ca}^{2+} < \text{K}^+ < \text{Cl}^- < \text{NH}_4^+ < \text{SO}_4^{2-} < \text{NO}_3^-$. The same trend has been observed i.e. SO_4^{2-} , NO_3^- and NH_4^+ ions contribute mainly in $\text{PM}_{2.5}$ mass concentration. The average concentration of SO_4^{2-} and NO_3^- in winter was higher than in summer.

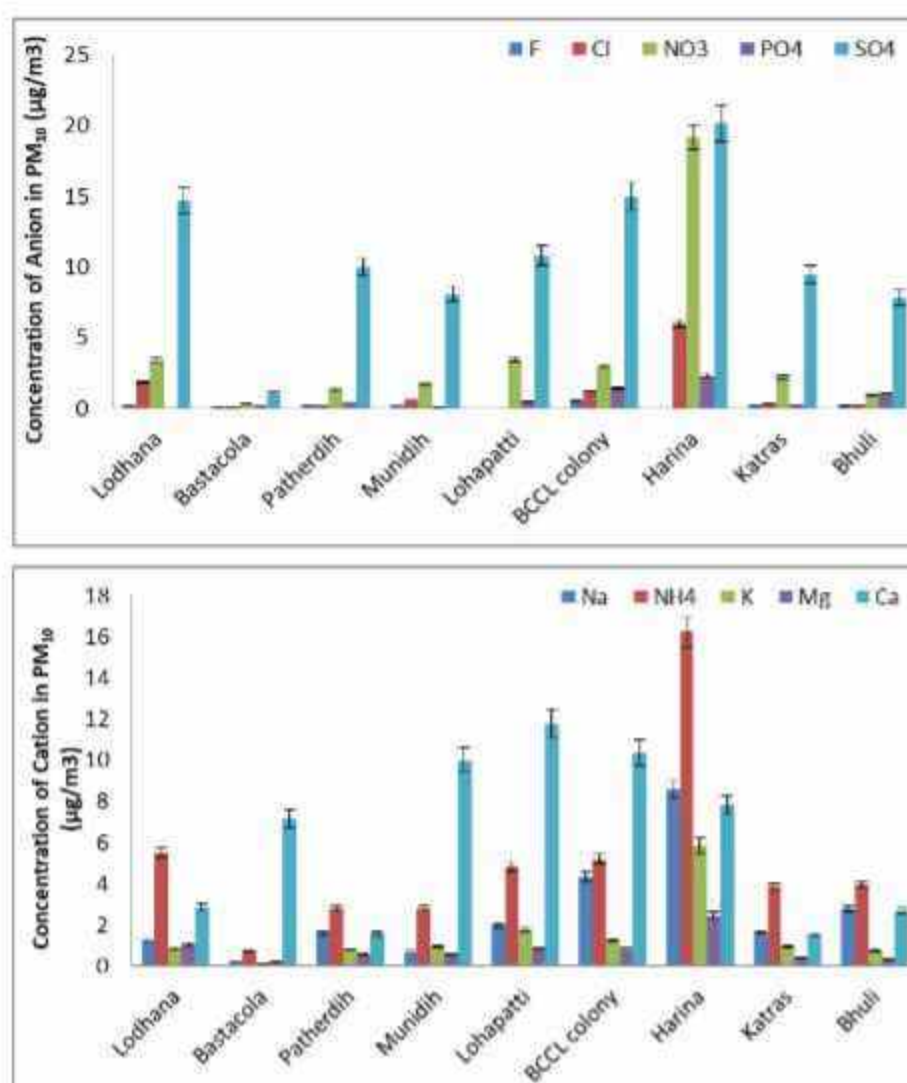
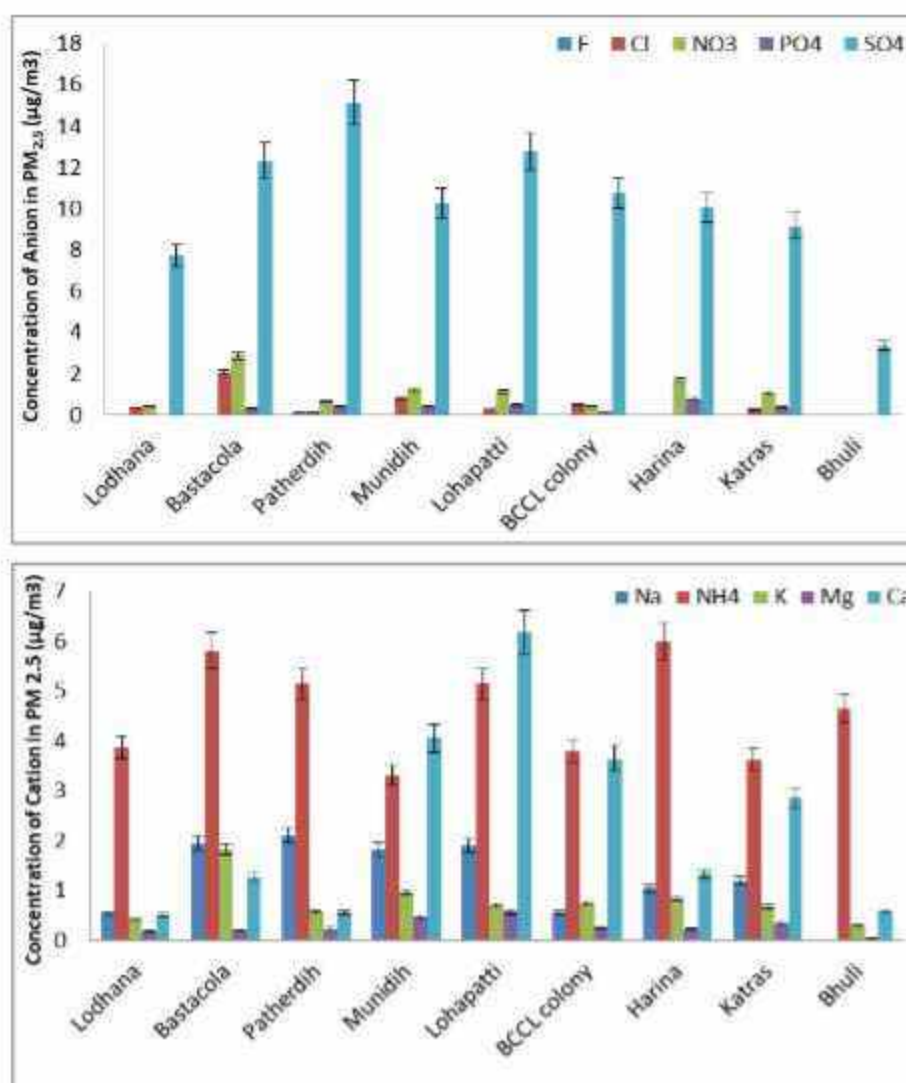
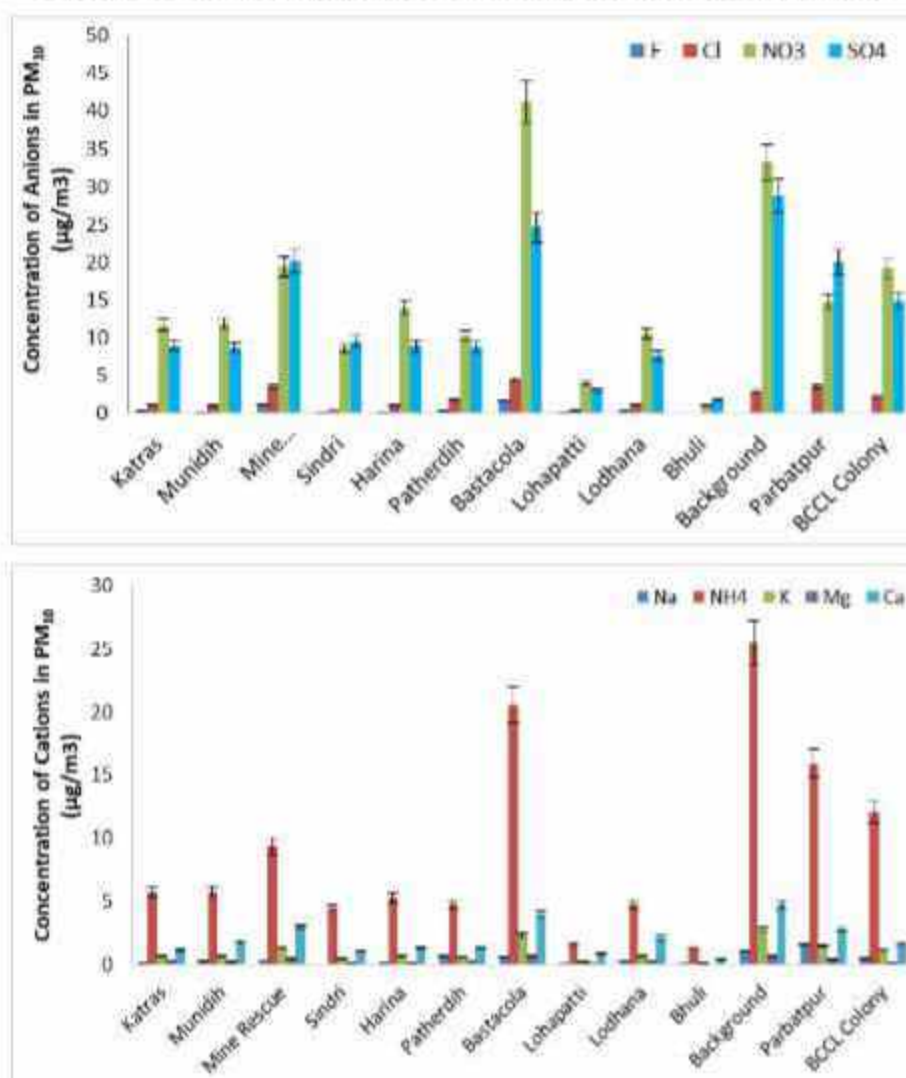
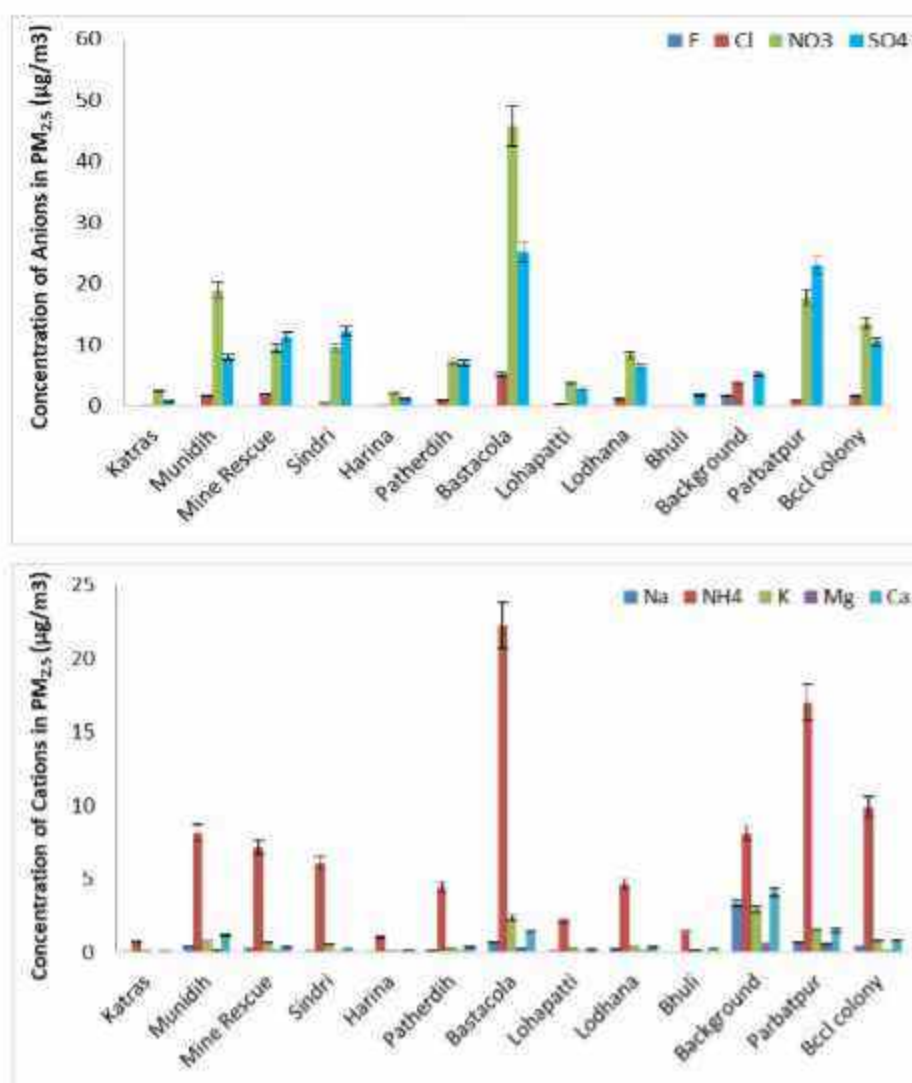


Figure 3.12: Anion and Cation concentration in PM_{10} in summer

Figure 3.13: Anion and Cation concentration in $PM_{2.5}$ in summerFigure 3.14: Anion and Cation concentration in PM_{10} in winter

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

Chapter 4 Receptor modelling

4.1. Source Apportionment

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

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

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

4.1.1. Chemical Mass Balance (CMB)

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

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

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

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

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

The CMB model assumptions are:

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

The following steps are followed for running the CMB model:

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

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

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

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

4.1.2. Source profiling

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

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

4.1.3. Ambient profiling

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

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

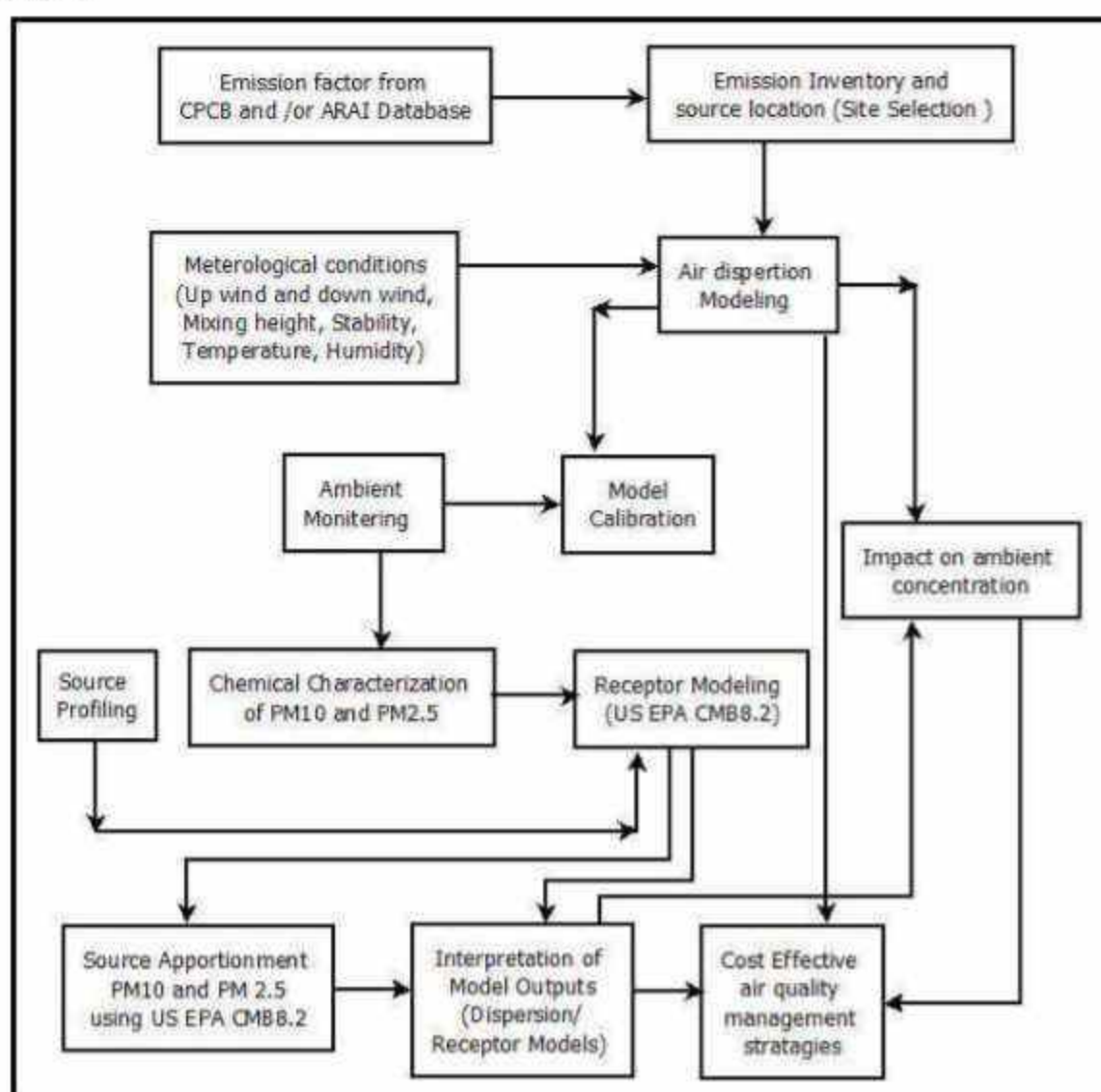


Figure 4.1: General methodology followed in the source apportionment studies

4.2. Results of the Chemical Mass Balance

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

4.2.1. Domestic combustion

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

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

4.2.2. Industrial Emission

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

4.2.3. Coal Mining

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

4.2.4. Transportation

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

4.2.5. Secondary Inorganic Aerosol

During summer, the secondary inorganic aerosol contribution to PM_{10} and $\text{PM}_{2.5}$ is about 8% and 16%, respectively. Secondary inorganic aerosols contribution found in winter is about 14% and 17%, respectively for PM_{10} and $\text{PM}_{2.5}$. The secondary inorganic aerosol source is a high concentration of nitrate (NO_3^-), sulphate (SO_4^{2-}), and ammonium ($(\text{NH}_4)^+$). These secondary products are formed in the atmosphere, being emitted either by natural or anthropogenic sources. The oxidation of NO_x forms the secondary nitrate. It is favoured by low temperature (Li et al. 2004), while high temperature and strong solar radiations favour the formation of secondary sulfates through photochemical reactions (Seinfeld and Pandis, 2016). Secondary inorganic aerosol formation from precursors (SO_2 and NO_2) enhances the pollution burden over the

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

4.2.6. Agriculture

The agriculture contribution observed that 5% for PM₁₀ and 2% for PM_{2.5} in the study period during the summer season. In the winter season, the contribution is 3% and 2% for PM₁₀ and PM_{2.5} respectively. Agricultural activities contribute ammonium to the atmosphere (Pant and Harrison, 2012; Jain et al., 2019). The OC and EC are also significant agricultural activity sources (Ram and Sarin 2011; Sharma et al. 2016a).

4.2.7. Open burning

The contribution of open burning in the summer season is 5% for both PM₁₀ and PM_{2.5}. In winter, the garbage burning contribution is 6% and 2% for PM₁₀ and PM_{2.5} respectively during study time. The abundance of tracers like K⁺, Pb, Br and considerable Cl⁻ marks this garbage/biomass burning source. K⁺ and levoglucosan are globally employed as biomass burning markers. Biomass consists of residential and agricultural wastes, post-harvest residue, cow dung, dry leaves, fuelwood, and wildfires (Almeida et al., 2006; Khare and Baruah, 2010; Shridhar et al., 2010). The OC and EC are also traced insignificant amounts along with K⁺, indicating the biomass burning emanations (Cesari et al., 2018; Sharma et al., 2014; Jain et al., 2018).

4.2.8. Road Resuspension dust

The re-suspension dust is a significant contributor to PM₁₀. The contribution of resuspension dust is during the summer season 12% while in the winter season the emission contribution is 10% for PM₁₀. In the summer season, resuspension dust's contribution is higher because of the high wind velocity and dry condition. The lower percentage contribution of road dust to fine particulate matter is attributed to substantial road dust particulates in coarse mode, found in other studies (Gupta et al., 2007; Masri et al., 2015). Crustal elements are significant constituents of airborne soil and re-suspension road dust. Generally, they contribute to coarse aerosols, including Al, Si, Ca, Ti, Mg, Fe, and Na used as tracers for soil dust or crustal re-suspension (Lough et al. 2005; Begum et al. 2011). The marker elements that have been used in India for the identification of soil dust include Al, Si, Ca, Ti, Fe, Pb, Cu, Cr, Ni, Co, and Mn (Sharma et al., 2017). Cu, Zn, and Ba are associated with road dust/re-suspension dust due to the release of these marker elements from cars and non-exhaust sources.

4.2.9. Other emission Contribution

Other area sources contributed in the summer season is 12% for PM₁₀ and 7% for PM_{2.5} during the study period. In the winter season, emission contribution is 14% for PM₁₀ and 9% for PM_{2.5}.

4.3 Inferences

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

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

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

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

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

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

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

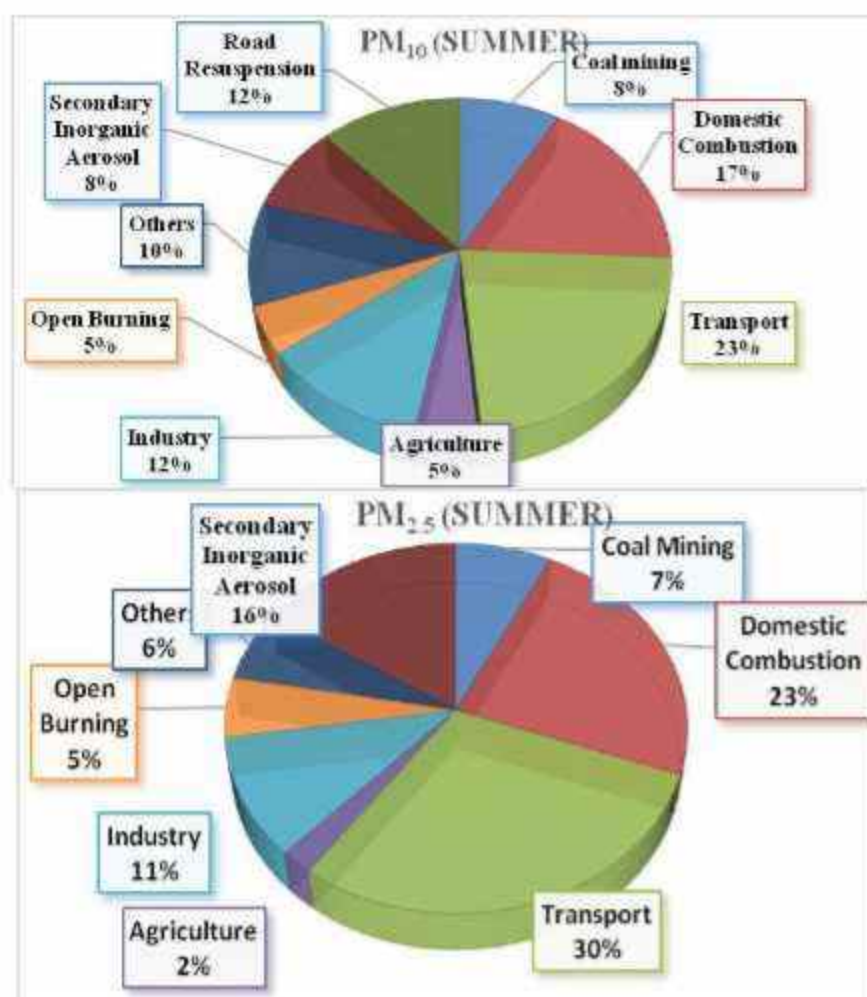


Figure 4.2: Source contribution at receptor locations of PM₁₀ and PM_{2.5} in summer

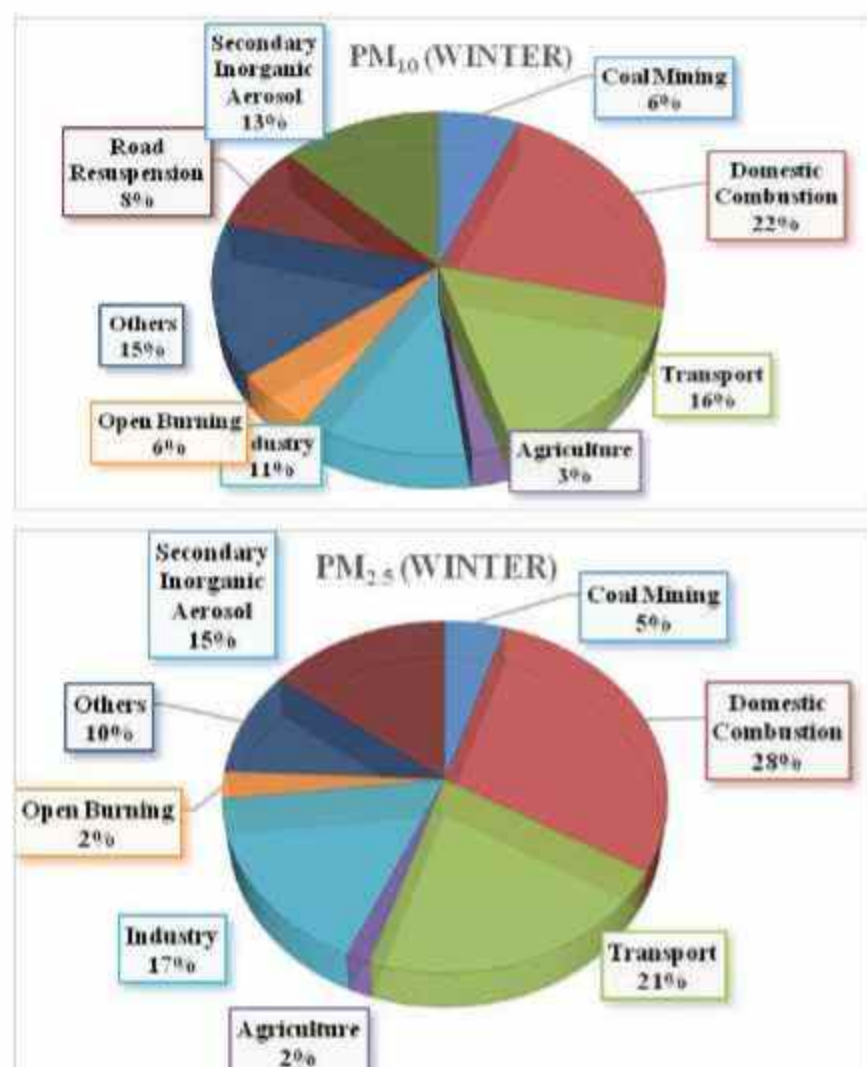


Figure 4.3: Source contribution at receptor locations of PM₁₀ and PM_{2.5} in winter

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

Area/Location	Particle size	Sources	Elements and Ions	References
Delhi	PM ₁₀ and PM _{2.5}	Secondary Nitrate, Secondary Sulfate, Vehicular emission, Biomass burning, Soil dust, Fossil fuel combustion, Sodium and magnesium salt, Industrial emission	Al, Mg, Ca, Ti, Fe, Cr, Mn, Zn, As, Pb, Br, M, F ⁻ , Cl ⁻ , NO ₃ ⁻ , SO ₄ ²⁻ , K ⁺ , NH ₄ ⁺ , and Na ⁺	Jain et. Al., 2020
Mangalore	PM ₁₀ and PM _{2.5}	Construction dust, Diesel generator, Tyre wear emission, Brake lining emission, Sand dust emission, gasoline vehicle emission, Diesel vehicle emission, Unpaved and paved road emission, Biomass burning, LPG stove emission, Solid fuel emission, Ferrous and steel industries emission, Fabrication and welding emission, Kerosene stove emission	As, Ba, Cd, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Sr, Zn, F ⁻ , Cl ⁻ , NO ₃ ⁻ , PO ₄ ³⁻ , SO ₄ ²⁻ , Na ⁺ , K ⁺ , Mg ²⁺ and Ca ²⁺	G. Kalaiarasan et al. 2018
Delhi NCR	PM ₁₀ and PM _{2.5}	Dust construction, Vehicle emission, Biomass Burning, Industrial emission, Secondary Pollutants, DG sets emission,	Al, Si, P, S, Cl, Br, V, Mn, Fe, Co, Ni, Cu, Zn, As, Ti, Ca, F ⁻ , Cl ⁻ , NO ₃ ⁻ , Br ⁻ , NO ₂ ⁻ , SO ₄ ²⁻ , Na ⁺ , K ⁺ , Mg ²⁺ and Ca ²⁺	Report No. ARAI/16-17/DHI-SA-NCR/Final Report August 2018
Delhi	PM _{2.5}	Secondary Aerosol, Vehicular emission, Biomass burning, Soil dust, Fossil fuel combustion, Sea salt, Industrial emission	Al, Mg, S, Si, Cl, K, Ca, Ti, Cu, Mn, Fe, Zn, Br, Cr, As, Pb, F ⁻ , Cl ⁻ , NO ₃ ⁻ , SO ₄ ²⁻ , K ⁺ , NH ₄ ⁺ , and Na ⁺	Jain et. Al., 2017
Nagpur	PM _{2.5}	DG sets, biomass burning, resuspended dust, secondary aerosol and mobile sources.	Al, Ba, Cd, Cr, Cu, Fe, Mg, Mn, Ni, Pb, Si, Zn, F ⁻ , Cl ⁻ , NO ₃ ⁻ , PO ₄ ³⁻ , SO ₄ ²⁻ , Na ⁺ , K ⁺ , Mg ²⁺ and Ca ²⁺	Pipalatkar et al., 2014
Raipur	PM _{2.5}	Brick kiln process, steel re-rolling mills, steel processing industries, biomass burning, metallurgical industrial emissions and coal burning	Al, As, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, S, Sb, Se, V, Zn, Na ⁺ , K ⁺ , Mg ²⁺ , NH ₄ ⁺ , F ⁻ , Cl ⁻ , NO ₃ ⁻ , SO ₄ ²⁻ , and Ca ²⁺	Matawle et al., 2014
Hyderabad	PM ₁₀ and PM _{2.5}	Vehicles exhaust, resuspension of dust, secondary sulfates, secondary nitrates, biomass	Na, Mg, K, Al, Si, Ca, Fe, Cl, SO ₄ ²⁻ , NO ₃ , NH ₄ ⁺	Guttikunda et al., 2013

		burning, coal burning		
Pune	PM ₁₀ and PM _{2.5}	Vehicles, DG sets, construction dust, solid fuels emissions, resuspended dust	Al, Pb, Cu, Zn, As, Se, Br, Ni, Fe, Mn, Mg, Cr, Ti, Ca, Cd, S, Si, Na, Ba, Sb, Cd, Sr, Cl ⁻ , NO ₃ ⁻ , SO ₄ ²⁻ , K ⁺ , NH ₄ ⁺	ARAI, 2010
Kanpur	PM ₁₀ and PM _{2.5}	Vehicles, open burn, road dust, domestic wood, coal and LPG, metal smelting, DG sets.	Cl ⁻ , NO ₃ ⁻ , SO ₄ ²⁻ , K ⁺ , NH ₄ ⁺ , Na ⁺ , Ca ²⁺ , Mg ²⁺ , Si, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Cd, Sn, Sb, Pb	CPCB, 2010b
Mumbai	PM ₁₀ and PM _{2.5}	Wood combustion, Fuel oil combustion, kerosene combustion, biomass burning, LPG, ammonium sulfate, ammonium nitrate, heavy duty diesel vehicles emissions, soil dust.	Na, Mg, Al, Si, P, S, Cl, Ca, Br, V, Mn, Fe, Co, Ni, Cu, Zn, As, Ti, Ga, Rb, Y, Zr, Pd, Ag, In, Sn, La, Se, Sr, Mo, Cr, Cd, Sb, Ba, Hg, and Pb, F ⁻ , Cl ⁻ , Br ⁻ , NO ₂ ⁻ , NO ₃ ⁻ , SO ₄ ²⁻ , K ⁺ , NH ₄ ⁺ , Na ⁺ , Ca ²⁺ , Mg ²⁺	CPCB, 2010a
Chennai	PM ₁₀ and PM _{2.5}	Vehicles, DG sets, bakeries, soil dust, construction dust, paved road dust, kerosene and LPG emissions.	As, Ag, Ca, Na, Fe, Mg, Cu, Zn and other metals. Cl ⁻ , NO ₃ ⁻ , SO ₄ ²⁻ , K ⁺ , NH ₄ ⁺ , Na ⁺ , Mg ²⁺	IIT Madras, 2010
Bangalore	PM ₁₀ and PM _{2.5}	Petrol vehicles, diesel vehicles, secondary particulates, fuel oil burning, wood domestic wood burning, DG set, kerosene generator set, paved road dust re suspension, soil dust.	Na, Mg, Al, Si, P, S, Cl, Ca, Br, V, Mn, Fe, Co, Ni, Cu, Zn, As, Ti, Ga, Rb, Y, Zr, Pd, Ag, In, Sn, La, Se, Sr, Mo, Cr, Cd, Sb, Ba, Hg, and Pb, F ⁻ , Cl ⁻ , Br ⁻ , NO ₂ ⁻ , NO ₃ ⁻ , SO ₄ ²⁻ , Na ⁺ , K ⁺ , Mg ²⁺ and Ca ²⁺	TERI, 2010

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

References:

- Srishti Jaina, S. K. Sharma, N. Vijayan, T. K. Mandal, Seasonal characteristics of aerosols ($PM_{2.5}$ and PM_{10}) and their source apportionment using PMF: A four-year study over Delhi, India. *Environmental Pollution* 262 (2020) 114337.
- G. Kalaiarasan, R. M. Balakrishnan, N. A. Sethunath, S. Manoharan. Source apportionment studies on particulate matter (PM_{10} and $PM_{2.5}$) in ambient air of urban Mangalore, India. *Journal of Environmental Management* 217 (2018) 815e824816.
- Source Apportionment of $PM_{2.5}$ & PM_{10} of Delhi NCR for Identification of Major Sources. Report No. ARAI/16-17/DHI-SA-NCR/Final Report August 2018.
- Jain, Srishti; Sharma, Sudhir Kumar; Choudhary, Nikki; Masiwal, Renu; Saxena, Mohit; Sharma, Ashima; Mandal, Tuhin Kumar; Gupta, Anshu; Gupta, Naresh Chandra; Sharma, Chhemendra (2017). Chemical characteristics and source apportionment of $PM_{2.5}$ using PCA/APCS, UNMIX, and PMF at an urban site of Delhi, India. *Environmental Science and Pollution Research*, 24(17), 14637–14656. doi:10.1007/s11356-017-8925-5.
- Pipalatkhar, P., Khaparde, V.V., Gajghate, D.G., Bawase, M. a, 2014. Source apportionment of $PM_{2.5}$ using a CMB model for a centrally located Indian city. *Aerosol Air Qual. Res.* 14, 1089-1099.
- Matawle, J.L., Pervez, S., Dewangan, S., Tiwari, S., Bisht, D.S., Pervez, Y.F., 2014. $PM_{2.5}$ chemical source profiles of emissions resulting from industrial and domestic burning activities in India. *Aerosol Air Qual. Res.* 14, 2051-2066.
- Guttikunda, S.K., Kopakka, R.V., Dasari, P., Gertler, A.W., 2013. Receptor model-based source apportionment of particulate pollution in Hyderabad, India. *Environ. Monit. Assess.* 185, 5585-5593.
- Gummeneni, S., Yusup, Y. Bin, Chavali, M., Samadi, S.Z., 2011. Source apportionment of particulate matter in the ambient air of Hyderabad city, India. *Atmos. Res.* 101, 752-764.
- ARAI, 2010. In: C.P.C.B (Ed.), Air Quality Monitoring and Emission Source Apportionment Study for Pune, India. The Automotive Research Association of India, Pune, India.
- CPCB, 2010b. In: C.P.C.B (Ed.), Air Quality Assessment, Emissions Inventory and Source Apportionment Studies for Kanpur City, India. Indian Institute of Technology Kanpur, India.
- CPCB, 2010a. In: C.P.C.B (Ed.), Air Quality Assessment, Emissions Inventory and Source Apportionment Studies Mumbai, India. National Environmental Engineering Research Institute, India.
- IIT Madras, 2010. In: C.P.C.B (Ed.), Air Quality Monitoring, Emission Inventory and Source Apportionment Study for Chennai, India. Indian Institute of Technology Madras, India.
- TERI, 2010. In: C.P.C.B (Ed.), Air Quality Assessment, Emission Inventory and Source Apportionment Study for Bangalore City, India. The Energy and Resources Institute, India.
- D. Cesari, G.E. De Benedetto, P. Bonasoni, M. Busetto, A. Dinoi, E. Merico, D. Chirizzi, P. Cristofanelli, A. Donato, F.M. Grasso, A. Marinoni, Seasonal variability of $PM_{2.5}$ and PM_{10} composition and sources in an urban background site in Southern Italy. *Sci. Total Environ.*, 612 (2018), pp. 202-213.
- F. Amato, A. Alastuey, A. Karanasiou, F. Lucarelli, S. Nava, G. Calzolari, M. Severi, S. Becagli, L.G. Vorner, C. Colombi, C. Alves, D. Custódio, T. Nunes, M. Cerqueira, C. Pio, K. Eleftheriadis, E. Diapouli, C. Reche, M.C. Minguillón, M.I. Manousakas, T. Maggos, S. Vratolis, R.M. Harrison, X. Querol, AIRUSE-LIFEC: a harmonized PM speciation and source apportionment in five southern European cities. *Atmos. Chem. Phys.*, 16 (2016), pp. 3289-3309.

- M.O. Andreae, P. Merlet, Emission of trace gases and aerosols from biomass burning. *Glob. Bio Geochem. Cycles*, 15 (2001), pp. 955-966.
- Li Z, Hopke PK, Husain L, Qureshi S, Dutkiewicz VA, Schwab JJ, Demerjian KL (2004) Sources of fine particle composition in New York city. *Atmos Environ* 38(38):6521-6529.
- Seinfeld J H, Pandis S N (2016) *Atmospheric chemistry and physics: from air pollution to climate change*. John Wiley & Sons.
- Kumar AV, Patil RS, Nambi KSV (2001) Source apportionment of suspended particulate matter at two traffic junctions in Mumbai, India. *Atmos Environ* 35(25):4245-4251.
- Sharma SK, Mandal TK, Saxena M, Sharma A, Datta A, Saud T (2014b) Variation of OC, EC, WSIC and trace metals of PM₁₀ in Delhi, India. *J Atmos Solar-Terres Phy* 113:10-22.
- Kulshrestha A, Satsangi PG, Masih J, Taneja A (2009) Metal concentration of PM_{2.5} and PM₁₀ particles and seasonal variations in urban and rural environment of Agra, India. *Sci Total Environ* 407(24):6196-6204.
- Kar S, Maity JP, Samal AC, Santra SC (2010) Metallic components of traffic-induced urban aerosol, their spatial variation, and source apportionment. *Environ Monit Assess* 168(1-4):561-574.
- S.M. Almeida, C.A. Pio, M.C. Freitas, M.A. Reis and M.A. Trancoso. Source apportionment of atmospheric urban aerosol based on weekdays/weekend variability: evaluation of road re-suspended dust contribution. *Atmos. Environ.*, 40 (11) (2006), pp. 2058-2067.
- P. Khare and B.P. Baruah. Elemental characterization and source identification of PM_{2.5} using multivariate analysis at the suburban site of north-east India. *Atmos. Res.*, 98 (1) (2010), pp. 148-162.
- V. Shridhar, P.S. Khillare, T. Agarwal and S. Ray. Metallic species in ambient particulate matter at rural and urban location of Delhi. *J. Hazard Mater.*, 175 (1) (2010), pp. 600-607.
- D. Cesari, G.E. De Benedetto, P. Bonasoni, M. Busetto, A. Dinoi, E. Merico, D. Chirizzi, P. Cristofanelli, A. Donato, F.M. Grasso and A. Marinoni. Seasonal variability of PM_{2.5} and PM₁₀ composition and sources in an urban background site in Southern Italy. *Sci. Total Environ.*, 612 (2018), pp. 202-213.
- S. Jain, S.K. Sharma, T.K. Mandal and M. Saxena. Source apportionment of PM₁₀ in Delhi, India using PCA/APCS, UNMIX and PMF. *Particuology*, 37 (2018), pp. 107-118.
- Ram K, Sarin MM (2011) Day-night variability of EC, OC, WSOC and inorganic ions in urban environment of Indo-Gangetic Plain: implications to secondary aerosol formation. *Atmos Environ* 45(2):460-468.
- Sharma SK, Mandal TK, Srivastava MK, Chatterjee A, Jain S, Saxena M, Ghosh SK (2016a) Spatio-temporal variation in chemical characteristics of PM₁₀ over Indo-Gangetic Plain of India. *Environ Sci Pollut Res* 23(18):18809-18822.

Chapter 5 Dispersion Modelling

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

5.1. Wind data analysis

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

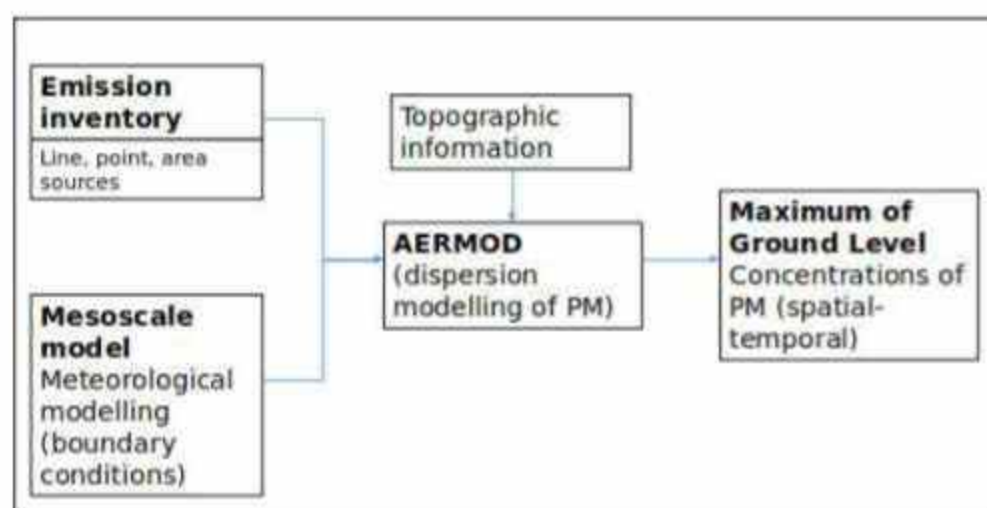


Figure 5.1: Methodology followed in the study.

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

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

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

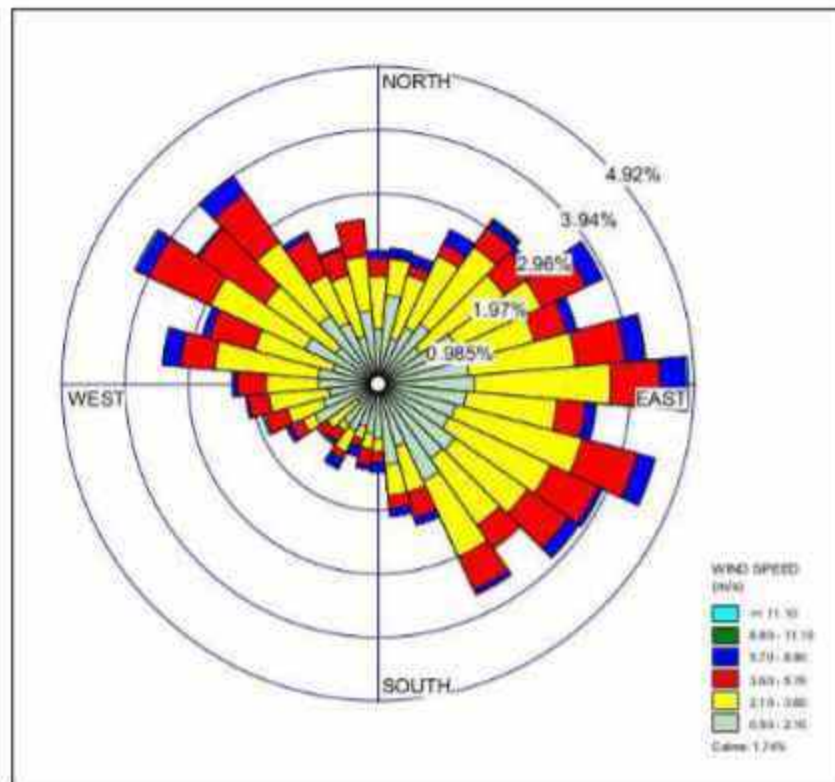


Figure 5.2: Windrose of the study area during March-June, 2019 (wind direction blowing towards the center)

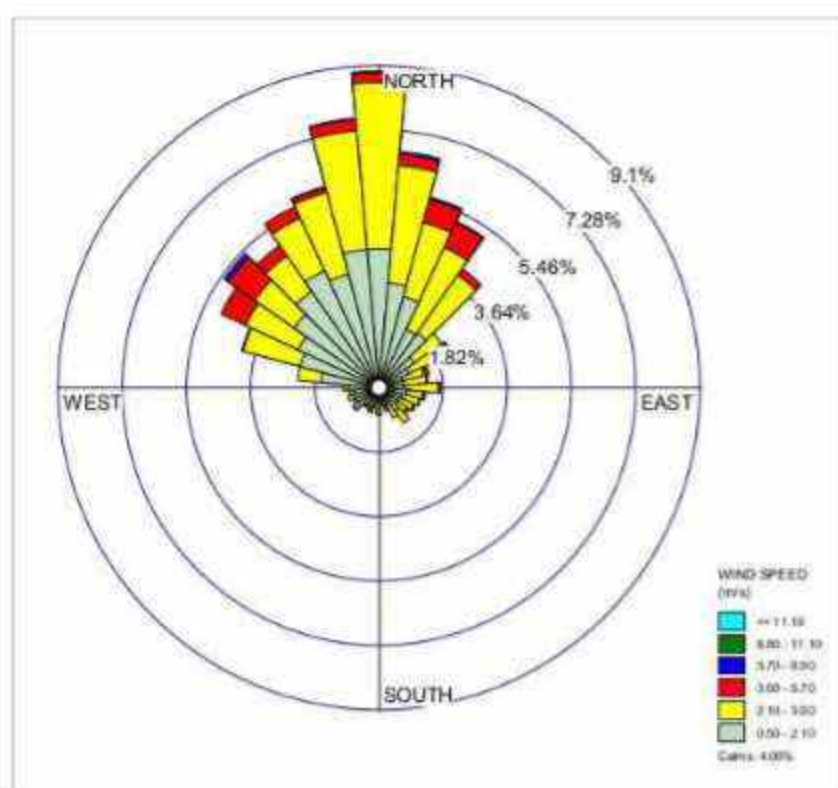


Figure 5.3: Windrose of the study area during November-December 2019 (wind direction blowing towards the centre)

5.2. Dispersion of Particulate matter

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

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

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

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

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

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

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

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

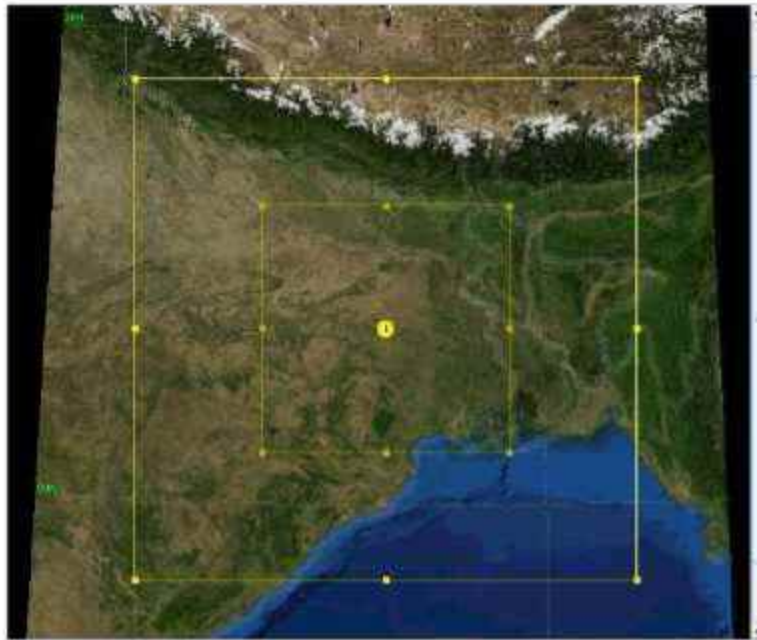


Figure 5.4: AERMOD grid covering the Jharia Coal Fields (JCF). The line, area, and point sources covered in the study are indicated in red color. The UTM coordinates of the left bottom point are $x=406111$ and $y=2603492$, and the coordinates of the right top point are $x=456248$ and $y=2653417$.

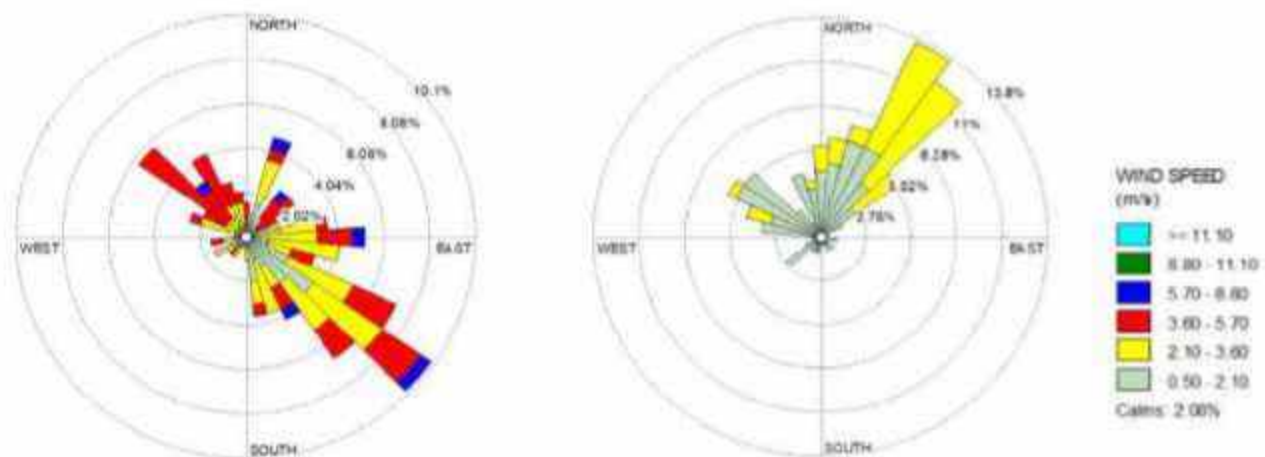


Figure 5.5: Windrose diagram for the summer (left) and winter seasons (right) at Jharia Coal Fields during the sampling period. Wind direction is flowing towards the centre.

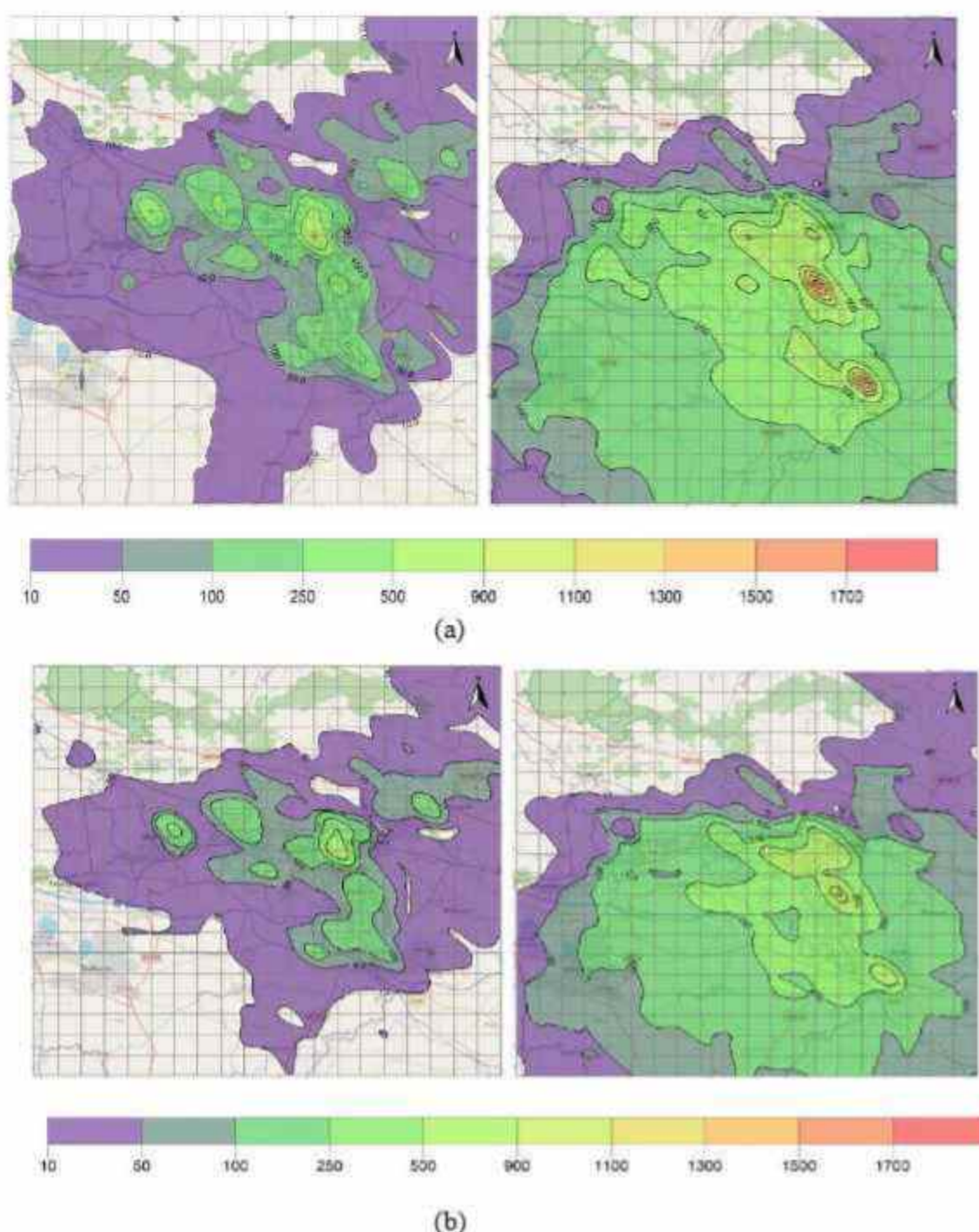


Figure 5.6: 24-hour average maximum ground level concentration of PM contours in the study area simulated during the study periods in summer (left) and winter (right) seasons (a) PM_{10} ($\mu\text{g}/\text{m}^3$) and (b) $PM_{2.5}$ ($\mu\text{g}/\text{m}^3$)

5.3 Validation of the model

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

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

Table 5.1 Performance Stimulation Metric

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

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

Chapter 6 Recommendation

6.1. Mine industries

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

6.2. Area Sources

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

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

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

6.3. Line Source

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

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

6.4. Others

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

Annexure -1

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

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

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

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



GROUNDWATER LEVEL & QUALITY REPORT FOR CLUSTER OF MINES, BCCL

(Assessment year – 2022-23)

[CLUSTER – I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XIII, XIV, XV & XVI of Mines, BCCL]

JHARIA COALFIELD AND RANIGANJ COALFIELD (PART)

**For
(BHARAT COKING COAL LIMITED)**

(A Subsidiary of Coal India Limited)

KOYLA BHAWAN (DHANBAD)

**Prepared by
Hydrogeology Department
Exploration Division
CMPDI (HQ), Ranchi**

MARCH – 2023



cmpdi
A Mini Ratna Company

**GROUNDWATER LEVEL & QUALITY REPORT
FOR CLUSTER OF MINES, BCCL**

(Assessment year – 2022-23)

[CLUSTER – I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XIII, XIV, XV & XVI of Mines, BCCL]

JHARIA COALFIELD AND RANIGANJ COALFIELD (PART)

**For
(BHARAT COKING COAL LIMITED)**

(A Subsidiary of Coal India Limited)

KOYLA BHAWAN (DHANBAD)

**Prepared by
Hydrogeology Department
Exploration Division
CMPDI (HQ), Ranchi**

MARCH – 2023

PERSONS ASSOCIATED

Swagata Dutta

Asst. Manager (Geology)

Geology Department

Regional Institute – II

CMPDI, Dhanbad

Rituparna Roy

Manager (Geology)

Hydrogeology Section

Exploration Division

CMPDI (HQ), Ranchi

Gaurav Kr. Singh

Manager (Geology)

Hydrogeology Section

Exploration Division

CMPDI (HQ), Ranchi

Kumar Vaibhav

Dy. Manager (Environment)

Regional Institute – II

CMPDI, Dhanbad



CMPDIL

CENTRAL MINE PLANING & DESIGN INSTITUTE

HYDROGEOLOGY SECTION, EXPLORATION DEPARTMENT

GONDWANA PLACE, KANKE ROAD, RANCHI, JHARKHAND- 834031

(Accredited Groundwater Professional Institutions by CGWA)

(Accredited as a GWCO by QCI-NABET)

(Accredited by NABL, CMPDI, RI-II, Lab)

CONTENT

Sl. No	Contents	Page No
1	Annexure-I Details of The Report	1
2	Annexure-II Groundwater Level and Quality Report for Cluster of Mines of BCCL	2-88
3	Chapter-1.0 Introduction	2-6
4	1.1 Location details and brief about the report	2
5	1.2 Objective of the study	2
6	1.3 Scope of the report	2
7	1.4 Topography and Drainage	4
8	1.5 Details regarding Wetland	4
9	1.6 Climate & Rainfall	5-6
10	Chapter-2.0 Geology & Hydrogeological Set-up of the Area	7-10
11	2.1 Regional Geology of the Coalfield	7
12	2.2 Hydrogeological setup	8
13	2.3 Aquifers Description	8-9
14	2.4 General Aquifer Parameters	9-10
15	Chapter-3.0 Ground Water Level data of the Cluster of Mines of BCCL	10-
16	3.1 Historical groundwater level	11
17	3.2 Depth to water level and Hydraulic gradient	13
18	3.3 Quarterly groundwater level, Cluster of mines during 2020-21	14
	A. Ground Water Levels of Cluster-I	14-15
	B. Ground Water Levels of Cluster-II	16-17
	C. Ground Water Levels of Cluster-III	18-19
	D. Ground Water Levels of Cluster-IV	20-21
	E. Ground Water Levels of Cluster-V	22-23
	F. Ground Water Levels of Cluster-VI	24-25
	G. Ground Water Levels of Cluster-VII	26-27
	H. Ground Water Levels of Cluster-VIII	28-29
	I. Ground Water Levels of Cluster-IX	30-31
	J. Ground Water Levels of Cluster-X	32-33
	K. Ground Water Levels of Cluster-XI	34-35
	L. Ground Water Levels of Cluster-XIII	36-37
	M. Ground Water Levels of Cluster-XIV	38-39

	N. Ground Water Levels of Cluster-XV	40-41
	O. Ground Water Levels of Cluster-XVI	42-43
19	Chapter-4.0 Ground water level scenario	44
20	Chapter-5.0 Groundwater Quality	45
21	Chapter-6.0 Stage of Groundwater extraction	48
22	Chapter-7.0 Impact of Mining on Ground Water Regime	50
23	7.1 General consequences of Coal Mines on ambient Hydrogeological Regime	50
24	7.2 Potential consequences of OC & UG coal mines on Hydrogeological Regime	50
25	7.3 Estimation of Radius of Mine Influence zone	51
26	Chapter-8.0 Conservation measures & future strategy	51
27	Chapter-9.0 Existing / Proposed Rainwater harvesting structures in BCCL coal mines	54-59
28	Annexure-III List of RAMSAR Wetlands as given on official website of MoEF & CC	60
29	Annexure-IV Rainfall Data	61
30	Annexure-V Ground Water Level Monitoring Data	63-67
31	Annexure-VI Ground Water Level Hydrographs	68-84
32	Annexure-VII Ground Water Quality analysis data	85-90
33	Abbreviations	91

LIST OF TABLES

Fig No	Contents	Page No
1	Regional Geological Succession of JCF	8
2	Generalized Hydrogeological Units developed in the study Area	9
3	Aquifer parameters considered for the study Area	10
4	Historical Groundwater Level	15
5	Depth to water table	13
6	Average hydraulic gradient	13
7	GW level data Cluster wise	44
8A, B	Block / Cluster wise GW Development scenario	48-49

LIST OF PLATES

Sl No	Plate No	Contents	Scale
1	I	Location Map of Groundwater Level Monitoring stations	1:50000
2	II	Location Map of Groundwater Quality Monitoring stations	1:50000
3	III	Location Map of Proposed Piezometers	1:50000
4	IV	Water table Contour Map of JCF	1:50000
5	V	Depth to Groundwater Level map of JCF	1:50000

LIST OF FIGURES

Table No	Contents	Page No
1 & 2	Historical Rainfall trend at Jharkhand	6-7
3 to 14	Existing / Proposed Rainwater Harvesting Structure	54-59

DETAILS OF THE REPORT

SI No.	ITEMS	INFORMATIONS
1	Geographical Area	Jharia Coalfield (JCF): 453 sq. km. Raniganj Coalfield (RCF part): 19.64 sq. km. (Cluster-XVI area only)
2	Major Physiographic Units	Dissected Pediplain with surface Reduced Level (RL) varies from 160 m to 220 m above mean sea level (AMSL) in JCF and 100 m to 140 m AMSL in RCF.
3	Drainage System	Damodar River is the master drainage flowing along western boundary of the JCF. Jamunia River, Khudia River, Katri River, Jarian Nala, Ekra Jore, Kari Jore, Kashi Jore, Chatkari Jore and their tributaries are flowing through the JCF area. Damodar River, Barakar River is the master drainage of the part of RCF area (CV Area).
4	Annual Rainfall (IMD-report)	Jharkhand State: 1264.10 mm Rainfall data given in Annexure-IV .
5	Geological Formations	Gondwana Formation (Talchir Formation, Barakar Formation, Barren Measure Formation & Raniganj Formation)
6	Aquifer System	Unconfined/Phreatic Aquifer – thickness 25 m (Avg.) Semi-confined to confined Aquifer – thickness from 25 m upto 650 m
7	Hydrogeological properties (Aquifer Pump Test)	Unconfined Aquifer (Damoda BJ Section & Block-II): Hydraulic Conductivity – upto 0.50 m/day Transmissivity – 10 - 42 m ² /day Semi-confined to confined Aquifer (Sitatala & Kumari Block): Hydraulic Conductivity – 0.0006-1.44 & 0.05-0.0027 m/day Transmissivity – 0.06 – 0.573 m ² /day
8	Groundwater Level Monitoring Network	Out of total 252 nos. of monitoring stations 64 nos located within core mining area and rest comes within Buffers zone. 60 Nos. of Groundwater monitoring well (Dug Wells) network established by CMPDI to record groundwater level data in and around the Core Zone of JCF and 4 Nos. of Groundwater monitoring well (Dug Wells) in RCF (CV Area).
9	Groundwater Levels Below Ground Level (bgl)	JCF area: Pre-monsoon – 0.42 to 11.90 m (Avg. 5.12 m bgl) in '2022-23 Post-monsoon – 0.29 to 11.12 m (Avg. 3.32 m bgl) in '2022-23 RCF area (part): Pre-monsoon – 1.73 to 2.68 m (Avg. 2.20 m bgl) in '2022-23 Post-monsoon – 1.63 to 2.20 m (Avg. 1.90 m bgl) in '2022-23
10	Groundwater Quality	Potable as per GEC-2015 Norms (Annexure- VIII)
11	Proposed Piezometers	Piezometers (23 nos.) to monitor impact of coal mining on groundwater regime within the coalfield area (JCF & part of RCF)
12	Stage of Groundwater Development (CGWB)	Dhanbad District-Safe to Over-exploited category (GWRA-2022)

GROUNDWATER LEVEL & QUALITY REPORT FOR CLUSTER OF MINES OF BCCL

1.0 INTRODUCTION

1.1 LOCATION DETAILS AND BRIEF ABOUT THE PROJECT

The 15 nos. Cluster of mines (Cluster-I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XIII, XIV, XV and XVI) of BCCL is located in the Jharia coalfield in Bokaro and Dhanbad districts of Jharkhand and part of Raniganj coalfield in Dhanbad district of Jharkhand.

The area of Jharia Coalfield (JCF) is 453 sq. km. and Raniganj Coalfield (RCF part) is 19.64 sq. km. (Cluster-XVI area only). Located about 3.0 km south-west of Dhanbad town and 10.0 km north-east of Bokaro town. The coalfield bounded by Jamunia River in the west, Damodar river in the south, and Metamorphics (hard rock) in the north and east side. **(Plate-I)**.

1.2 OBJECTIVE OF THE STUDY:

The objective of the report is to conduct hydrogeological study by quarterly monitoring of groundwater level and quality of the Jharia coalfield and Raniganj coalfield (part) within BCCL command area for 15 Cluster of mines. The data collected shall be submitted to the MoEF&CC, CPCB & SPCB within stipulated timeframe. The work is being done yearly and required to be continued as per the specific condition mentioned invariably in Environmental Condition (EC) for all of the Clusters of BCCL.

1.3 SCOPE OF THE STUDY:

The following scope has been taken into account for hydro-geological investigation of the study area.

- i) To monitor the groundwater levels four times/year during (May, August, Nov and Jan).
- ii) To monitor the groundwater quality during May including Arsenic and Fluoride.
- iii) To evaluate the status of ground water level condition in the area.
- iv) To study the ground water flow direction in the mining areas.
- v) To study the depth to ground water level condition in the mining areas.
- vi) To study the ground water quality data and interpretation in the mining areas.

File No. 08HBDD/JRRI/BCCL/ENV/0003/2018-BD Divn.-CMPDI (Computer No. 68378)
Receipt No. 188686/2018/O/s HEAD OF BUSINESS DEVELOPMENT, CMPDI HQ
भारत कोकिंग कोल लिमिटेड

एक मिनी रत्न कंपनी

(कोल इंडिया लिमिटेड का एक अंग)

कोयलाभवन, कोयलानगर, धनबाद -826005



A Mini Ratna Company

(A Subsidiary of Coal India Limited)

Regd.Off: Koyla Bhawan, Koyla Nagar

CIN: U10101JH1972GOI000918

Environment Department

पत्र संख्या भाकोकोलि/उप महाप्रबंधक(पर्या0)/संचिका-18/1086- दिनांक : 14.06.2018

1089/11

सेवा में,

महाप्रबंधक

व्यापार विकास

सीएमपीडीआई - कांके रोड रांची ८३४०३१-

Sub: For work of Ground water level and quality monitoring

महोदय,

This is with reference to earlier letter ref no. BCCL/HOD(Env)/F-Env/13/161 dated 11.02.2014 regarding conducting hydrological study by quarterly monitoring of groundwater level and quality of the study to be carried out by establishing a network of existing wells. The monitoring for quantity shall be done four times a year in pre-monsoon (May), monsoon (August), post-monsoon (November) and winter (January) season and for quality including Arsenic and Fluoride during month of May. Data thus collected shall be submitted to the Ministry of Environment & Forest and to Central Pollution Control Board/SPCB quarterly within one month of monitoring.

The above work is being done yearly and required to be continued as per the specific condition mentioned invariably in Environment Clearance order of all clusters of BCCL.

This is for your kind information and further necessary action

भवदीय

14/6/18
उप-महाप्रबंधक (पर्यावरण)

Copy To:

१ महाप्रबंधक (गवेषण), कांके रोड रांची ८३४०३१-

1.4 TOPOGRAPHY AND DRAINAGE

Northern part of the JCF area covered with hills and thin forest. In general, the altitude varies from 220 m above mean sea level (AMSL) in Barora area (Cluster-I) to 160 m AMSL in Sudamdih area (Cluster-X). Pediplains developed over sedimentary rocks or Gondwana formation consisting of Sandstone, Shale, coal, etc. Dissected pediplains developed over Gondwana formations found in Jharia, Baghmara, Katras areas etc. However, in RCF (part) area, the altitude varies from 100 m to 140 m AMSL (Cluster-XVI). The general slope of the topography is towards south, i.e. Damodar River.

The drainage pattern of the area is dendritic in nature. The drainage system of the area is the part of Damodar sub-basin. All the rivers that originate or flow through the coalfield area have an easterly or southeasterly course and ultimately joins Damodar River - the master drainage. The drainage of the JCF is mainly controlled by Jamuniya River (5th order), Khudia nala (3rd order), Katri River (4th) and Chatkari nala (3rd order) flowing from north to south and joins Damodar River. Whereas, Barakar River and Khudia River are controlling the drainage pattern of RCF (part) and joins Damodar River in the south. Damodar River is the main drainage channel and flows from west to east along the southern boundary of JCF and RCF.

The drainage map of the JCF and part of RCF has been prepared on topographic map of scale 1:50,000 (**Plate-I**). The watershed of all tributary rivers (Jamuniya River to Barakar River) falls within the north-western part of Damodar sub-basin which comes under Lower Ganga Basin.

Besides, a large number of ponds/tanks distributed in and around JCF, out of which one prominent lake is located at Topchanchi in the north-west part. Two reservoirs, Maithon dam on Barakar River and Panchet dam on Damodar River near to Chanch Victoria Area of BCCL (part of RCF), are the main source of water supply to the nearby area. Jharia Water Board, Damodar Water Supply Scheme and Mineral Area Development Authority (MADA) are supplying water.

1.5 DETAILS REGARDING WETLANDS

A **wetland** is a distinct ecosystem that gets flooded by water, either permanently or seasonally. The primary factor that distinguishes **wetlands** from other landforms or water bodies is its characteristic vegetation (aquatic plants). Wetland are protective ecosystem as per new guidelines of CGWA & MoEF&CC. There are no Wetlands in and around the area (Jharia coalfield and Raniganj coalfield) as per the list available on official website of MoEF&CC, Govt. of India. The list enclosed as **Annexure-III**.

1.6 CLIMATE & RAINFALL

The Jharia Coalfield (JCF) and part of Raniganj Coalfield (RCF) area in Dhanbad District belongs to sub-humid tropical climatic region. The maximum temperature during summer shoots up to 45° C and falls between 10° C to 5° C in winter. The maximum rainfall occurs during the period between June and September. Rainfall data of IMD Dhanbad and Mine Rescue Station Dhanbad given in **Annexure-IV**.

In Jharkhand state, Daily Rainfall data from 1989 to 2018 considered for analysis of trend variability and mean rainfall patterns. From the daily rainfall data, monthly rainfall series of each station is computed and then monthly district rainfall series is constructed by considering arithmetic average of all the station rainfall values within the district. The monthly rainfall series of the state is computed by using area weighted rainfall values of all the districts within the state. The objective of the analysis is to:

1. Identify the spatial pattern of the mean rainfall
2. Understand district wise observed rainfall trend and variability in annual and SW monsoon season (June, July, August and September).

Daily station rainfall data is utilized for identification of the mean spatial patterns and rainfall intensity trends. From mean and standard deviation (SD), the coefficient of variation (CV) is calculated using following equation:

$$\text{Coefficient of variation (CV)} = [\text{Standard Deviation} / \text{Mean}] \times 100$$

The analysis has done in two parts. For identification of the spatial pattern mean rainfall and variability and observed trends we have used district rainfall series and results have been brought out for four southwest monsoon months viz. June, July, August, September, for the southwest monsoon season and also for annual.

Table shows the mean rainfall (mm) and coefficient of variation of the state for the monsoon months, southwest monsoon season and annual during the period 1989-2018. It can be seen that the state gets highest rainfall (31%) of southwest monsoon rainfall in July month while the August month get 28% of the southwest monsoon rainfall. June and September receive 19% and 22% of southwest monsoon rainfall. Also more than 84% of annual rainfall receives during the southwest monsoon season only. The variability of monsoon or annual rainfall is also very less.

Jharkhand State

	June	July	August	September	Sub-total	Annual
Mean	190.3	313.9	289.2	225.7	1019.1	1211.4
CV	44.4	29.0	24.8	37.0	18.7	16.9

Dhanbad District

	June	July	August	September	Sub-total	Annual
Mean	203.9	327.7	302.5	271.5	1105.6	1332.2
CV	41.0	35.0	33.5	48.7	20.8	19.4

Fig. 1 and 2 show the time series of rainfall in mm for the months of June, July, August and September along with southwest monsoon season and annual rainfall. The trend lines are displayed for each of the series. Neither monthly rainfall nor seasonal rainfall shows any significant increasing/decreasing trend while annual rainfall shows significant decreasing trend. The monthly rainfall during June, July, August and September as well as seasonal rainfall show decreasing trend. During the last 30 years, highest rainfall of 390.3 mm was received in June in the year 1994, 492.1 mm was received in July in the year 2017, 431.5 mm was received in August in the year 1997, while highest rainfall of 395.2 in September was received in the year 1995. Highest annual rainfall of 1587.9 mm was received in the year 1999 and highest southwest monsoon rainfall of 1364.6 mm was received in the year 1994 (Climate Research and Services, IMD, Ministry of Earth Sciences, Pune, Jan'2020).

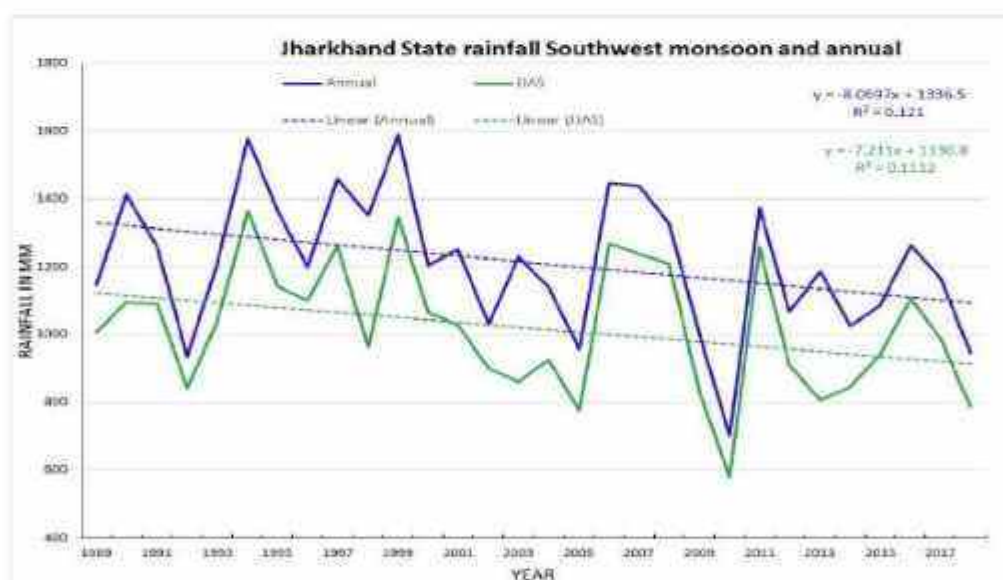


Fig-1.

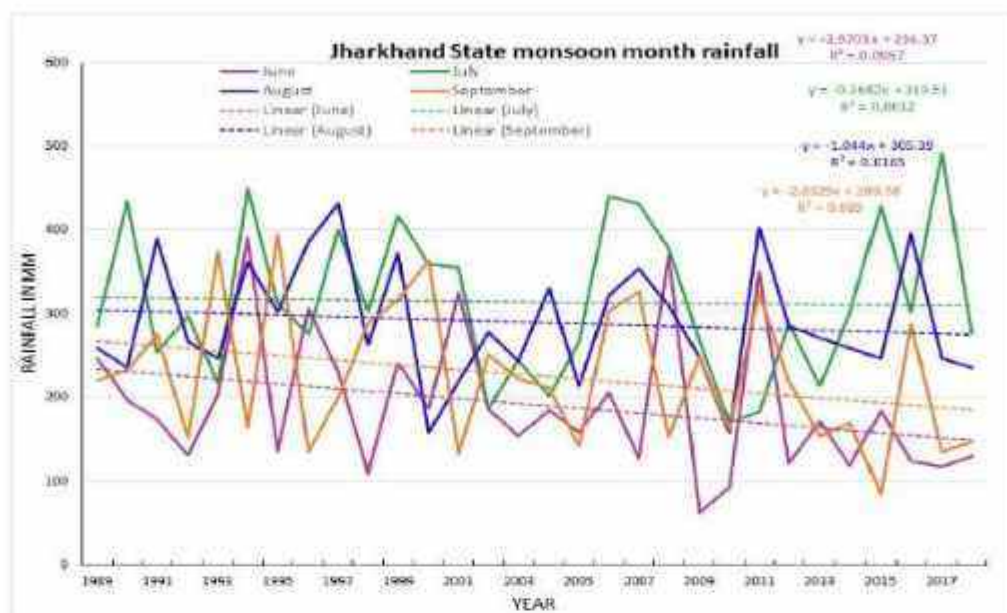


Fig-2.

2.0 GEOLOGY AND HYDROGEOLOGICAL SETUP OF THE AREA

2.1 REGIONAL GEOLOGY

The Jharia Coalfield covering an area of 453 sq. km. is located in Dhanbad District, Jharkhand. The non-coal bearing Talchir Formation is exposed in patches along the northern fringe of the Coalfield. The Barakar Formation (Coal Bearing horizon) overlies the Talchir and covers the most part of the Jharia Coalfield and have an area of 218 sq. km. This is successively overlain by the non-coal bearing Barren Measures Formation which is mainly exposed in the central part of the Coalfield. This, in turn, is overlain by the Raniganj Formation (Coal Bearing horizon) in the south-west part of the Coalfield and covers an area of 54 sq. km.

Chanch-Victoria Area is located in the western part of Raniganj Coalfield. The Raniganj coalfield represents the eastern most coal basin in the Damodar Valley Region, located at the border of Dhanbad District of Jharkhand and Bardhaman District of West Bengal. The Coalfield is almost elliptical in shape and covers an area of about 1530 sq. km. Out of this, only 35 sq. km. comes under leasehold area of BCCL within which 19.64 sq. km is the study area (Cluster-XVI only). The coal bearing formations of the area belongs to Barakar Formation of the Lower Gondwana in **Table-1**.

Table – 1: Regional Geological Succession of Jharia Coalfield

Geological Formations		Age
Quaternary/Recent	Soil cover/Weathered mantle	Recent
Post-Gondwana	Dolerite	Upper Cretaceous
	Lamprophyres	Jurassic
Damoda Group	Raniganj Formation	Upper Permian
	Barren Measures Formation	Middle Permian
	Barakar Formation	Lower Permian
	Karharbari	
	Talchir Formation	Upper Carboniferous
-----Unconformity-----		
Metamorphics		Proterozoic

2.2 HYDROGEOLOGICAL SET- UP

The permeable formations, mainly composed of sandstone, behave as aquifer units. The coal seam and shales developed in the area act as impermeable beds i.e. aquiclude. The aquifer materials of Gondwana Formation constitute of fine to coarse grain sandstone having primary porosity of inter-granular void space. The secondary porosity formed due to presence of faults, fracture, joints, etc. Sandstones of Gondwana formation in JCF and RCF are very hard, compact and cemented and form less potential aquifer, particularly in deeper aquifer system. The secondary porosity along with primary porosity forms a conduit system making these formations good aquifers for movement and storage of ground water.

2.3 AQUIFERS DESCRIPTION

The aquifer system for shallow and deeper aquifer has been established through hydrogeological studies, exploration, surface and subsurface geophysical studies in the JCF and RCF (part) covering all geological formations. The aquifer can be divided into two zones – Un-confined/Phreatic (shallow) and Semi-confined to confined (deeper) aquifer.

PHREATIC/UN-CONFINED AQUIFER

The top aquifer occurred above the top most coal seam/shale bed is called un-confined or water table aquifer and it consists of relatively permeable formation such as weathered sandstone and loose soil. The thickness of the un-confined aquifer is varying from few meters to 50 m. This un-confined aquifer is more potential than semi-confined to confined aquifer.

SEMI-CONFINED TO CONFINED AQUIFER

The semi-confined to confined aquifer consisting of sandstone bed is sandwiched between coal seams/shale beds and thus, multiple aquifer system developed due to presence of multiple number of coal seams/shale beds. With the presence of intercalated shale and carbonaceous shale beds and reduction in permeability with depth, the lower aquifers are poor in potentiality.

Table –2 Generalized Hydrogeological Units developed in the study Area

Sl. No.	Type of Aquifer	Depth range (m)	Core zone (within 2 km)	Buffer zone (within 10 km)
1.	Unconfined	0 – 50 (Avg. 25)	Alluvium, weathered sandstone	Alluvium, weathered sandstone
2.	Semiconfined/ confined	Beyond 25 upto 650 m	Multiple Sandstone horizons in Barakar formation	Multiple Barakar sandstone, Barren Measure, Raniganj sandstone, Talchir shale and Metamorphics

2.4 GENERAL AQUIFER PARAMETERS

PHREATIC/UN-CONFINED AQUIFER

The wells tested by CMPDI for determination of aquifer parameters in Damuda (BJ Section) and Block-III area of JCF. The hydraulic conductivity of the un-confined aquifer is 0.50 m/day as computed from pumping tests on the wells. The transmissivity of the unconfined aquifer ranges from 10.68 m²/day to 41.48 m²/day.

SEMI-CONFINED TO CONFINED AQUIFER

The sandstone partings in-between impervious layers of shale and coal seams is designated as semi-confined / confined aquifers. The sandstones in these aquifers are fine to coarse grained, hard and compact with very low porosity. Mostly groundwater occurs in the weak zones formed due to weathering, fracture, faults, which create the secondary porosity. The hydrogeological parameter has determined by CMPDI in Sitanala Block by conducting aquifer performance test (APT). The hydraulic conductivity (K) of semi-confined aquifer in Barakar Formation ranges from 0.0006 m/day to 1.44 m/day. The hydrogeological parameter has also been determined at Kumari OCP Block in the central JCF by conducting aquifer performance test. The hydraulic conductivity (K) of semi-confined aquifer in Barakar Formation in this area ranges from 0.0027 m/day to 0.05 m/day.

Table – 3: Aquifer parameters considered for the study Area

Hydraulic Parameter	Unconfined aquifer Site: Damuda (BJ Section) and Block-III area	Semi-confined aquifer Site: (1): Sitanala Block (2): Kumari Block
Transmissivity (m ² /d)	10.68 – 41.48	0.0621 – 0.573
Hydraulic conductivity (m/d)	0.5	0.05 – 0.0027
Specific yield	0.03 to 0.04 (as per GEC recommended values)	

3.0 GROUND WATER LEVEL MONITORING

To collect the representative groundwater levels in the study area, CMPDI has established a monitoring network of total 252 monitoring stations out of which 64 located within core zone and rest falls in Buffer zone. Total 60 nos. dug well within JCF and 04 nos. dug well within RCF (part) area (Details of the Hydrograph stations & water level given in **Annexure-V, VA & VB**) spread over the entire BCCL leasehold area, **Plate-I**. Water level data collection in all monitoring stations has been done in pre-monsoon as well as in post monsoon whereas in 64 monitoring stations the data collection has been done on quarterly basis (May'22, Aug'22, Nov'22 and Jan'23).

Depth to water level of the water table depict the inequalities in the position of water table with respect to ground surface and is useful in delineating recharge / discharge areas, planning of artificial recharge structure and shows the overall status of the groundwater level in the area. Historical groundwater level

(GWL) of entire JCF and part of RCF with fluctuation, GWL of Non-mining / Mining areas and GWL of the Cluster of Mines of BCCL are shown in this report to assess the effect of Coal mining activity on the groundwater regime in and around the Coalfield area.

Mining is a dynamic phenomenon. The mining activity creates dis-equilibrium in environmental scenario of the area and disturbs the groundwater conditions/regime in particular. The impact on shallow water regime due to mining activity can be broadly viewed as under:

- Historical GWL with annual fluctuation over the years
- GWL scenario in Non-mining and Mining area (OC/UG mines)
- GWL scenario of Cluster of mines of BCCL

3.1 HISTORICAL GROUNDWATER LEVEL (GWL)

Historical GWL of JCF and part of RCF of CMPDI monitoring stations given from 2005 to 2021 (total 64 stations within Coalfield area). Pre-monsoon and Post-monsoon GWL with Fluctuation has been mentioned below in the table.

Table – 4: Historical Groundwater Level

Period		(Water level in metre below ground level)								
		Pre-Monsoon (April/May)			Post-Monsoon (Nov/Dec)			Fluctuation		
		From	To	Average	From	To	Average	From	To	Average
JCF	2005	0.07	19.08	6.29	0.84	12.13	3.20	0.12	12.45	3.21
	2007	0.40	19.27	5.66	0.35	8.21	2.87	0.02	16.15	2.96
	2008	0.45	18.35	5.42	0.35	14.20	3.62	0.03	9.22	2.45
	2010	0.85	14.47	5.24	0.10	15.88	4.48	0.02	5.55	1.54
	2012	1.27	18.68	5.58	0.15	7.80	2.72	0.08	13.45	2.96
	2013	0.70	19.20	5.65	0.45	8.35	2.77	0.29	15.88	3.17
	2014	0.70	16.28	4.92	0.75	14.98	3.27	0.25	10.15	2.17
	2015	1.38	17.20	6.00	0.45	14.58	3.92	0.28	7.62	2.15
	2016	0.78	16.73	5.64	0.30	12.43	3.19	0.23	6.35	2.88
	2017	0.67	16.28	5.61	0.15	6.97	2.41	0.10	12.10	3.25
	2018	1.20	14.58	5.55	0.40	7.17	2.83	0.20	9.45	2.68
	2019	0.95	15.88	5.46	0.45	5.95	2.34	0.20	13.40	3.05
	2020	0.80	16.25	4.95	0.75	10.10	3.26	0.25	11.05	2.15
	2021	0.62	11.26	5.23	0.05	7.62	2.28	0.15	9.03	2.94
	2022	0.42	11.90	5.12	0.29	11.12	3.32	0.03	7.2	1.80
RCF (part)	2008	5.02	10.50	7.59	2.85	4.90	3.71	1.82	6.60	3.87
	2010	2.20	8.85	4.74	2.78	9.58	4.63	0.68	1.10	0.89
	2011	3.57	8.02	4.98	2.50	6.21	3.75	0.55	1.90	1.23
	2012	3.10	7.34	4.59	1.55	7.00	3.66	0.05	2.78	0.94
	2013	1.70	9.87	6.54	2.90	8.85	4.71	1.02	5.54	2.84
	2014	3.27	6.48	4.57	2.13	3.03	2.63	0.54	3.45	1.94
	2015	3.38	9.52	5.33	2.68	8.20	5.11	1.06	1.32	1.81
	2016	3.61	10.65	6.24	0.90	6.50	3.18	1.63	4.40	3.06
	2017	1.93	5.80	3.25	1.63	3.78	2.47	1.63	3.78	0.78
	2018	2.34	8.70	4.35	1.75	5.70	2.75	0.41	2.55	1.59
	2019	1.60	9.35	5.29	0.80	3.88	2.10	0.80	5.47	3.20
	2020	2.30	9.70	4.30	1.75	5.50	2.70	0.40	2.75	1.60
	2021	2.00	6.20	3.34	1.10	5.25	2.44	0.80	0.95	0.90
	2022	1.73	2.68	2.20	1.63	2.2	1.91	0.10	0.48	0.29

3.2 DEPTH TO WATER LEVEL & HYDRAULIC GRADIENT

Depth to water level (DTW) range in different formations with respect to mining and non-mining areas is summarized in the Table-5.

Table – 5: Depth to water table

Formation	Area	DTW (bgl, m) [Year-2022-23]	
		Pre-monsoon (Apr/May)	Post-monsoon (Nov/Dec)
Sedimentary (Gondwana Formation / Core Zone)	Non-mining	2.0-10.0	1.0-10.0
	Mining	1.0-12.0	0.50-11.0
Metamorphics (Hard rock)	Peripheral part of the Coalfield	<2.0-7.0	1.0-7.0

The study revealed that water table is in shallow depth and there is no significant stress in the water table due to coal mining activity. Mining and Non-mining areas shows barely any difference in water table condition in JCF and RCF (part) area. The average hydraulic gradient of the water table within mining and non-mining areas is given in Table-6. No significant change in hydraulic gradient is observed. Relatively steep gradient near active opencast mining areas w.r.t., non-mining, underground mines and Metamorphics areas is observed.

Table – 6: Average hydraulic gradient

Sl. No	Formation	Area	Average hydraulic gradient
1	Sedimentary (Gondwana Formation / Core Zone)	Non-Mining	1.0×10^{-3} to 2.5×10^{-3}
		Mining	1.0×10^{-2} to 4.0×10^{-3}
2	Metamorphics (Buffer Zone)	Peripheral part of the Coalfield	1.0×10^{-3} to 3.5×10^{-3}

3.3 GROUND WATER LEVEL DATA OF THE CLUSTER OF MINES OF BCCL

A GROUND WATER LEVEL OF CLUSTER-I

Cluster-I (Damuda Group of Mines consisting of Damuda UG, Albion OCP, Proposed BJ Section OCP and Abandoned Gutway OCP) of Barora area, BCCL is located in the western most part of Jharia coalfield in Bokaro district of Jharkhand. The life of the project has been worked out to be up to 15 years considering annual target production of 1.17 MTPA. It is located in the extreme western part of JCF in Bokaro district of Jharkhand (Toposheet no – 73 I/1).

The present leasehold area of Cluster-I is 575.0 Ha. The Damuda block area marked by more or less flat and gently undulating topography. The RL varies from 179 m to 208 m AMSL and the general slope of topography is towards east. Jamuniya River, Kari Jore, Podo Jore and its tributaries are controlling the drainage system of the area. The area comes under the watershed of Jamuniya River.

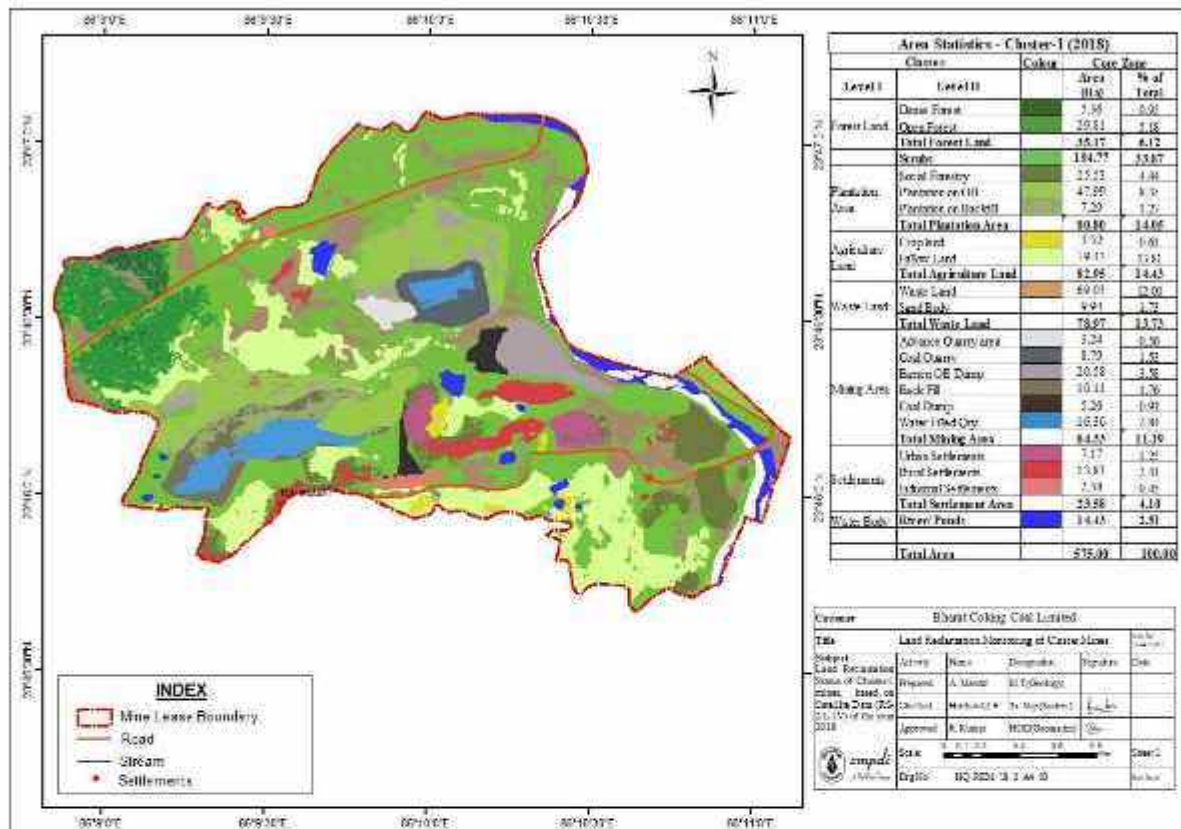
Monitoring stations (**B-15, B-21A, B51 and B-53**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'22, August'22, and Nov'22 and January'23. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2022-23				2021-22				2020-21			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	B-15	Bera Basti	3.67	0.45	1.02	2.30	1.46	0.25	0.35	1.01	3.70	0.15	1.47	1.70
2	B21A	Dugdha	9.65	5.55	4.35	Abn.	8.38	2.50			10.00	4.15	5.80	6.70
3	B-51	Taranga	5.06	0.00	4.57	2.87	5.70	0.90	1.00	4.88	5.00	0.88	2.10	3.00
4	B-53	Karmatanr	4.42	1.78	3.54	1.68	4.85	1.52	1.87	2.87	3.12	1.07	1.40	1.92
Average WL (bgl)			5.70	1.95	3.37	2.28	5.10	1.29	1.07	2.92	3.70	0.15	1.47	1.70

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.46 m Max – 10.00 m
 Post-monsoon GW Level (m): Min – 0.35 m Max – 5.80 m

LAND USE / LAND COVER MAP OF THE CLUSTER-I MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	393.69 x 10 ⁴	0.0	393.69 x 10 ⁴
2	Open Land	204.89 x 10 ⁴	0.0	204.89 x 10 ⁴
3	Road/ Paved Area	09.0 x 10 ⁴	0.0	09.0 x 10 ⁴
4	Rooftop area of building/ sheds	14.58 x 10 ⁴	0.0	14.58 x 10 ⁴
5	Total	575.00 x 10 ⁴	0.0	575.00 x 10 ⁴

B. GROUND WATER LEVEL OF CLUSTER-II

Cluster-II consists of seven mines namely; Block II Mixed mines (OCP & UGP), Jamunia OCP, Shatabdi OCP, Muraidih Mixed mines (OCP & UGP), and Phularitand OCP of BCCL is located in the western most part of Jharia coalfield in Bokaro district and Dhanbad district of Jharkhand. The life of the project has been worked out to be up to 30 years considering annual target production of 20.215 MTPA. It is located in the extreme western part of Jharia Coalfield in Dhanbad district of Jharkhand (Toposheet no- 73 I/1 and I/5).

The present leasehold area of Cluster-II is 2260.54 Ha. The Damuda block area marked by more or less flat and gently undulating topography. The RL varies from 176 m to 235 m AMSL. Jamuniya River, Khudia River and its tributaries are controlling the drainage system of the area. The area comes under the watershed of Jamuniya River and Khudia River.

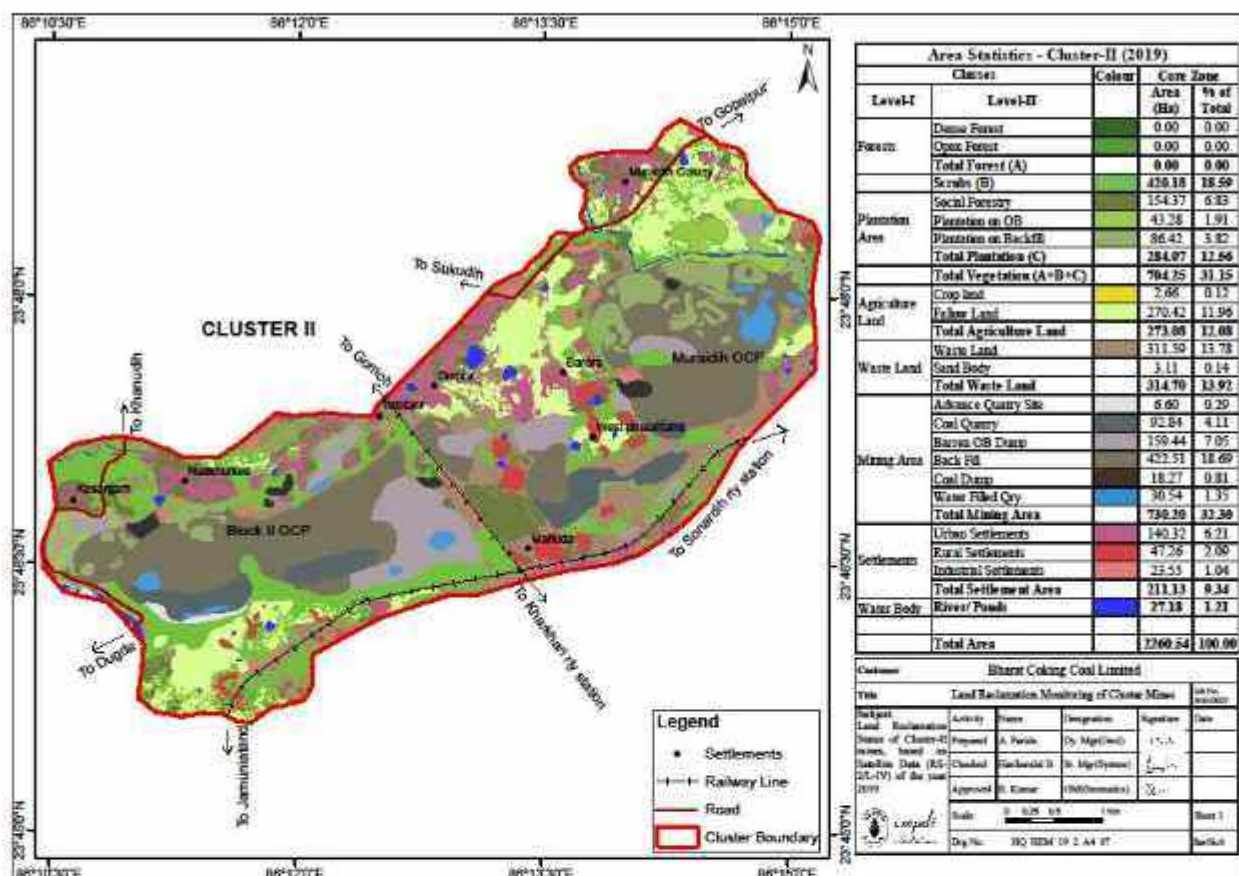
Monitoring stations (**B-1, B-59, B-60, B-61A and B-62A**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'22, August'22, and Nov'22 and January'23. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2022-23				2021-22				2020-21			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	B-1	Muraidih	2.10	1.65	1.81	2.73	2.58	0.58	1.91	2.03	3.28	0.73	1.63	1.73
2	B-59	Khodovaly	4.50	0.44	1.14	1.04	5.49	0.30	0.90	0.95	5.25	0.67	1.40	2.10
3	B-60	Bahiyardih	10.53	1.08	5.80	9.38	11.26	1.33	2.23	6.53	10.33	0.91	3.21	6.13
4	B61A	Kesargora	1.20	0.52	0.97	Abn	4.42	0.47	0.97	0.97	3.32	0.85	1.60	2.07
5	B62A	Sadiyardih	6.45	1.77	4.91	5.15	6.87	1.35	4.50	4.60	6.95	2.77	3.00	4.95
Average WL (bgl)			4.96	1.09	2.93	4.58	6.12	0.81	2.10	3.02	5.83	1.19	2.17	3.40

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.20m Max – 11.26 m
Post-monsoon GW Level (m): Min – 0.90 m Max – 5.80 m

LAND USE / LAND COVER MAP OF THE CLUSTER-II MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	977.33 x 10 ⁴	0.0	977.33 x 10 ⁴
2	Open Land	1072.08 x 10 ⁴	0.0	1072.08 x 10 ⁴
3	Road/ Paved Area	140.32 x 10 ⁴	0.0	140.32 x 10 ⁴
4	Roof top area of building/ sheds	70.81 x 10 ⁴	0.0	70.81 x 10 ⁴
5	Total	2260.54 x 10 ⁴	0.0	2260.54 x 10 ⁴

C. GROUND WATER LEVEL OF CLUSTER-III

Cluster-III consists of nine mines namely, Jogidih UG, Govindpur UG, Maheshpur UG, Kooridih/Block-IV Mixed Mine, New Akashkinaree Mixed Mine, South Govindpur UG (closed), and Teturiya UG (closed) mines. The life of the project has been worked out to be up to 60 years considering annual production target of 3.60 MTPA. This Cluster of mines is located in western part of Jharia Coalfield in Dhanbad district of Jharkhand (Toposheet no – 73 I/5).

The present leasehold area of Cluster-III is 1552.53 Ha. The area is plain with gentle undulation with RL varying from 160 m to 208.80 m AMSL. The general slope of the area is towards south. Khudia River, Baghdigi Jore, Katri River and its tributaries are controlling the drainage system of the area. The area comes under the watershed of Khudia River.

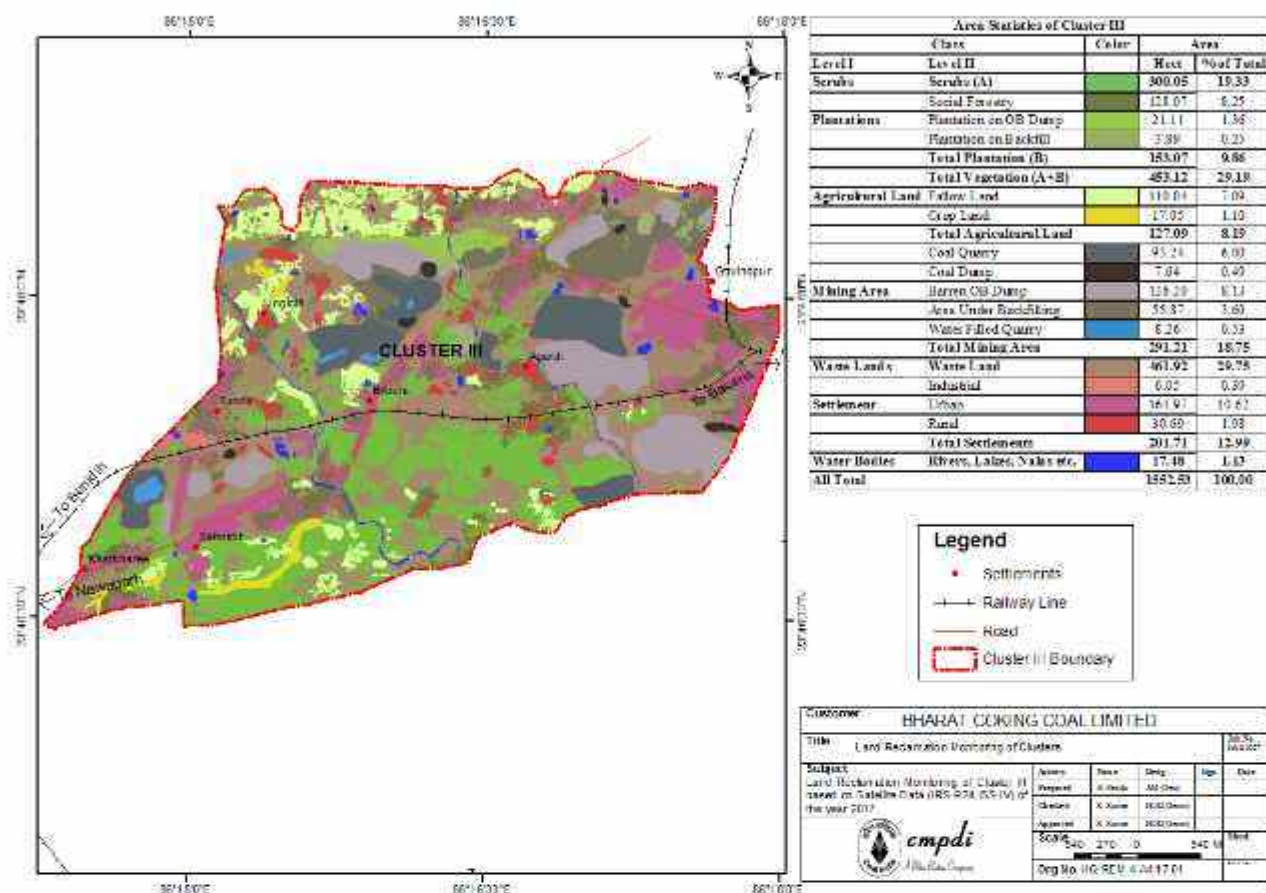
Monitoring stations (**A-12, A-25, A-29, B-14 and B-60**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'22, August'22, and Nov'22 and January'23. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2022-23				2021-22				2020-21			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A12	Jamua	1.50	0.30	0.67	0.70	1.92	0.50	1.10	1.72	2.60	0.32	0.50	1.20
2	A25	Sinidih	3.31	1.33	2.08	2.51	5.78	1.73	2.43	2.53	2.98	1.30	1.83	2.53
3	A29	Dharmaband	4.60	1.20	1.15	1.12	6.49	2.90	5.90	6.65	6.20	1.21	3.20	3.25
4	B14	Mathadih	3.24	0.09	2.60	2.55	2.84	0.24	2.04	2.10	2.44	0.32	1.04	1.69
5	B60	Sonardih	10.53	1.08	5.80	9.38	11.26	1.33	2.23	6.53	10.33	0.91	3.21	6.13
Average WL (bgl)			4.64	0.80	2.46	3.25	5.66	1.34	2.74	3.91	4.91	0.81	1.96	2.96

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.50 m Max – 11.26 m
Post-monsoon GW Level (m): Min – 0.50 m Max – 5.90 m

LAND USE / LAND COVER MAP OF THE CLUSTER-III MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	580.21 x 10 ⁴	0.0	580.21 x 10 ⁴
2	Open Land	770.61 x 10 ⁴	0.0	770.61 x 10 ⁴
3	Road/ Paved Area	164.97 x 10 ⁴	0.0	164.97 x 10 ⁴
4	Rooftop area of building/ sheds	36.74 x 10 ⁴	0.0	36.74 x 10 ⁴
5	Total	1552.53 x 10 ⁴	0.0	1552.53 x 10 ⁴

D. GROUND WATER LEVEL OF CLUSTER-IV

Cluster-IV consists of six mines namely, Amalgamated Keshalpur & West Mudidih colliery, Amalgamated Angarpathra & Ramkanali colliery, Katras-Choitudih Colliery, Salanpur colliery and Gaslitand colliery of Katras area, BCCL. It is located in the north-central part of Jharia Coalfield in Dhanbad district of Jharkhand. The life of the project has been worked out to be more than 30 years considering annual target production of 9.55 MTPA (Toposheet no – 73 I/5).

The present leasehold area of Cluster-IV is 1123.79 Ha. The area has a general undulating topography, with an overall gentle south-west slope. The RL varies from 182 m to 216 m AMSL. Katri River, Kumari Jore and their tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Katri River.

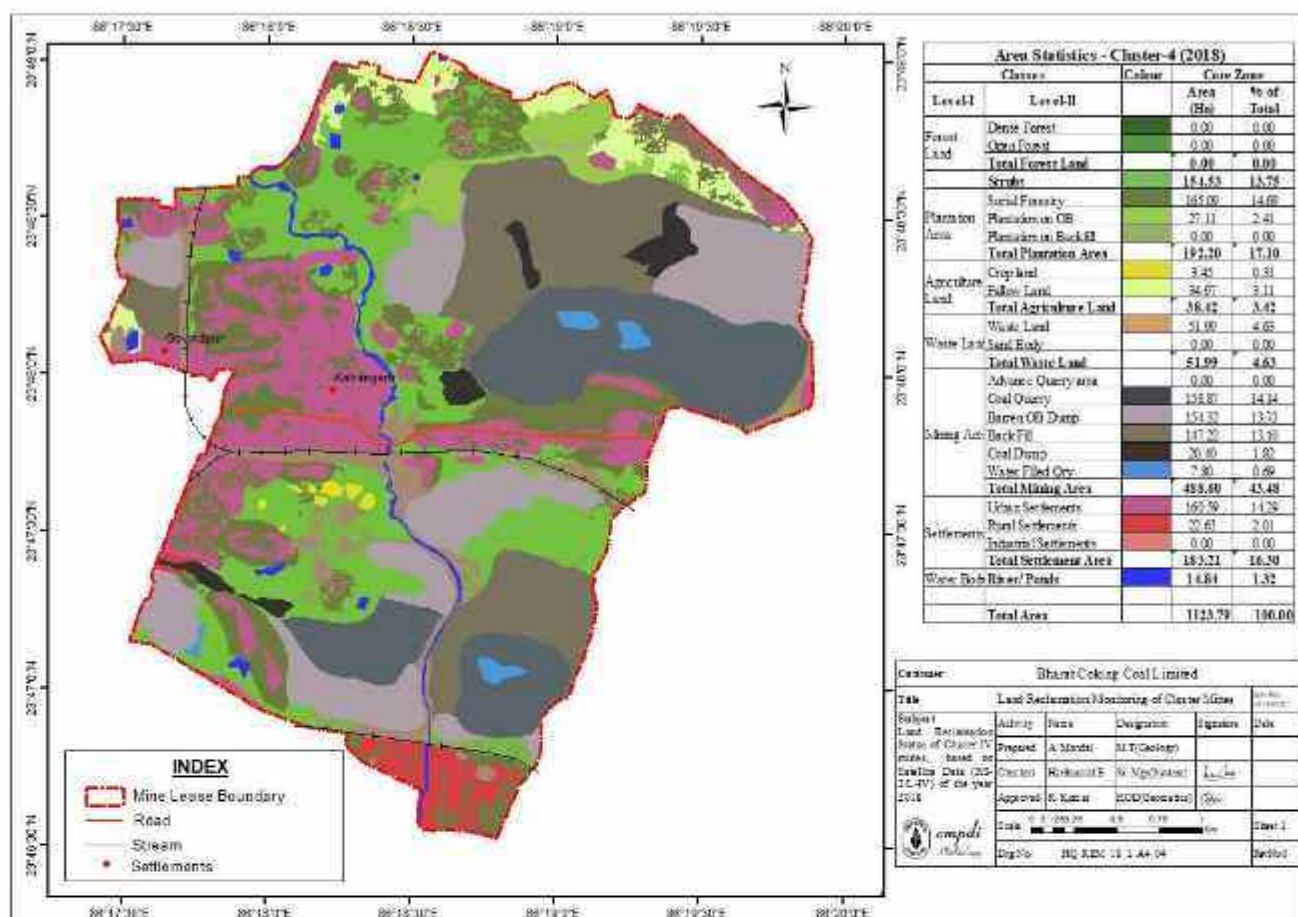
Monitoring stations (**A-26, A28A, B-64 and B-65A**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'22, August'22, and Nov'22 and January'23. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2022-23				2021-22				2020-21			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A-26	Malkhera	6.42	2.83	4.31	3.62	6.70	2.10	2.73	3.63	6.98	2.69	3.18	4.78
2	A28A	Lakarka	4.23	2.85	3.30	3.57	6.23	0.53	3.75	4.47	4.00	1.33	3.03	3.35
3	B-64	Keshalpur	1.00	0.35	0.60	0.75	2.35	0.30	0.95	1.00	1.85	0.93	0.50	1.37
4	B65A	Jhinjipahari	7.45	0.50	2.27	3.45	9.03	0.45	1.42	2.80	9.25	0.03	2.30	4.10
Average WL (bgl)			4.78	1.63	2.62	2.85	6.08	0.85	2.21	2.98	5.52	1.25	2.25	3.40

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.00 m Max – 9.25 m
Post-monsoon GW Level (m): Min – 0.50 m Max – 4.31 m

LAND USE / LAND COVER MAP OF THE CLUSTER-IV MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	385.15 x 10 ⁴	0.0	385.15 x 10 ⁴
2	Open Land	555.43 x 10 ⁴	0.0	555.43 x 10 ⁴
3	Road/ Paved Area	160.59 x 10 ⁴	0.0	160.59 x 10 ⁴
4	Rooftop area of building/ sheds	22.63 x 10 ⁴	0.0	22.63 x 10 ⁴
5	Total	1123.79 x 10 ⁴	0.0	1123.79 x 10 ⁴

E. GROUND WATER LEVEL OF CLUSTER-V

Cluster-V consists of twelve mines namely, Tetulmari OC & UG mines, Mudidih OC & UG mines, Nichitpur OC mine, Sendra Bansjora OC & UG mines, Bansdeopur OCP (proposed) & UG Mines, Kankanee OC & UG mines and Loyabad UG mine (closed) of Sijua area, BCCL. This Cluster of mines is located in northern part of Jharia Coalfield in Dhanbad district of Jharkhand. The life of the project has been worked out to be more than 30 years considering annual production target of 6.311 MTPA (Toposheet no – 73 I/6).

The present leasehold area of Cluster-V is 1724.52 Ha. The area has a general undulating topography, with an overall gentle south-west slope. The RL varies from 210 m to 170 m AMSL. Jarian Nala, Nagri Jore, Ekra Jore and their tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Jarian Nala and Ekra Jore.

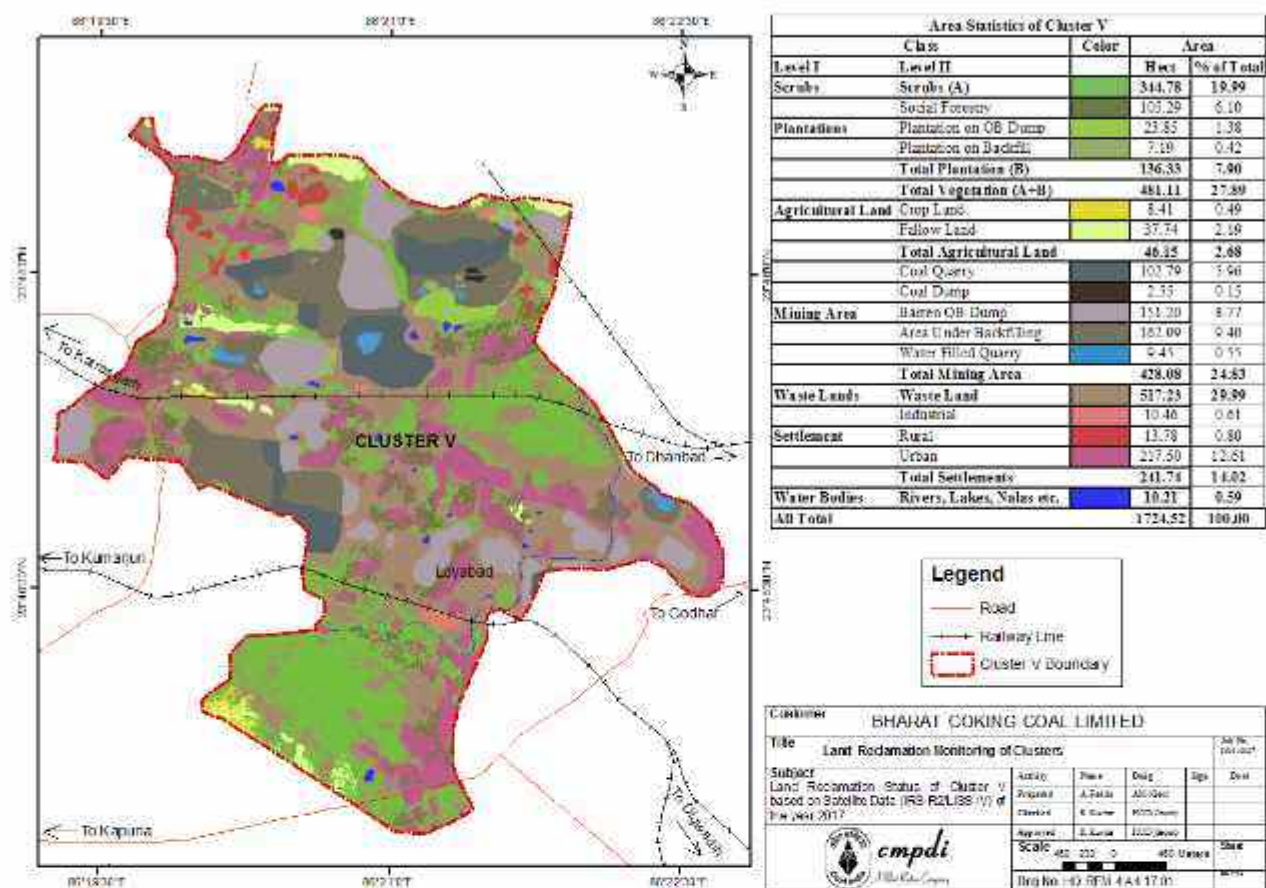
Monitoring stations (**A-3, A-16, A-27 and D-23**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'22, August'22, and Nov'22 and January'23. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2022-23				2021-22				2020-21			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A-3	Sijua	0.42	0.22	0.29	0.32	0.62	0.07	0.05	0.07	1.57	0.02	0.47	0.77
2	A-16	Ekra	5.80	1.35	3.08	2.99	3.45	1.90	2.00	3.00	7.15	1.34	1.75	3.20
3	A-27	Tetulmari	1.90	0.10	1.33	1.50	1.67	0.80	0.90	1.13	2.40	0.03	1.10	1.90
4	D-23	Jogta	1.85	0.45	1.57	1.85	5.43	1.87	1.60	1.65	5.60	1.69	3.35	3.70
Average WL (bgl)			2.49	0.53	1.57	1.67	2.79	1.16	1.14	1.46	4.18	0.77	1.67	2.39

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 0.42 m Max – 7.15 m
Post-monsoon GW Level (m): Min – 0.05 m Max – 3.35 m

LAND USE / LAND COVER MAP OF THE CLUSTER-V MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	527.26 x 10 ⁴	0.0	527.26 x 10 ⁴
2	Open Land	973.52 x 10 ⁴	0.0	973.52 x 10 ⁴
3	Road/ Paved Area	217.50 x 10 ⁴	0.0	217.50 x 10 ⁴
4	Rooftop area of building/ sheds	24.24 x 10 ⁴	0.0	24.24 x 10 ⁴
5	Total	1724.52 x 10 ⁴	0.0	1724.52 x 10 ⁴

F. GROUND WATER LEVEL OF CLUSTER-VI

Cluster-VI consists of four coal mines namely, East Bassuriya opencast (OC), Bassuriya underground (UG), Gondudih Khas-Kusunda OC and Godhur Mixed Mines (OC and UG) of BCCL. This Cluster of mines is located in central part of Jharia Coalfield in Dhanbad district of Jharkhand. The life of the project has been worked out to be more than 30 years considering annual production target of 7.631 MTPA (Toposheet no – 73 I/6).

The present leasehold area of Cluster-VI is 831.83 Ha. The area has a general undulating topography with general slope towards south. The RL varies from 180 m to 240 m AMSL. Ekra Jore, Kari Jore and their tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Ekra Jore and Kari Jore.

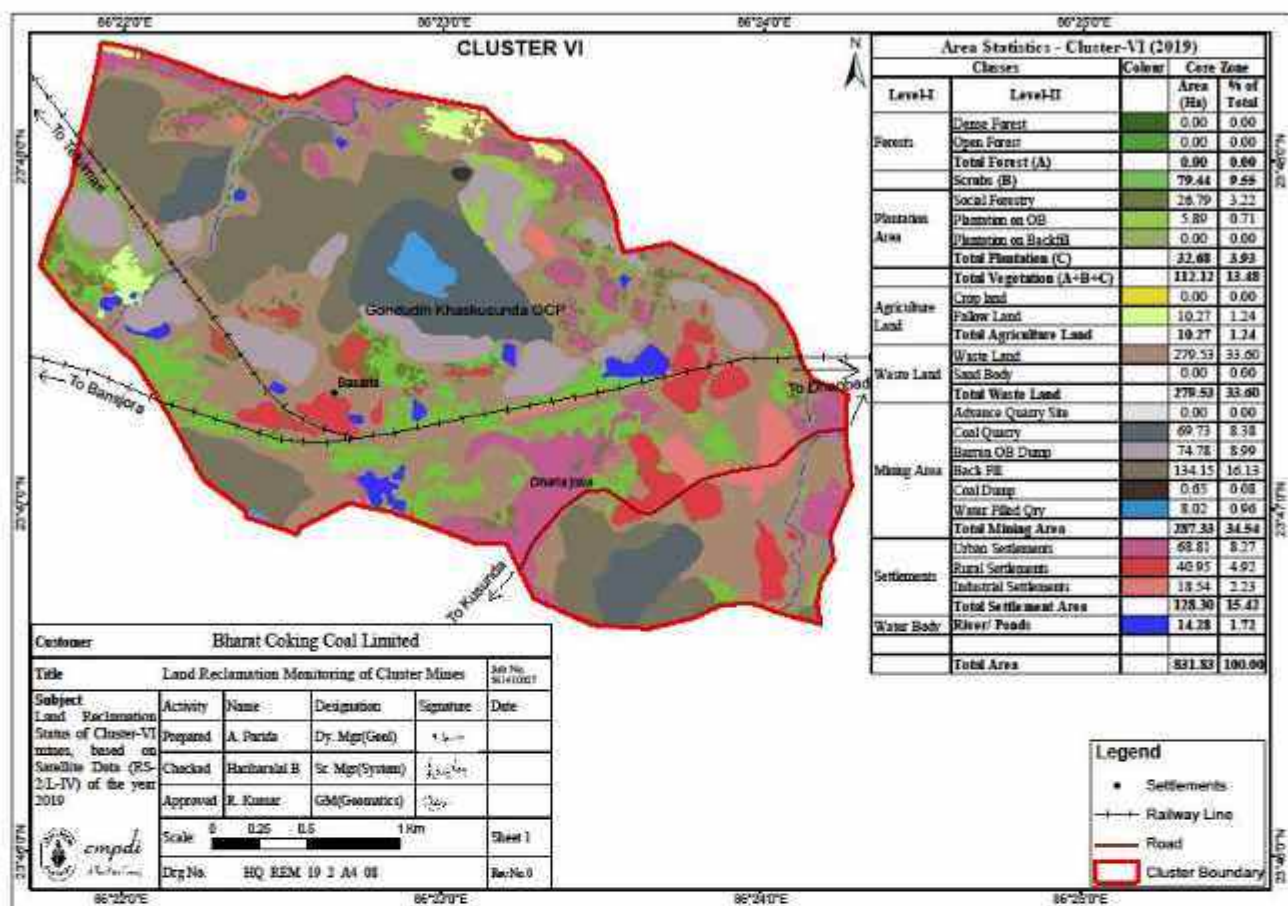
Monitoring stations (**D-25 and D-30**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'22, August'22, and Nov'22 and January'23. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2022-23				2021-22				2020-21			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D25	Godhur	11.9	2.58	4.70	5.30	10.50	2.90	3.80	4.40	10.50	2.28	5.62	6.40
2	D30	Borkiboa	4.37	1.80	2.29	4.15	4.23	0.60	0.84	1.80	4.50	1.65	1.35	2.40
Average WL (bgl)			8.14	2.19	3.50	4.73	7.37	1.75	2.32	3.10	7.50	1.97	3.49	4.40

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 4.23 m Max – 11.90 m
Post-monsoon GW Level (m): Min – 0.84m Max – 5.62 m

LAND USE / LAND COVER MAP OF THE CLUSTER-VI MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	122.39 X 10 ⁴	0.0	122.39 X 10 ⁴
2	Open Land	581.14 X 10 ⁴	0.0	581.14 X 10 ⁴
3	Road/ Paved Area	68.81 X 10 ⁴	0.0	68.81 X 10 ⁴
4	Rooftop area of building/ sheds	59.49 X 10 ⁴	0.0	59.49 X 10 ⁴
5	Total	831.83 X 10 ⁴	0.0	831.83 X 10 ⁴

G. GROUND WATER LEVEL OF CLUSTER-VII

Cluster-VII consists of fourteen mines within Kusunda Area, Bastacolla Area and PB Area, B.C.C.L, Jharia Coalfield. Coal mines namely Dhansar UG, Dhansar OCP, Kusunda OCP and Viswakarma OCP (proposed) are under the administrative control of Kusunda Area and Industry UG (closed), Alkusa UG, Ena OCP, S.Jharia/Rajapur OCP, Burragarh UG, Simlabahal UG, Huriladih UG, Bhutgoria UG (Re-opening), Kustore UG (closed) and E.Bhuggatdih UG (closed) are under Bastacolla and PB Area. This Cluster of mines is located in east central part of Jharia Coalfield in Dhanbad district of Jharkhand. The life of the project has been worked out to be more than 30 years considering annual production target of 8.226 MTPA (Toposheet no – 73 I/6).

The present leasehold area of Cluster-VII is 2127.70 Ha. The area has a general undulating topography with general slope towards south. The RL varies from 172 m to 221 m above M.S.L. Kari Jore, Chatkari Jore and their tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Kari Jore and Chatkari Jore.

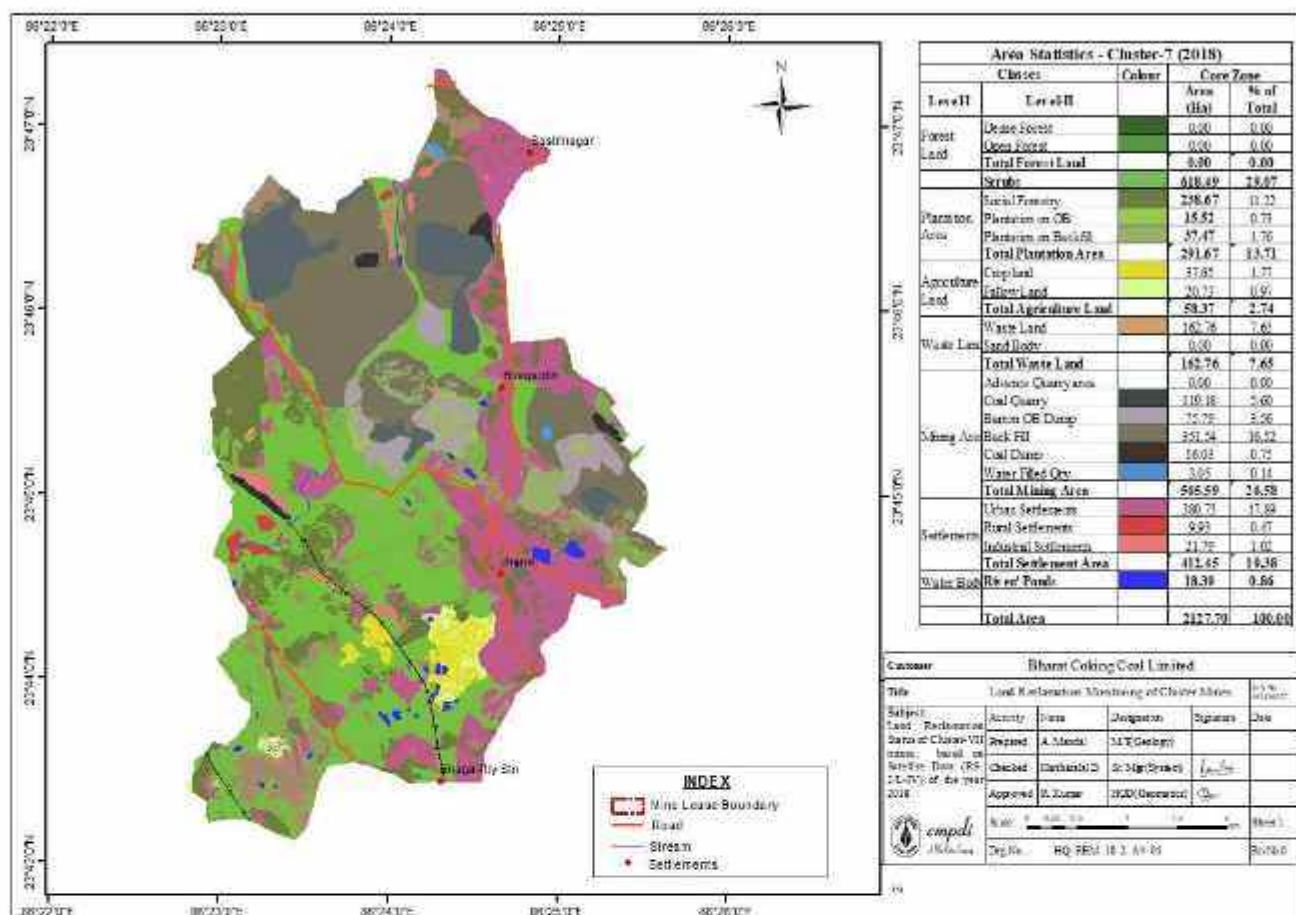
Monitoring stations (**D-3, D-4, D-33, D-34, D-47, D-55 and D-80**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'22, August'22, and Nov'22 and January'23. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2022-23				2021-22				2020-21			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D-3	Dhansar	5.96	0.55	1.32	1.34	3.41	0.80	0.85	1.30	1.75	1.05	1.30	1.45
2	D-4	Jharia	1.71	0.98	1.55	1.66	3.01	1.41	1.16	1.61	2.81	1.16	1.71	2.16
3	D33	Kustore	1.20	0.45	0.65	0.95	1.75	0.62	0.85	1.60	2.35	0.25	1.65	2.35
4	D34	Kusunda	5.00	2.15	3.15	3.22	3.78	2.05	2.90	2.95	4.75	2.10	2.40	2.55
5	D47	Parastanr	6.55	5.32	5.85	11.40	4.05	3.22	2.45	4.88	4.55	1.90	4.35	4.20
6	D55	Hariladih	11.32	9.46	11.12	Abn.	9.52	5.62	7.62	9.02	8.42	2.97	5.47	8.62
7	D80	Bastacolla	3.30	2.40	3.08	1.80	7.10	2.17	2.55	3.10	5.00	2.30	3.05	3.80
Average WL (bgl)			5.01	3.04	3.82	3.40	4.66	2.27	2.63	3.49	4.23	1.68	2.85	3.59

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.20 m Max – 11.32 m
Post-monsoon GW Level (m): Min – 0.65 m Max – 11.12 m

LAND USE / LAND COVER MAP OF THE CLUSTER-VII MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	968.53 x 10 ⁴	0.0	968.53 x 10 ⁴
2	Open Land	746.72 x 10 ⁴	0.0	746.72 x 10 ⁴
3	Road/ Paved Area	380.73 x 10 ⁴	0.0	380.73 x 10 ⁴
4	Rooftop area of building/ sheds	31.71 x 10 ⁴	0.0	31.71 x 10 ⁴
5	Total	2127.70 x 10 ⁴	0.0	2127.70 x 10 ⁴

H. GROUND WATER LEVEL OF CLUSTER-VIII

Cluster - VIII of B.C.C.L mines are under administrative control of Bastacolla Area, Jharia Coalfield. Cluster-VIII consists of ten mines namely Bastacolla mixed mines (OC & UG), Bera mixed mines (OC&UG), Dobari UG, Kuya mixed mines (OC&UG), Proposed Goluckdih (NC) OC mine, Ghanoodih OC mine and Kujama OC mine. This cluster is located in west part of Jharia Coalfield in Dhanbad district of Jharkhand. All the above mines are contiguous in nature and the environmental impact is overlapping in ambient environment due to cumulative effect of mining activities. The life of the project has been worked out to be up to 25 years considering annual production target of 6.383 MTPA (toposheet no. 73 I/5 and I/6).

The present leasehold area of Cluster-VIII is 1331.95 Ha. The area has a general undulating topography with general slope towards south and south-west. The ground elevation in the area ranges from 175 m to 221 m AMSL. Chatkari Jore, Tisra Jore and their tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Chatkari Jore.

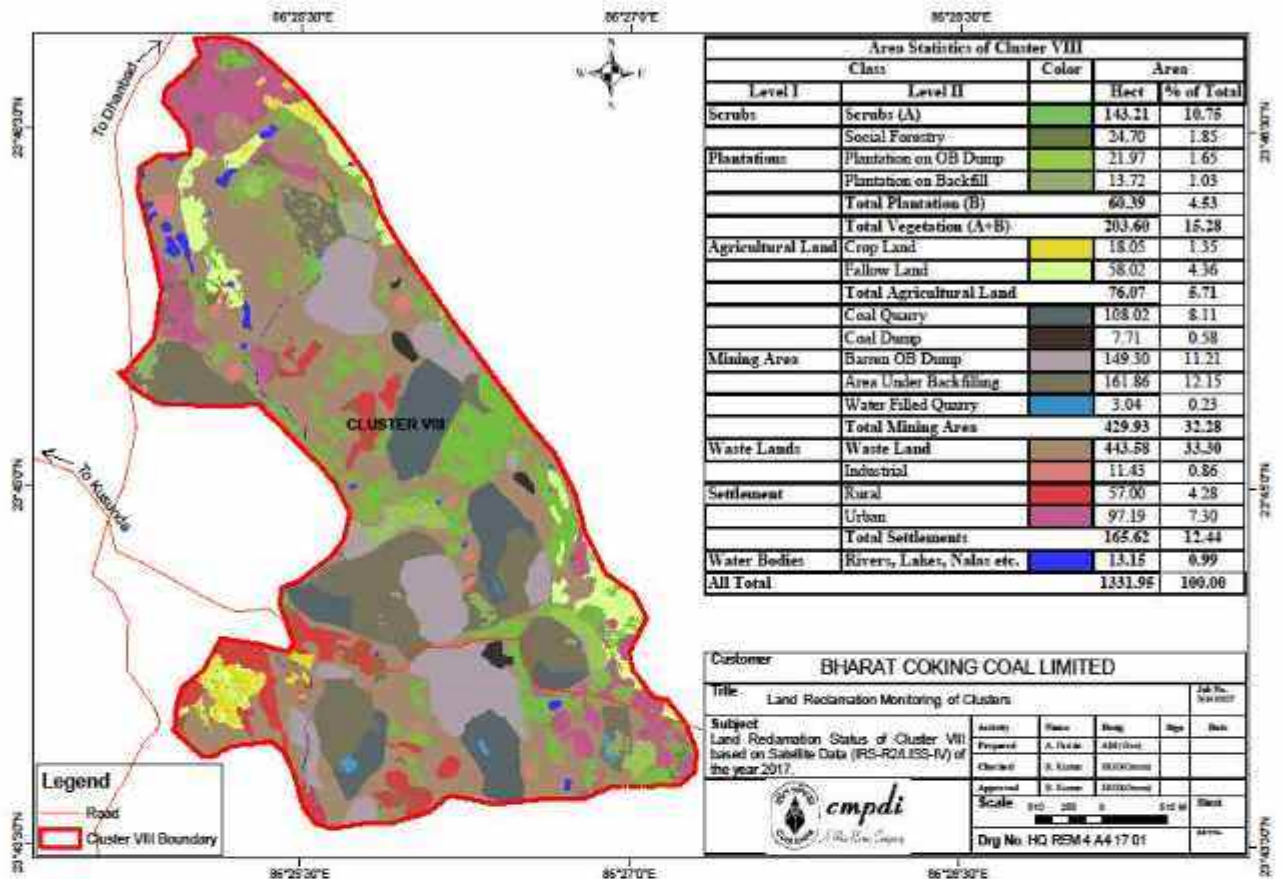
Monitoring stations (**D-8, D-43, D-49 and D-51**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'22, August'22, and Nov'22 and January'23. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2022-23				2021-22				2020-21			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D-8	Alokdiha	6.32	4.25	5.42	6.34	4.55	1.85	2.27	3.20	5.83	1.70	2.75	3.20
2	D43	Alagdih	5.35	3.11	4.71	5.65	4.65	2.40	2.60	3.35	6.60	2.31	2.55	3.05
3	D49	Galucdih	2.00	1.27	1.91	2.17	1.40	0.73	0.85	1.00	3.25	1.41	1.65	1.98
4	D51	Chankuiya	10.95	6.55	8.50	Abn.	9.43	5.65	5.65	7.50	8.45	6.03	5.70	7.35
Average WL (bgl)			6.16	3.80	5.14	4.72	5.01	2.66	2.84	3.76	6.03	2.86	3.16	3.90

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.40 m Max – 10.95 m
Post-monsoon GW Level (m): Min – 0.85 m Max – 8.50 m

LAND USE / LAND COVER MAP OF THE CLUSTER-VIII MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	279.69 x 10 ⁴	0.0	279.69 x 10 ⁴
2	Open Land	886.66 x 10 ⁴	0.0	886.66 x 10 ⁴
3	Road/ Paved Area	97.19 x 10 ⁴	0.0	97.19 x 10 ⁴
4	Rooftop area of building/ sheds	68.43 x 10 ⁴	0.0	68.43 x 10 ⁴
5	Total	1331.95 x 10 ⁴	0.0	1331.95 x 10 ⁴

I. GROUND WATER LEVEL OF CLUSTER-IX

Mines of cluster-IX are under administrative control of Lodna Area of B.C.C.L in western part of Jharia Coalfield which is located in Dhanbad district of Jharkhand. Cluster- IX consists of eight mines namely; North Tisra/South Tisra OCP, Jeenagora OCP, North Tisra UG, Lodna UG, Bagdigi UG, Bararee UG, Joyrampur UG and Jealgora UG (closed). Among them N. Tisra/S. Tisra OCP, Jeenagora OCP and N. Tisra UG mine will be amalgamated and will form North Tisra/South Tisra Expansion OCP. All above the mines are contiguous in nature and the environmental impact is overlapping in ambient environment due to cumulative effect of mining activities. The life of the project has been worked out to be up to 30 years considering annual production target of 8.513 MTPA (toposheet no. 73 I/6).

The present leasehold area of Cluster-IX is 1967.22 Ha. The topography of the area is undulating with gentle slope towards south. The RL varies from 221 m to 188.44 m AMSL. Chatkari Jore, Tisra Jore, Sulunga Jore and their tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Chatkari Jore.

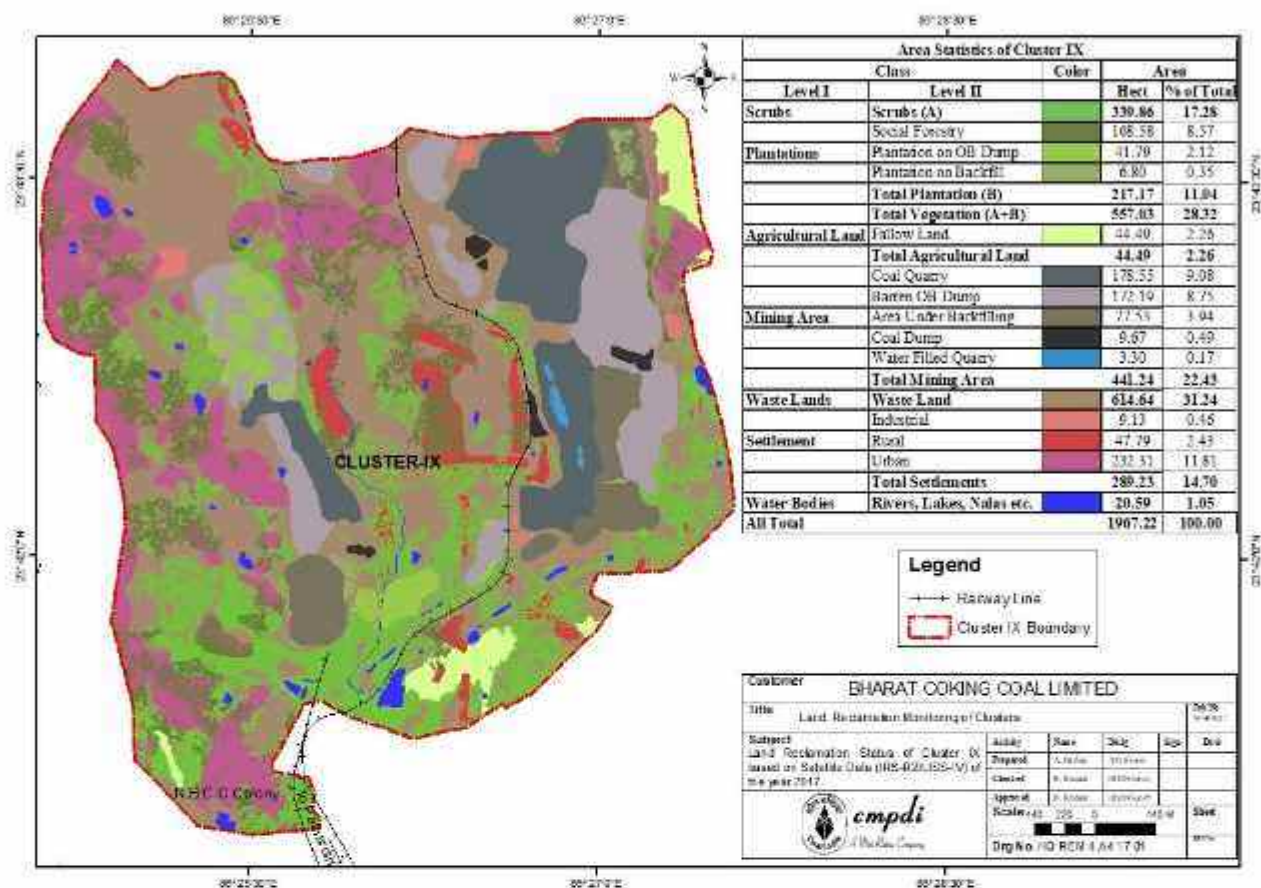
Monitoring stations (D-5, D-7, D-39, D-40A, D-41 and D-74) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'22, August'22, and Nov'22 and January'23. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2022-23				2021-22				2020-21			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D-5	Jiyalgora	8.40	3.36	7.01	8.95	7.28	3.35	4.00	6.40	8.60	3.20	7.70	7.90
2	D-7	Golden Pahari	9.03	2.17	5.67	6.57	6.08	2.38	2.63	3.88	7.33	2.56	5.13	5.35
3	D-39	Tilaboni	7.50	1.85	3.05	1.75	10.70	4.60	5.10	8.15	9.40	3.35	6.05	6.78
4	D40A	Khapa Dhawra	2.35	1.60	1.80	Abn.	1.95	1.35	1.80	2.35	1.95	0.30	1.43	6.78
5	D-41	Joyrampur	1.55	0.90	0.88	0.92	1.95	1.34	1.38	1.45	3.30	1.43	1.45	1.60
6	D-74	BhulanBararee	6.17	3.20	5.77	7.90	6.93	3.20	2.90	3.70	4.30	2.58	3.93	4.00
Average WL (bgl)			5.83	2.18	4.03	5.22	5.82	2.70	2.97	4.32	5.81	2.24	4.28	4.54

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.55 m Max – 10.70 m
 Post-monsoon GW Level (m): Min – 0.88 m Max – 7.70 m

LAND USE / LAND COVER MAP OF THE CLUSTER-IX MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	601.52 x 10 ⁴	0.0	601.52 x 10 ⁴
2	Open Land	1076.47 x 10 ⁴	0.0	1076.47 x 10 ⁴
3	Road/ Paved Area	232.31 x 10 ⁴	0.0	232.31 x 10 ⁴
4	Rooftop area of building/ sheds	56.92 x 10 ⁴	0.0	56.92 x 10 ⁴
5	Total	1967.22 x 10 ⁴	0.0	1967.22 x 10 ⁴

J. GROUND WATER LEVEL OF CLUSTER-X

Cluster-X consists of Bhowrah North OC & UG, Bhowrah South OC & UG, Amalgamated Sudamdih Patherdih, Sudamdih Shaft, Amlabad UG (Closed) and Sudamdih Coal Washery which comes under the administrative control of Eastern Jharia Area of Bharat Coking Coal Limited (B.C.C.L - A Subsidiary of Coal India Limited). This cluster of mines is located in eastern part of Jharia Coalfield in Dhanbad district of Jharkhand. The life of the project has been worked out to be more than 30 years considering annual production target of 2.289 MTY.

Cluster-X mine involves leasehold area of about 2057.47 Ha of land. It is covered in Survey of India toposheet no. 73 I/6. The area of Bhowrah North OC & UG, Bhowrah South OC & UG, Amalgamated Sudamdih Patherdih, Sudamdih Shaft, Amlabad UG (Closed) are 280.83 Ha, 571.58 Ha, 498.61 Ha, 391.50 Ha and 386.95 Ha respectively.

The present leasehold area of Cluster-X is 2057.47 Ha. The area has an undulating topography with gentle slope towards south and south-east. The RL varies from 185 m to 150.0 m AMSL. Gaurkuthi Nala and few seasonal streams are controlling the drainage pattern of the area. The area comes under the watershed of Damodar River.

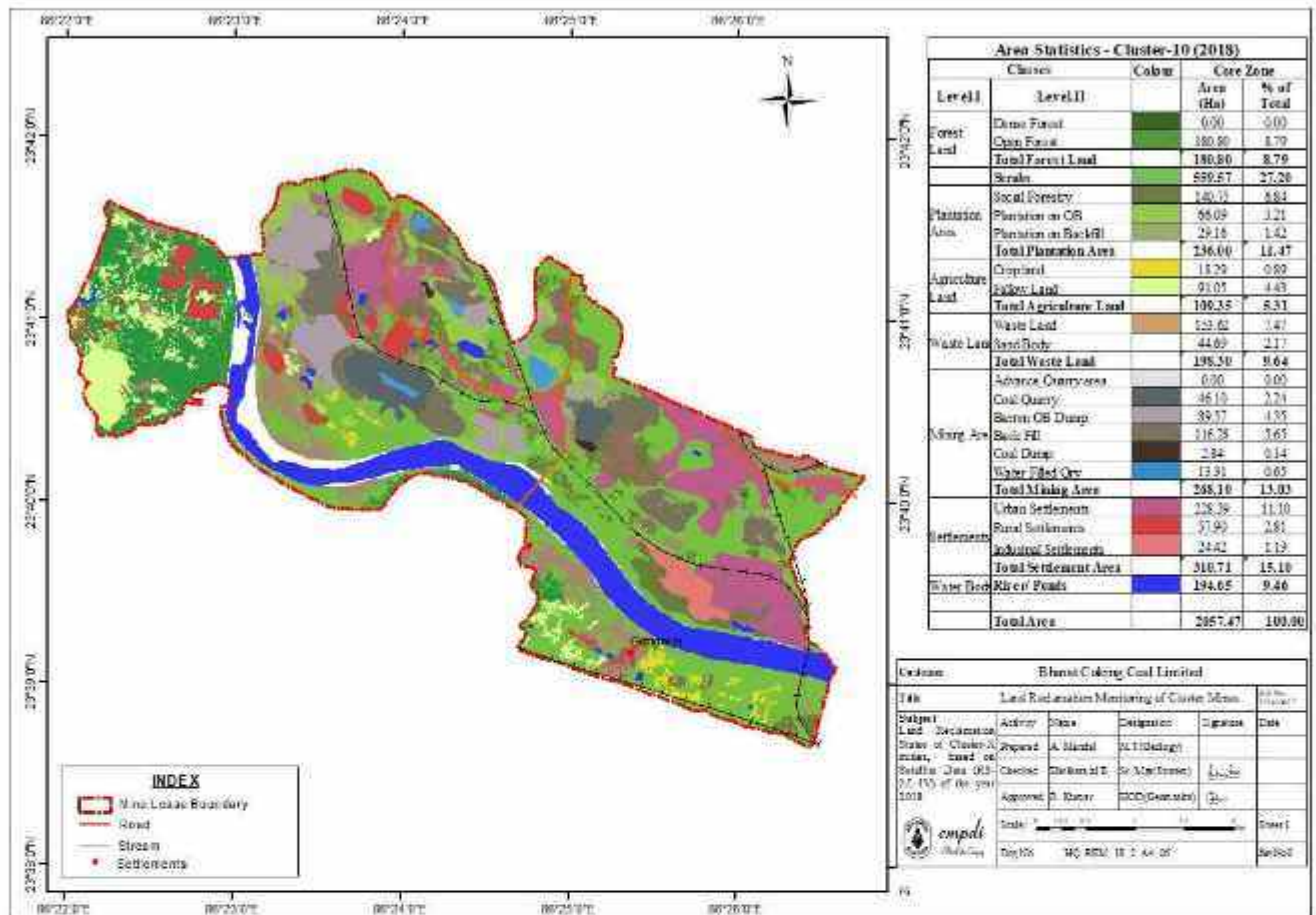
Monitoring stations (**A-19, D-35, D-36 and D-77**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'22, August'22, and Nov'22 and January'23, the Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2022-23				2021-22				2020-21			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A-19	Bhowrah	4.10	1.82	2.54	1.79	3.30	1.95	1.90	2.20	6.05	2.30	3.25	3.70
2	D-35	Patherdih	6.10	3.70	4.68	5.50	6.60	2.70	2.90	4.30	8.20	2.98	5.40	5.62
3	D-36	Sudamdih	3.25	0.15	0.60	1.44	2.02	0.45	0.55	0.55	2.10	0.06	1.00	1.15
4	D-77	Amlabad	6.50	3.40	4.70	6.00	5.98	2.60	4.69	5.60	6.40	5.90	3.50	4.25
Average WL (bgl)			4.99	2.27	3.13	3.68	4.48	1.93	2.51	3.16	5.69	2.81	3.29	3.68

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 2.02 m Max – 8.20 m
Post-monsoon GW Level (m): Min – 0.55 m Max – 5.40 m

LAND USE / LAND COVER MAP OF THE CLUSTER-X MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	1085.72 x 10 ⁴	0.0	1085.72 x 10 ⁴
2	Open Land	661.04 x 10 ⁴	0.0	661.04 x 10 ⁴
3	Road/ Paved Area	228.39 x 10 ⁴	0.0	228.39 x 10 ⁴
4	Rooftop area of building/ sheds	82.32 x 10 ⁴	0.0	82.32 x 10 ⁴
5	Total	2057.47 x 10 ⁴	0.0	2057.47 x 10 ⁴

K. GROUND WATER LEVEL OF CLUSTER-XI

Cluster-XI consists of eight coal mines; Moonidih UG, Gopalichak UG Project, Kachi Balihari 10/12 Pit UG, Pootkee Balihari Project UG, Bhagaband UG, Kendwadih UG (closed), Pootkee UG (closed), Kachi Balihari 5/6 Pit UG (closed) which are under the administrative control of Western Jharia Area of Bharat Coking Coal Limited (B.C.C.L - A Subsidiary of Coal India Limited). The Cluster- XI is located in central part of Jharia Coalfield in Dhanbad district of Jharkhand. The life of the project has been worked out to be up to 50 years considering annual production target of 6.604 MTPA (toposheet no. no. 73 I/5 7 73 I/6).

The present leasehold area of Cluster-XI is 3527.58 Ha. The area has an undulating topography with gentle slope towards south. The RL varies from 201 m to 166 m AMSL. Katri River, Jarian Nala, Ekra Jore and Kari Jore are controlling the drainage of the area. The area comes under the watershed of Katri River and Kari Jore.

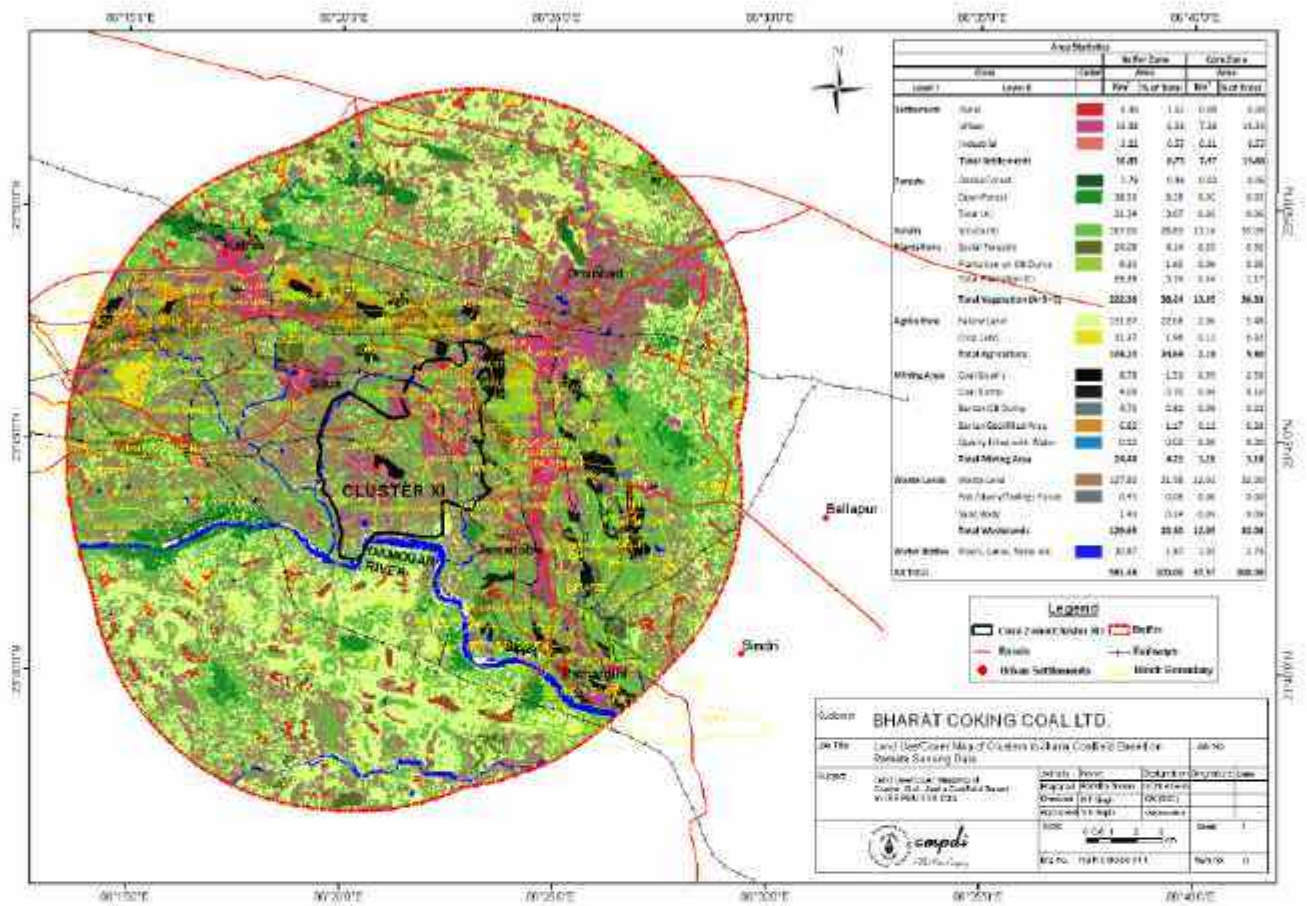
Monitoring stations (**A-17, A-18, A-20 and A-32**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'22, August'22, and Nov'22 and January'23. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2022-23				2020-21				2019-20			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A-17	Kachi Balihari	2.62	2.06	2.59	2.64	3.36	1.62	2.37	2.54	2.14	0.64	1.69	1.79
2	A-18	Baghaband	0.62	0.49	0.56	Abn.	1.09	0.54	0.57	0.74	1.09	0.39	0.34	0.89
3	A-20	Gorbudih	5.59	3.18	3.54	5.27	5.47	1.47	2.02	3.07	8.47	1.44	3.87	4.42
4	A-32	Baludih	2.25	0.65	1.75	2.79	2.35	0.73	0.96	1.50	1.90	0.36	1.75	1.80
Average WL (bgl)			2.77	1.60	2.11	3.57	3.07	1.09	1.48	1.96	3.40	0.71	1.91	2.23

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 0.62m Max – 8.47 m
Post-monsoon GW Level (m): Min – 0.34 m Max – 3.87 m

LAND USE / LAND COVER MAP OF THE CLUSTER-XI MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	1060.61 x 10 ⁴	0.0	1293.46 x 10 ⁴
2	Open Land	1518.33 x 10 ⁴	0.0	1509.06 x 10 ⁴
3	Road/ Paved Area	171.08 x 10 ⁴	0.0	171.08 x 10 ⁴
4	Rooftop area of building/ sheds	777.56 x 10 ⁴	0.0	563.06 x 10 ⁴
5	Total	3527.58 x 10 ⁴	0.0	3527.58 x 10 ⁴

L. GROUND WATER LEVEL OF CLUSTER-XIII

Cluster-XIII, consists of one running mine (Murulidih 20/21 pit UG mine) and six abandoned mines i.e. Bhurungiya colliery, Muchraidih colliery, Hantoodih colliery, Padugora colliery, Murulidih colliery and Bhatdee colliery of Western Jharia area, BCCL which is located in the south-western part of Jharia coal field in Dhanbad district of Jharkhand. The area is covered under Survey of India toposheet no. 73 I/6. The life of the project has been worked out to be about 15 years considering annual production target of 0.234 MTPA.

The present leasehold area of Cluster-XIII is 1898.62 Ha. The area has an undulating topography with gentle slope towards south-east. The maximum RL is 224 m AMSL in the north-western part of the area whereas the minimum RL is 179 m AMSL at southern part. The area comes under the watershed area of Jamunia River and Katri River.

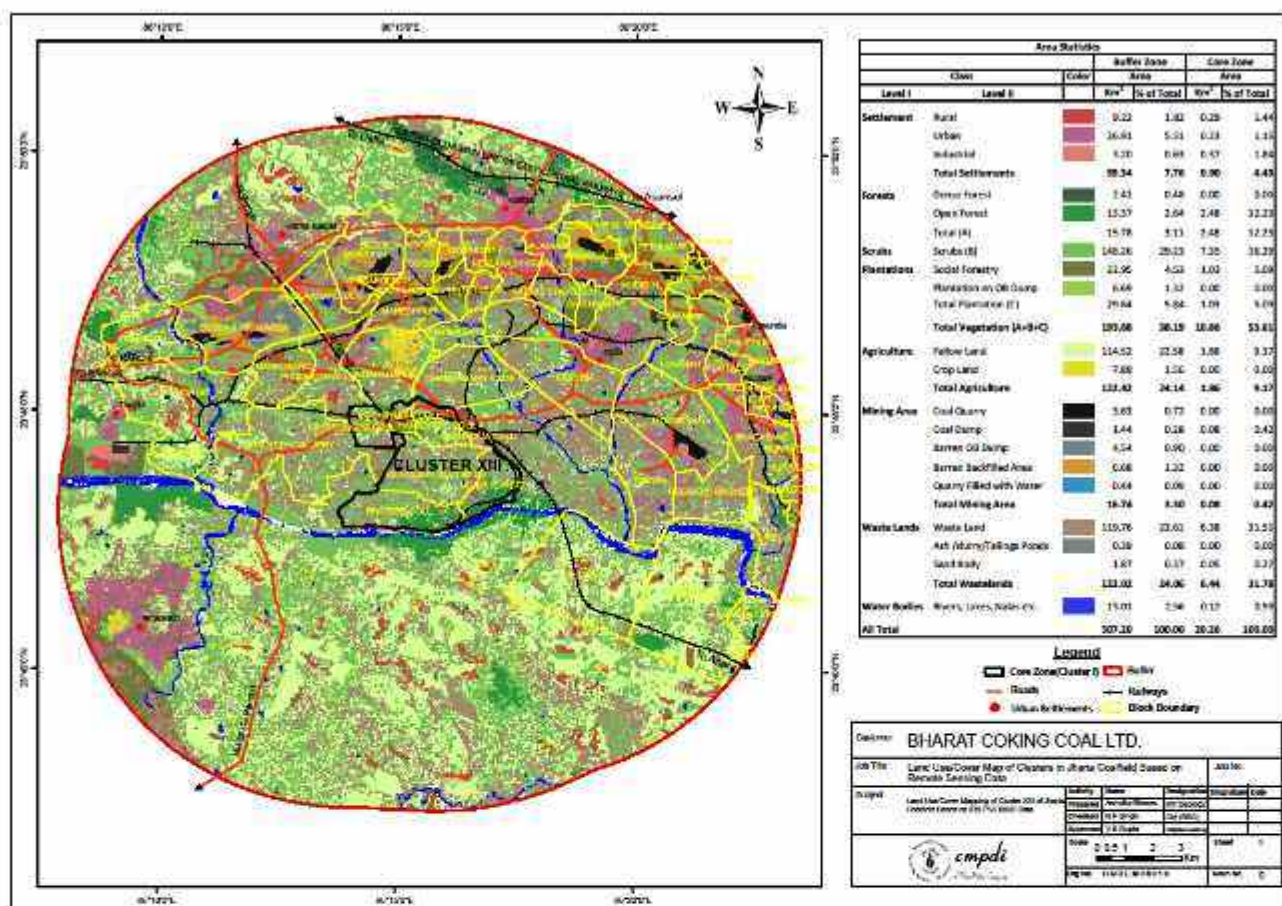
Monitoring stations (**A-22, A-23, A-33, A-34, B-25 and B-48**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'22, August'22, Nov'22 and January'23. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2022-23				2021-22				2020-21			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A22A	Nagdah	6.35	1.90	2.10	Abn.	2.90	0.40	1.10	1.50	2.90	0.20	1.98	2.00
2	A-23	Machhayara	7.97	1.14	4.79	6.67	9.52	1.87	2.82	4.82	8.92	1.12	5.62	7.12
3	A-33	Mahuda Wa	3.50	0.50	2.05	2.95	2.85	0.80	0.85	1.33	4.55	0.38	1.85	2.85
4	A-34	Mahuda vil.	8.20	3.65	6.35	6.95	5.20	1.83	3.55		8.35	3.43	3.45	5.35
5	B-25	Mahuda more	6.40	2.90	3.52	Abn.	5.10	1.98	2.58	3.30	7.90	3.02	2.55	3.45
6	B-48	Mahuda	6.85	0.65	6.25	5.80	7.23	2.28	6.05	6.60	8.20	3.37	3.85	4.51
Average WL (bgl)			6.55	1.57	4.18	5.59	5.47	1.53	2.83	3.51	6.80	1.92	3.22	4.21

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 2.85 m Max – 8.35 m
Post-monsoon GW Level (m): Min – 0.85 m Max – 6.35 m

LAND USE / LAND COVER MAP OF THE CLUSTER-XIII MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	1484.41 x 10 ⁴	0.0	1570.48 x 10 ⁴
2	Open Land	183.28 x 10 ⁴	0.0	97.22 x 10 ⁴
3	Road/ Paved Area	71.84 x 10 ⁴	0.0	71.83 x 10 ⁴
4	Rooftop area of building/ sheds	159.09 x 10 ⁴	0.0	159.09 x 10 ⁴
5	Total	1898.62 x 10 ⁴	0.0	1898.62 x 10 ⁴

M. GROUND WATER LEVEL OF CLUSTER-XIV

Mines of Cluster-XIV are under administrative control of Western Jharia Area of B.C.C.L (Jharia Coalfield) which is located in Dhanbad district of Jharkhand. This cluster consists of Lohapatty UG and Lohapatty OC patch (proposed). The life of the project has been worked out to be up to 08 years considering annual production target of 0.526 MTPA. It is covered in Survey of India toposheet no. 73 I/2.

The present leasehold area of Cluster-XIV is 1418.25 Ha. The topography of the area is undulating with slope towards south west. The maximum RL is 224 m in the north-eastern part whereas the minimum RL is 170 m above mean sea level on the south-western part of the area. Jamunia River and its tributaries are controlling the drainage of the area. The area comes under the watershed area of Jamunia River.

Monitoring stations (**B-23, B-24 and B-67**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'22, August'22, and Nov'22 and January'23. The Ground water level data is presented in the table below:

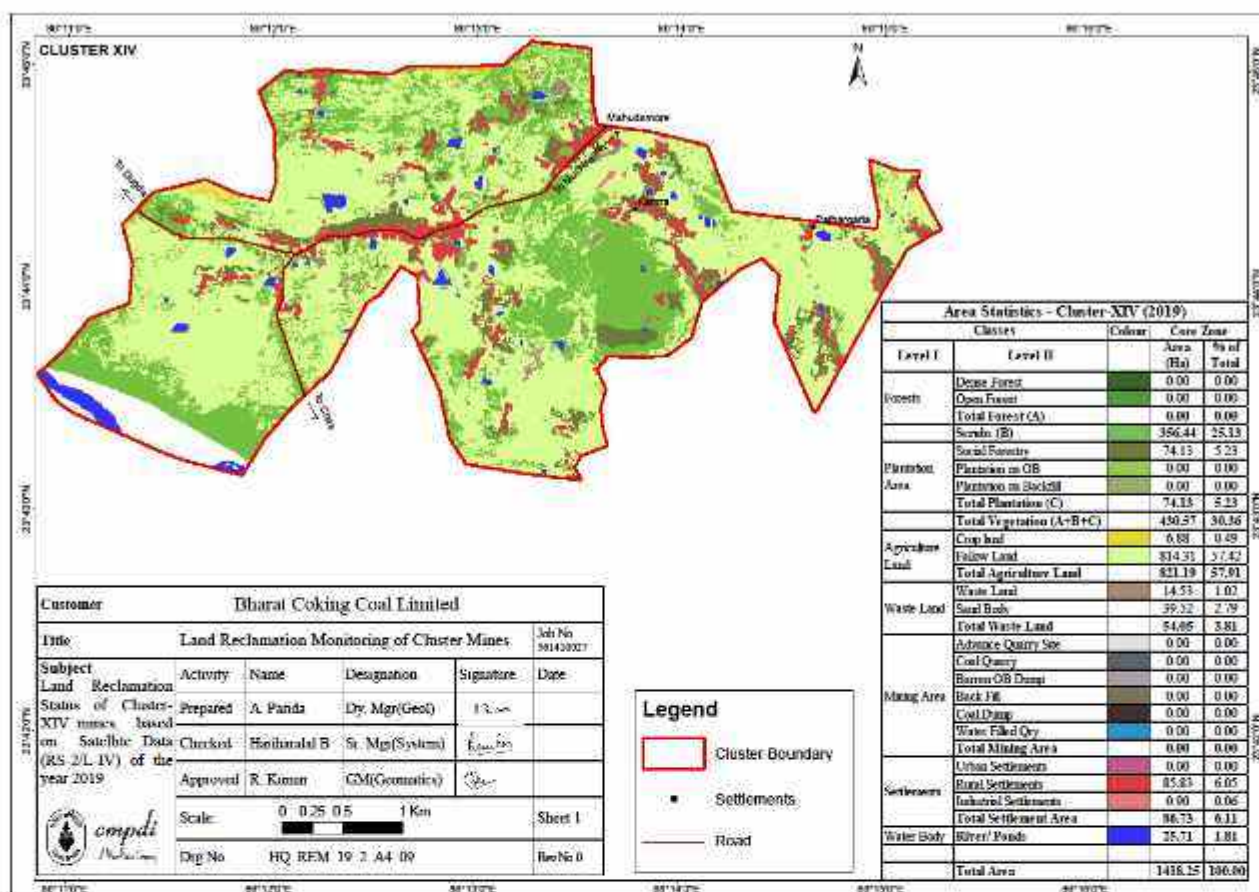
Sl No.	Well No.	Location	Water level (bgl in meters)											
			2022-23				2021-22				2020-21			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	B-23	Lohapatti	2.98	1.31	1.73	2.12	4.12	1.24	1.44	1.81	3.24	0.77	1.76	2.69
2	B-24	Telmuchu	5.53	1.34	3.46	4.23	5.68	1.55	2.08	3.07	5.48	1.13	3.53	4.38
3	B-67	Simatanr	8.50	3.55	6.30	7.35	8.95	2.45	2.95	3.65	7.55	1.83	3.95	5.90
Average WL (bgl)			5.67	2.07	3.83	4.57	6.25	1.75	2.16	2.84	5.42	1.24	3.08	4.32

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 2.98 m Max – 8.95 m

Post-monsoon GW Level (m): Min – 1.44 m Max – 6.30 m

LAND USE / LAND COVER MAP OF THE CLUSTER-XIV MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	1251.76 x 10 ⁴	0.0	1251.76 x 10 ⁴
2	Open Land	79.76 x 10 ⁴	0.0	79.76 x 10 ⁴
3	Road/ Paved Area	85.83 x 10 ⁴	0.0	85.83 x 10 ⁴
4	Rooftop area of building/ sheds	0.90 x 10 ⁴	0.0	0.90 x 10 ⁴
5	Total	1418.25 x 10 ⁴	0.0	1418.25 x 10 ⁴

N. GROUND WATER LEVEL OF CLUSTER-XV

Mines of Cluster - XV comes under administrative control of Govindpur Area and Barora Area of B.C.C.L. (Jharia Coalfield) which is located in Dhanbad district of Jharkhand. Cluster-XV consists of four coal mines; Kharkharee UG (underground mine) and Dharmaband UG which are under administrative control of Govindpur Area and Madhuband UG & Phularitand UG which are under the administrative control of Barora Area. The life of the project has been worked out to be up to 30 years considering annual production target of 0.423 MTPA. It is covered in Survey of India toposheet no. 73 I/1 and 73 I/5.

The present leasehold area of Cluster-XV is 1696.55 Ha. The topography of the area is undulating with slope towards south-west. The maximum RL is 235 m in the Kharkharee mine area whereas the minimum RL is 165 m AMSL on the eastern & western part of the Cluster. Jamunia River and Khudia River are controlling the drainage of the area. The area comes under the watershed area of both Jamunia River and Khudia River.

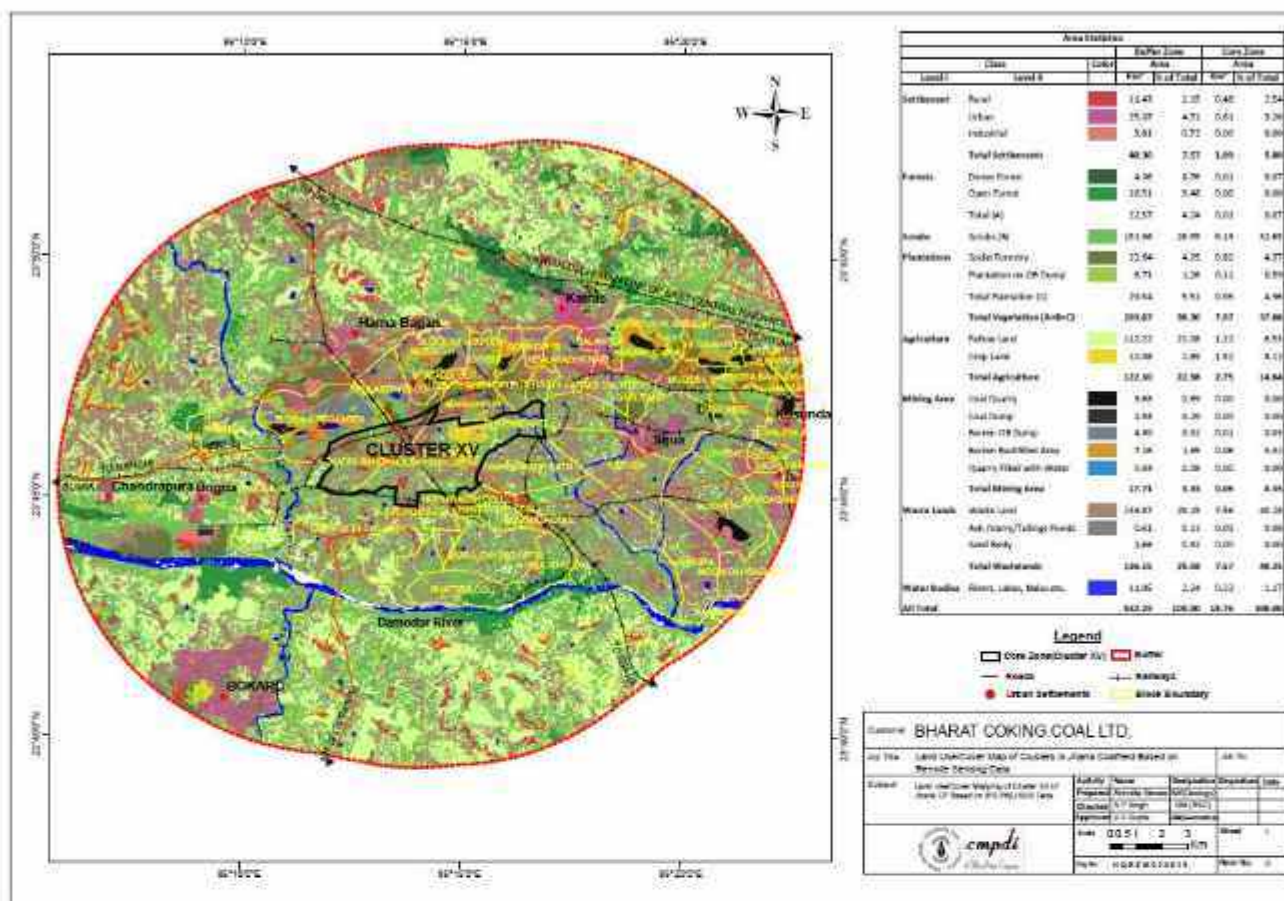
Monitoring stations (**A-24, B-32A and B-61A**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'22, August'22, and Nov'22 and January'23. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2022-23				2021-22				2020-21			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A24	Pipratanr	7.28	2.55	4.33	5.32	10.13		2.78	4.55	4.88	-	4.28	4.68
2	B32A	Madhuband	4.15	0.70	2.56	4.15	5.60	1.34	1.70	2.30	3.30	1.18	2.00	2.21
3	B61A	Kesargora	1.82	0.52	0.97	Abn.	4.42	0.47	0.97	0.97	3.32	0.85	1.60	2.07
4	B62A	Sadiyardih	6.45	1.77	4.91	5.15	6.87	1.35	4.50	4.60	6.95	2.77	3.00	4.95
Average WL (bgl)			4.96	1.09	2.93	4.58	6.72	0.91	1.82	2.61	3.83	1.02	2.63	2.99

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.82 m Max – 10.13 m
Post-monsoon GW Level (m): Min – 0.97 m Max – 4.91 m

LAND USE / LAND COVER MAP OF THE CLUSTER-XV MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	365.18 x 10 ⁴	0.0	365.18 x 10 ⁴
2	Open Land	1130.53 x 10 ⁴	0.0	1130.53 x 10 ⁴
3	Road/ Paved Area	101.67 x 10 ⁴	0.0	101.67 x 10 ⁴
4	Rooftop area of building/ sheds	99.17 x 10 ⁴	0.0	99.17 x 10 ⁴
5	Total	1696.55 x 10 ⁴	0.0	1696.55 x 10 ⁴

O. GROUND WATER LEVEL OF CLUSTER-XVI

Mines of Cluster - XVI (Dahibari-Basantimata Group of mines) are under administrative control of Chanch Victoria Area of B.C.C.L (western part of Raniganj Coalfield) which is located in Dhanbad district of Jharkhand. There are total five collieries within this Cluster- XVI (Dahibari-Basantimata OC, Basantimata UG, New Laikdih OC, Laikdih Deep UG and Chanch UG Colliery). All the above mines are contiguous in nature and the environmental impact is overlapping in ambient environment due to cumulative effect of mining activities. Life of the project has been worked out to be up to 24 years considering annual production target of 1.963 MTPA. It is covered in Survey of India toposheet no. 73 I/14.

The present leasehold area of Cluster-XVI is 2008.40 Ha. The topography of the area is undulating with slope towards south-west. The area is plain with gently undulating with elevation varying from 100 m to 140 m AMSL. The general slope of the area is towards southeast. Barakar River and Khudia River are controlling the drainage of the area. The area comes under the watershed area of Barakar River.

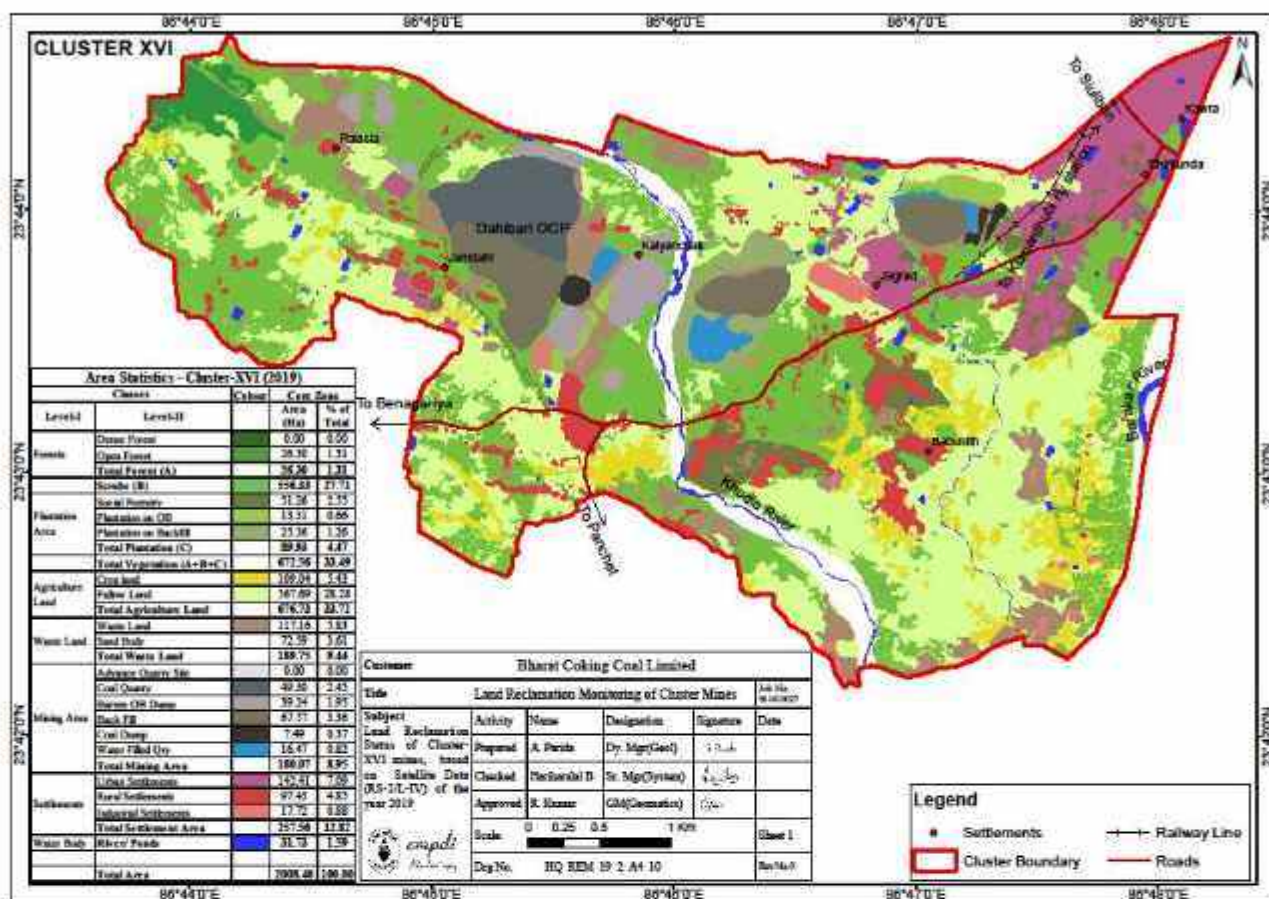
Monitoring stations (**DB-22, DB-23, DB-24 & DB-25**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'22, August'22, and Nov'22 and January'23. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2022-23				2021-22				2020-21			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	DB22	Dahibari, Basti	1.73	1.47	1.63	1.58	2.31	1.55	1.38	1.57	2.63	1.30	2.25	2.38
2	DB23	Dahibari OC	2.68	1.71	2.20	2.40	2.00	1.05	1.10	1.70	2.50	0.70	1.95	2.17
3	DB24	Dahibari	Abandoned				6.20	4.20	5.25	5.80	3.60	1.57	5.70	5.90
4	DB25	Basantimata	Abandoned				2.83	1.01	2.03	2.63	3.98	1.19	2.63	2.68
Average WL (bgl)			2.21	1.59	1.92	1.99	3.34	1.95	2.44	2.93	3.18	1.19	3.13	3.28

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.73 m Max – 6.20 m
Post-monsoon GW Level (m): Min – 1.10 m Max – 5.70 m

LAND USE / LAND COVER MAP OF THE CLUSTER-XVI MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	1349.29 x 10 ⁴	0.0	1349.29 x 10 ⁴
2	Open Land	401.55 x 10 ⁴	0.0	401.55 x 10 ⁴
3	Road/ Paved Area	142.41 x 10 ⁴	0.0	142.41 x 10 ⁴
4	Rooftop area of building/ sheds	115.15 x 10 ⁴	0.0	115.15 x 10 ⁴
5	Total	2008.40 x 10 ⁴	0.0	2008.40 x 10 ⁴

4.0 GROUND WATER LEVEL SCENARIO

The summarized water level data of all clusters given in **Table – 7**.

Table –7: Groundwater level data (Cluster-wise)

Sl. No.	Cluster of BCCL	No. of Monitoring Wells	Water level Below ground level (May, Aug, Nov'22 & Jan'23)	Avg. Fluctuation (in meters) during 2022-23	Geological Formation
1	I	4 nos.	0.45 to 9.65 m	2.33 m	Barakar
2	II	5 nos.	0.45 to 10.53 m	2.03 m	Barakar
3	III	5 nos.	0.30 to 10.53 m	2.18 m	Barakar
4	IV	4 nos.	0.35 to 7.45 m	2.16 m	Barakar
5	V	4 nos.	0.10 to 5.80 m	0.93 m	Barakar
6	VI	2 nos.	1.80 to 11.90 m	4.64 m	Barakar
7	VII	7 nos.	0.45 to 11.32 m	1.20 m	Barakar
8	VIII	4 nos.	1.27 to 10.95 m	1.02 m	Barakar
9	IX	6 nos.	0.90 to 9.03 m	1.80 m	Barakar
10	X	4 nos.	0.15 to 6.50 m	1.86 m	Barakar
11	XI	4 nos.	0.50 to 5.60 m	0.70 m	Barakar & Barren Measure
12	XIII	6 nos.	0.50 to 8.20 m	2.37 m	Raniganj
13	XIV	3 nos.	1.30 to 8.50 m	1.85 m	Raniganj
14	XV	4 nos.	0.50 to 7.30 m	1.80 m	Barakar & Barren Measure
15	XVI	4 nos.	1.50 to 2.70 m	0.30 m	Barakar

Depth to water level (in bgl) values describe that water level goes down to maximum 11.90 m during summer season and minimum up to 0.10 m during monsoon season of 2022. Un-confined aquifer is affected around 20 m to 30 m of maximum radius close to active opencast mining areas, showing steep gradient towards mine void. Other than that, there is no mining effect in the water level within JCF area and RCF area (part). Historical water level data and hydrograph of permanent observation stations from CGWB is shown in **Annexure–VI**. Water Table contour map and Depth to water level map both during pre & post-monsoon season is shown in **Plate-IV (A, B) & V (A, B)**.

Monitoring of groundwater (quantity & quality) to assess the present condition and resource has been done regularly in the coalfield area. Well hydrographs (**Annexure–VI**) are prepared and studied to identify long-term trends. Hydrograph trend analysis of CGWB monitoring wells and observation wells reveals

increasing groundwater level trends in most of the Cluster of mines. However, declining trends in both Pre and Post-monsoon GW level in Cluster-I, Cluster-V, Cluster-VI and Cluster-VII are recorded but no significant declining trend (>1.0 m/year) of water level is noticed in any particular area for the last 10 years within the coalfield area. Regarding quality monitoring, the water sample location map (**Plate-II**) with collection points details (dug wells) are given in **Annexure-V** and Quality is given in **Annexure-VII**.

5.0 GROUND WATER QUALITY

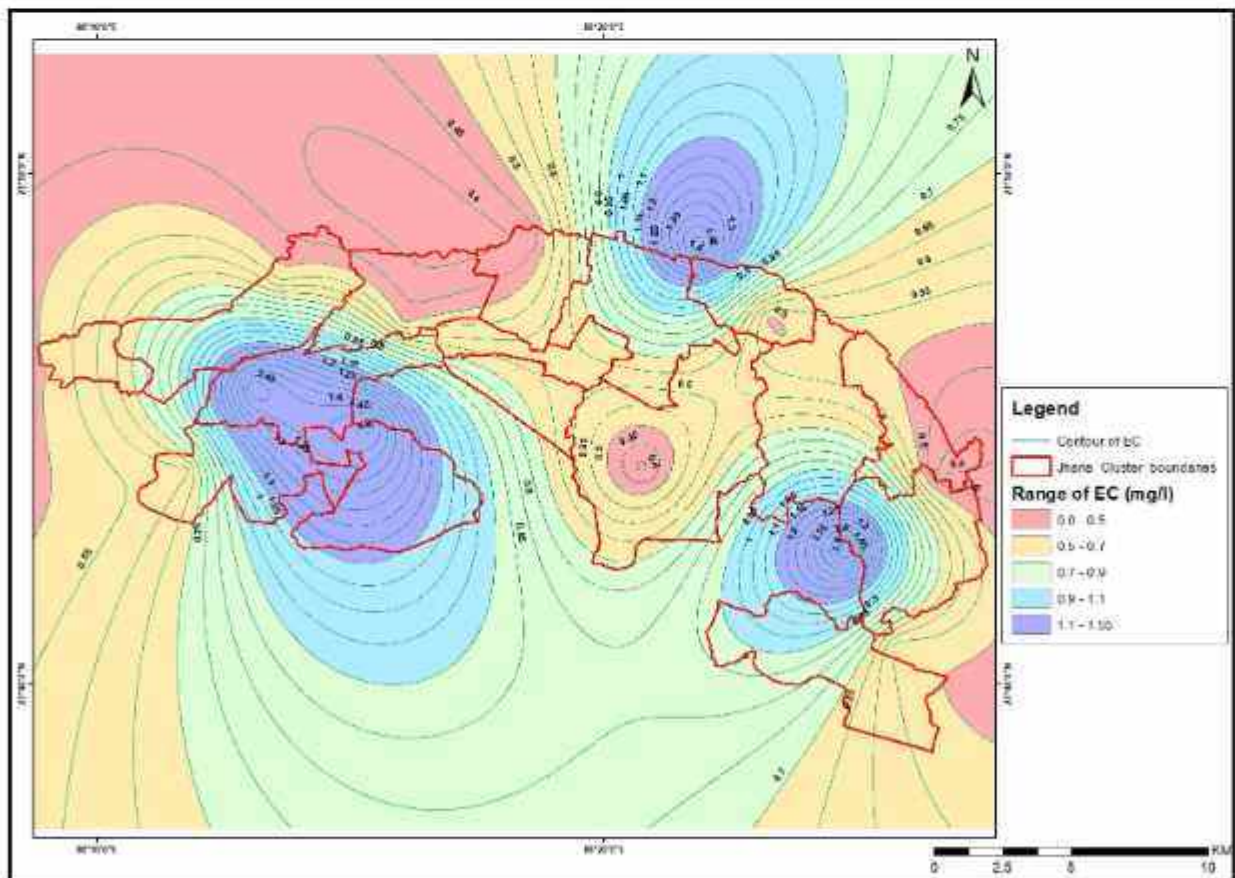
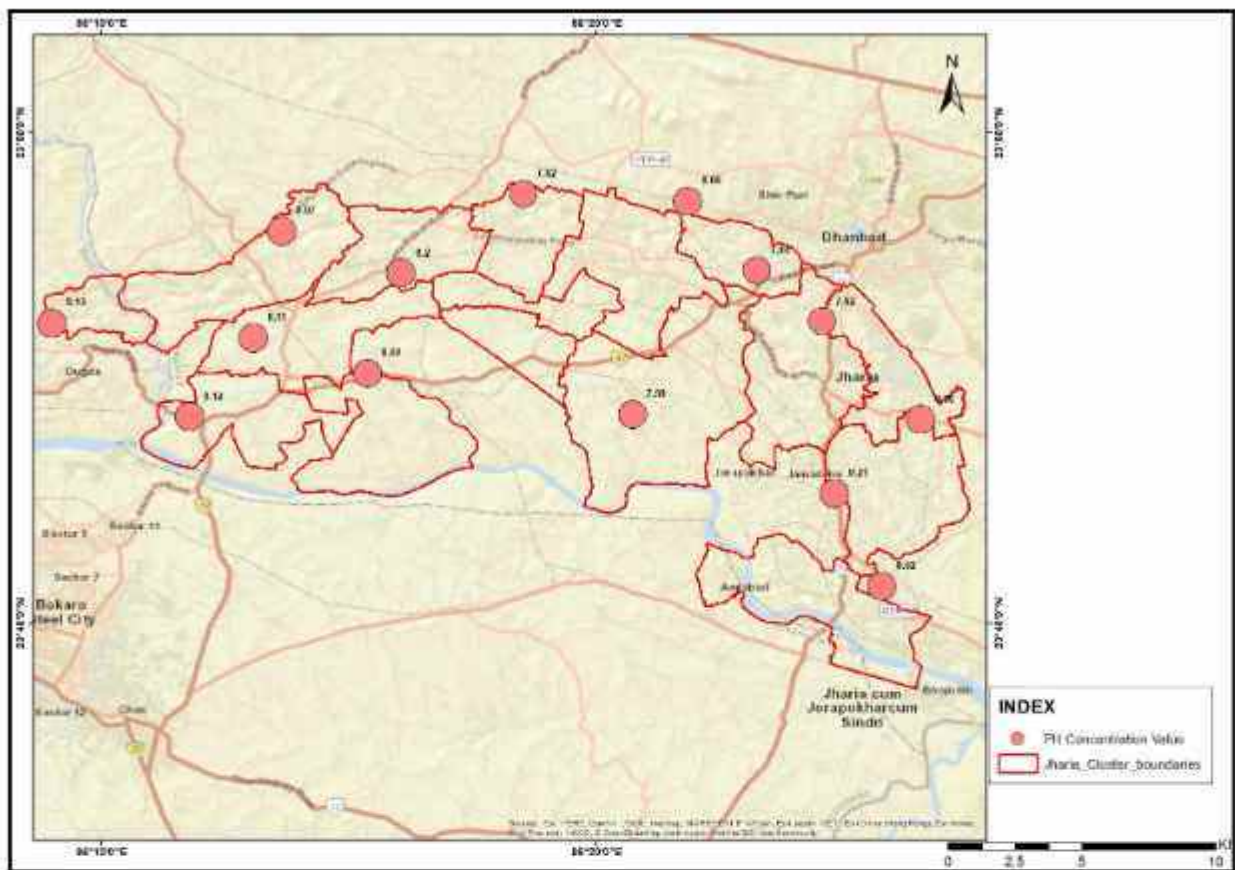
The ground water samples of the study area (15 nos. of Cluster of mines, BCCL) were collected from dug wells and analyzed. Fifteen ground water samples (GW-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15 & 16) analyzed during the month of June 2022 at CMPDI, RI-II, Dhanbad. The water sampling details is given in **Annexure-V** and Water sample locations are shown in **Plate-II**. The water quality data is presented in **Annexure-VII**.

The study of the variations in water quality parameters is described below:

The pH of the groundwater samples varies between 7.82 (GW-4) to 8.21 (GW-9), the pH is within the IS 10500:2012 limit of drinking water standard.

The mineral constituents dissolved in water constitute the dissolved solids. The total dissolved solids (TDS) vary from 192 (GW-11) to 764 mg/l (GW-9). The TDS values are ranging slightly above the IS 10500:2012 standards limit of drinking water.

The alkalinity of the water samples varies from 82 (GW-7) to 142 mg/l (GW-11) and are within the stipulated standard of (200 mg/l) drinking water. The concentration of calcium in the water samples varies from 38 (GW-1) to 172 mg/l (GW-13) and is **slightly above** the permissible limit (75 mg/l) of drinking water standards. The total hardness ranges between 152 (GW-8) to 666 mg/l (GW-5) and the value of total hardness in water samples are **above** the permissible limit (200 mg/l). The sulphate ranges between 42 (GW-4) to 178 mg/l (GW-13) and the value of sulphate in water sample are within the permissible limit (200 mg/l). The Iron, Copper, Manganese, Lead, Zinc and Chromium concentration in the water samples found to be below the upper IS 10500:2012 limits for drinking water.



6.0 STAGE OF GROUNDWATER EXTRACTION

The groundwater is mainly utilized for domestic needs and irrigation purposes. The groundwater abstraction is mainly through dug wells and bore wells. The stage of groundwater development in Dhanbad District is 76.30% (as per 2017 GWRA). The highest stage of development is in Jharia Block (127.0%) & Dhanbad Block (107.50%) and lowest stage of development is in Chirkunda Block (35.5%) as per GWRA-2013. The Gondwana sandstones in general, known to constitute good aquifers at many places. However, the yield potential of the area adjoining to active mines in the coal belt is poor. The active mines often act as groundwater "sinks". In contrast, the water logged abandoned mines and pits act as potential sources of groundwater. As per the assessment by Central Ground Water Board (CGWB), Patna in 2022, Block wise data of Dhanbad District given below:

Table-8A: Block wise Stage of Groundwater development

Sl No.	Administrative Unit		Category (GWRA-2013)	Category (GWRA-2017)	Category (GWRA-2022)
	District	Block			
1	Bokaro	Bermo	Over- exploited	Over- exploited	Over- exploited
2	Dhanbad	Baghmara	Critical	Critical	Safe
3	Dhanbad	Baliapur	Semi- Critical	Semi- Critical	Over- exploited
4	Dhanbad	Dhanbad	Over- exploited	Over- exploited	Semi-critical
5	Dhanbad	Jharia / Dhanbad Urban	Over- exploited	Over- exploited	Critical
6	Dhanbad	Topchachi	Critical	Critical	Critical
7	Dhanbad	Chirkunda	Safe	Safe	Safe

- Dynamic Groundwater Resource Assessment, CGWB as per 2013, 2017 and 2022.

Table-8B: Cluster wise Groundwater development scenario

Cluster/ Area	Adminis- trative Blocks/Stage Of GW Extraction	Total Water demand (cum/day)				Avg. GW level (bgl in m) 2022-23		GW level declining trend 2005-2022		Remarks
		Mine Discharge + BH pumping	Surface Water Source	Total Use (Domestic + Industrial)	Excess Or other use	Pre- monsoon	Post- monsoon	Pre- monsoon	Post- monsoon	
Cluster-I	Bermo (SOD: Over- exploited)	2173 (2065+108)	NIL	2112 (1698+414)	61	5.70	3.37	YES	YES	Recharge structure needed
Cluster-II	Baghmara	8350	Jamunia river	6737 (2755+3982)	1613	4.96	2.93	NO	NO	Excess mine water needed to be utilized
Cluster-III	(SOD: Safe)	12760 (10960+1800)	NIL	8946 (7849+1097)	3814	4.64	2.46	NO	NO	
Cluster-IV		5900	MADA	5100 (3605+1495)	800	4.78	2.62	NO	NO	
Cluster-V		12690 (11025+1665)	MADA	11063 (5710+5353)	1897	2.49	1.57	YES	YES	
Cluster-VI	Dhanbad	4150	MADA	4150 (1664+2486)	0.0	8.14	3.50	YES	NO	--
Cluster-VII	(SOD: Semi- critical)	21565	MADA	20826 (17596+3230)	739	5.01	3.82	YES	YES	Excess mine water needed to be utilized water
Cluster-VIII	Jharia / Dhanbad Urban	9320	MADA	5294 (3730+1564)	4026	6.16	5.14	NO	NO	
Cluster-IX		12980	MADA	9358 (4549+4809)	3622	5.83	4.03	NO	NO	
Cluster-X	(SOD: Critical)	11825	Damodar river	6201 (4255+1946)	5624	4.99	3.13	YES	NO	
Cluster-XI	Dhanbad (SOD: Critical)	24960	MADA & DVC	19425 (14015+5410)	5535	2.77	2.11	NO	NO	
Cluster-XIII	Baghmara	750	Damodar river	692	58.0	6.55	4.18	NO	NO	--
Cluster-XIV	(SOD: Safe)	943	NA	668	275	5.67	3.83	NO	NO	--
Cluster-XV		6200	NA	5941 (4600+1341)	259	4.93	3.19	NO	NO	--
Cluster-XVI	Chirkunda (SOD: Safe)	1910	DVC (Barakar river)	1730 (1380+350)	180	2.21	1.92	NO	NO	--

MADA – Mineral Area Development Authority, Jharkhand, Dhanbad (payment basis).

DVC – Damodar Valley Corporation, Maithon/Panchet, Jharkhand (payment basis).

7.0 IMPACT OF MINING ON GROUND WATER REGIME

7.1 GENERAL CONSEQUENCES OF COAL MINES ON AMBIENT HYDROGEOLOGICAL REGIME

Mining of coal either by opencast or underground method is bound to incise one or more water bearing strata (aquifers) which, in turn, may result in depletion or draw down in water levels and a corresponding inflow of water into the mine workings. The potential effects of coal mining operations on the hydrogeological regime are as under:

- ❖ Creates disruption in formation/aquifer
- ❖ Dewatering of aquifers
- ❖ Change in hydraulic gradient
- ❖ Modification in recharge of aquifers
- ❖ Change in groundwater flow pattern

The general need in mine planning from the hydrogeological point of view is the estimation of ground water seepage into the mine, its rate, the mine pumping capacity to meet the storm rainwater accumulation, extent of depression of water surface and management of mine effluent (mine water). It is also desirable that the consequences of mining operation on groundwater regime be determined in advance. However, the mine pumping in most of the cases are passive dewatering for the safety of the mine pit, active mine dewatering is done in few cases for very high potential aquifers.

7.2 POTENTIAL CONSEQUENCES OF OPENCAST AND UNDERGROUND COAL MINES ON HYDROGEOLOGICAL REGIME IN JHARIA COALFIELD

Generally, in the opencast and underground mines of Jharia Coalfield, alluvium and overlying weathered mantle are the first to be excavated, followed by upper Barakar Formation / Aquifer. Since these formations vary in thickness, compaction and their constituents over the area, their aquifer properties also vary.

The porosity and the compactness in the sandstone controls the discharge from these aquifers. The alluvium and weathered Formation wherever loose and fragile possess more porosity and this has high groundwater potential. Due to the mine cut, a depression in the water table is created. The initial discharges due to this depression is large in amount because of concentration of flow to that region. In the top zones, water table condition prevails and semi-confined conditions exist in the stratified section (Gondwana Sedimentary basin). With progress of mine operations, there is an increase in the depth of incision, as a result which, the semi-confined aquifers are also gets punctured.

During mining, the hydraulic gradients generally steepens down near mine i.e. within the mine influence area. In the up-dip region, only un-confined aquifer is punctured through the mining process and thus only unconfined aquifer is affected whereas in the down-dip region both un-confined and semi-confined aquifers may be affected. The confined aquifers of lower Barakar Formation in the mining area are not punctured as it lies below the working coal seams and hence normally there is no noticeable effect in the aquifer related to this formation.

7.3 ESTIMATION OF RADIUS OF MINE INFLUENCE ZONE

Radius of Influence can be defined as the radial distance from the center of the borehole to the point where there is no lowering of groundwater table/potentiometric surface.

The radius of influence (R) for Opencast and UG Mines within Jharia CF is calculated by using Sichardt's formula based on present mining scenario:

$$R_0 = C \cdot (H-h) \cdot \sqrt{K}$$

Where, R_0 - Radius of influence (m), C - Constant =3000,

(H-h)- Drawdown (m), K – Hydraulic conductivity (m/s).

Here, K for Barakar Formations is 0.05 m/d or 5.7×10^{-7} m/sec.

Here, it may be appropriate to mention that the presence of prominent boundaries/water bodies, faults or inter-fringing of sandstone and shale beds may restrict the propagation of drawdown cone. With the presence of low permeable beds such as clay/shale and younger coal seams in the formation, lying above the working seams the water level in the phreatic aquifer is not directly affected. Both, the phreatic and semi-confined aquifers, get affected during the working by board and pillar method as subsidence takes place while extracting total coal (depillaring). Surface vigilance and filling up subsided zone, if any, has to be constantly under observation. The effect on groundwater level for most of the coalmine in Jharia coalfield has been observed in the down-dip side, generally within a distance up to 500 m from active mine zone and becomes milder/ negligible thereafter.

8.0 CONSERVATION MEASURES & FUTURE STRATEGY

- BCCL has installed 25 Pressure Filter Plant of total capacity of 4.16 MGD to meet drinking water requirement in nearby area. At present 63 Water Treatment Plants are operational having

capacity of 16.16 MGD within Jharia Coalfield area. Further, installation of 28 more Pressure Filter Plants having capacity of 5.84 MGD are in progress.

- BCCL has participated in development of low cost technology for drinking water in a CSIR project along with CIMFR, Dhanbad and a pilot plant of 4000 Liters/hour is functional at PB Project site of BCCL. Similar plants have been proposed at other sites of BCCL.
- A scheme titled 'Scheme for multi-purpose utilization of surplus mine water of Barora Area, Block II and Govindpur Area of BCCL' was prepared with a view to harness the excess water discharge to take care of the persistence problem of water scarcity in the nearby villages. In the scheme, two water reservoirs of capacity 27 MG and 17 MG have been proposed in the non-coal bearing area for storage of 3250 GPM and 2000 GPM surplus mine water which will be fed by mine discharge at mines of Barora, Block-II and Govindpur Area through pipe line.
- Rooftop rainwater harvesting (RWH) has been taken up in the project areas using the administrative buildings. 138 no. of quarters having roof-top area of about 14950 sq. m. is ready to harvest rainwater and around 13150 cum/annum of water is going to recharge the nearby groundwater system through RWH structures. Proposal has already been made to facilitate this kind of RWH structure at suitable locations i.e., Lodna Area, Kusunda Area (Jawahar Nagar, Matkuria, Coal Board Colony), Sijua Area (Nichitpur and Tetulmari Colony) within Jharia Coalfield to augment groundwater recharge.
- After cessation of mining, with plenty of rainfall and abundant ground water recharge, the water levels will recoup and attain normalcy. Thus, the impact of mining on groundwater system may be considered as a temporary phenomenon. The abandoned mine workings (UG) behave as water pool and improves the resources availability in the coalfield area.
- Utilization of treated mine water discharge by both, industry and local people, in the mine influence area. The excess mine water can be used to recharge groundwater system by connecting pipelines to abandoned dug wells. Utilization of mine water for irrigation will also enhance the ground water recharge potential through artificial recharge in the area.
- Increase vegetative cover by plantation in the mine area under land amelioration measures. This will contain the surface run-off and increase the groundwater recharge.
- Imparting awareness among workers and local peoples about Rainwater harvesting and artificial recharge will have priority. This aspect is usually covered during the Environmental Week celebrated every year (5 to 12 June).
- 23 nos. of Piezometers have been installed within JCF and RCF to monitor GW level (**Plate-III**).

Monitoring of water quality of mine water discharge, local River/nala and domestic water source (dug well/hand pump wells) will continue under routine monitoring (May, August, November & Jan). The groundwater level during the month of Jan'23 has been recorded in those piezometers and given below:

PZ NO.	LATITUDE	LONGITUDE	January 2023 Water level (m) BGL
PZ7A	23.770115	86.410951	110.4
PZ7B	23.740017	86.39971	-
PZ7C	23.734152	86.443317	76.7
PZ8A	23.755621	86.427106	70
PZ9A	23.730468	86.446387	41.55
PZ13A	23.713845	86.251622	32.85
PZ14A	23.741512	86.213866	7.6
PZ14B	23.741512	86.213866	11.82
PZ1B	23.769165	86.175347	29.75
PZ1A	23.769176	86.175446	12.15
PZ2A	23.767181	86.189037	29.41
PZ2B	23.790844	86.24701	4.85
PZ5A	23.781658	86.356924	5.15
PZ5B	23.79986	86.36189	-
PZ4A	23.776446	86.312329	29.7
PZ4B	23.776503	86.312519	107.5
PZ3A	23.779754	86.241757	19.1
PZ3B	23.80146	86.282446	85.82
PZ3C	23.801619	86.282436	-
PZ11A	23.726355	86.341936	60.6
PZ9B	23.696164	86.41592	66.8
PZ10A	23.687975	86.405108	5.92
PZ16A	23.730825	86.760491	35.2

However, as per revised proposal, from assessment year 2023-24 the groundwater level and quality monitoring work in the BCCL command area will be revised as per the guidelines of CGWA, New Delhi regarding NoC from CGWA for groundwater abstraction in Mining Sector. As per revised proposal, total 150 nos. of Dug well and 23 nos. of Piezometers will be monitored in quarterly basis and total 50 nos. of groundwater quality sampling will be conducted during the month of May in each assessment year onwards. 12 nos. of existing monitoring wells have been discarded for evenly distribution of key wells within the buffer zone, these are: A-18, A-22A, B-25, B-21A, B-61A, D-23, D-40A, D-43, D-51, D-55, DB-24 & DB-25.

9.0 EXISTING/PROPOSED RAINWATER HARVESTING STRUCTURES IN BCCL COAL MINES

Fig-3 to 4.



Proposed Rain Water Harvesting Site GVTC, Cluster-I, Barora Area



Proposed Rain Water Harvesting Site Nehru Balika Vidhalaya, Cluster-I, Barora Area

Fig-5 to 6.



Proposed Rain Water Harvesting Site Barora Area Guest House, Cluster-I, Barora Area



Proposed Rain Water Harvesting Site Regional Hospital Baghmara, Cluster-I, Barora Area

Fig-7 to 8.



Proposed Rain Water Harvesting Site – Barora Area Office, Cluster-I, Barora Area



RECHARGE POND / ABANDONED IN THE JCF MINE AREA

Fig-9 to 10.



RECHARGE POND / ABANDONED IN THE JCF MINE AREA



FILTER PLANT IN THE MINE AREA

Fig-11 to 12.



RECHARGE POND / ABANDONED IN THE JCF MINE AREA



RECHARGE POND / ABANDONED IN THE JCF MINE AREA

Fig-13 to 14.



RECHARGE POND / ABANDONED IN THE JCF MINE AREA



Government of India
Ministry of Environment, Forest and Climate Change
Wetlands Division

List of Ramsar Sites in India

S. No	Name of Ramsar site	State	Area in hectares	Date of designation	Coordinates
1.	Ashtamudi Wetland	Kerala	6,140	19/08/2002	08°57'N 076°34'E
2.	Beas Conservation Reserve	Punjab	6,429	26/09/2019	31°23'N 075°11'E
3.	Bhitarkanika Mangroves	Odisha	65,000	19/08/2002	20°39'N 086°54'E
4.	Bhoj Wetland	Madhya Pradesh	3,201	19/08/2002	23°13'N 077°19'E
5.	Chandertal Wetland	Himachal Pradesh	49	08/11/2005	32°28'N 077°36'E
6.	Chilika Lake	Odisha	116,500	01/10/1981	19°42'N 085°21'E
7.	Deepor Beel	Assam	4,000	19/08/2002	26°07'N 091°39'E
8.	East Calcutta Wetlands	West Bengal	12,500	19/08/2002	22°27'N 088°27'E
9.	Harike Lake	Punjab	4,100	23/03/1990	31°13'N 075°12'E
10.	Hokersa Wetland	Jammu & Kashmir	1,375	08/11/2005	34°04'N 074°42'E
11.	Kanjli	Punjab	183	22/01/2002	31°25'N 075°22'E
12.	Keoladeo National Park (MR)	Rajasthan	2,873	01/10/1981	27°13'N 077°31'E
13.	Keshopur-Miani Community Reserve	Punjab	344	26/09/2019	32°05'N 075°23'E
14.	Kolleru Lake	Andhra Pradesh	90,100	19/08/2002	16°37'N 081°12'E
15.	Loktak Lake (MR)	Manipur	26,600	23/03/1990	24°25'N 093°49'E
16.	Nalsarovar	Gujarat	12,000	24/09/2012	22°46'N 072°02'E
17.	Nandur Madhameshwar	Maharashtra	1,437	21/06/2019	20°01'N 074°06'E
18.	Nangal Wildlife Sanctuary	Punjab	116	26/09/2019	31°23'N 076°22'E
19.	Nawabganj Bird Sanctuary	Uttar Pradesh	225	19/09/2019	26°36'N 080°39'E
20.	Parvati Arga Bird Sanctuary	Uttar Pradesh	722	02/12/2019	26°56'N 082°09'E
21.	Point Calimere Wildlife and Bird Sanctuary	Tamil Nadu	38,500	19/08/2002	10°19'N 079°37'E
22.	Pong Dam Lake	Himachal Pradesh	15,662	19/08/2002	32°01'N 076°04'E
23.	Remika Wetland	Himachal Pradesh	20	08/11/2005	31°37'N 077°27'E
24.	Ropar	Punjab	1,365	22/01/2002	31°01'N 076°30'E
25.	Rudrasagar Lake	Tripura	240	08/11/2005	23°28'N 091°16'E
26.	Saman Bird Sanctuary	Uttar Pradesh	526	02/12/2019	27°00'N 079°10'E
27.	Samaspur Bird Sanctuary	Uttar Pradesh	799	03/10/2019	25°59'N 081°23'E
28.	Sambhar Lake	Rajasthan	24,000	23/03/1990	27°00'N 075°00'E
29.	Sandi Bird Sanctuary	Uttar Pradesh	309	26/09/2019	27°18'N 079°58'E
30.	Sarsai Nawar Jheel	Uttar Pradesh	161	19/09/2019	26°58'N 079°15'E

Annexure – IV

Rainfall Data (in mm) At Dhanbad Observatory Station, IMD (Source: WRIS Website data)

Year	January	February	March	April	May	June	July	August	Sep	Oct	Nov	Dec	Annual
1994	26.5	20.0	3.3	23.5	4.5	289.5	245.5	240.0	134.0	40.5	0.0	0.0	1027.3
1995	15.0	18.3	20.0	0.0	34.5	122.0	140.1	257.0	446.0	0.0	34.0	5.5	1092.4
1996	12.5	12.5	5.2	0.0	0.0	210.5	138.5	400.0	214.0	24.0	0.0	0.0	1017.2
1997	10.5	17.5	2.8	63.5	41.5	231.5	599.3	621.1	196.8	16.5	34.0	16.0	1851.0
1998	20.5	21.0	160.0	18.0	40.0	80.0	347.0	409.0	123.0	120.5	11.0	0.0	1350.0
1999	0.0	0.0	0.0	0.0	64.0	150.0	511.0	336.0	510.5	124.0	0.0	0.0	1695.5
2000	2.0	15.0	0.0	20.0	68.0	452.5	270.5	89.0	234.5	-	0.0	0.0	1151.5
2001	0.0	0.0	34.0	13.0	104.0	448.7	552.5	121.0	107.0	126.5	0.0	0.0	1506.7
2002	12.0	10.0	26.0	0.0	32.5	185.0	150.0	125.5	310.0	64.0	0.0	0.0	915.0
2003	6.0	58.5	38.5	40.0	24.0	-	366.1	279.0	145.1	151.6	0.0	2.3	1111.1
2004	18.45	2.13	1.55	53.93	9.53	95.95	408.57	261.07	174.01	63.01	51.10	12.85	1152.15
2005	44.49	23.11	26.16	17.90	28.95	272.26	388.86	158.86	69.03	117.63	0.09	1.67	1149.01
2006	0.00	0.00	3.11	12.64	86.68	113.20	505.72	316.06	339.51	9.80	3.73	0.00	1390.45
2007	0.00	58.69	35.76	21.08	25.33	139.60	666.30	416.85	363.93	43.63	1.57	0.00	1772.74
2008	16.44	1.96	6.27	6.78	37.26	180.58	422.25	275.33	198.31	27.64	0.00	0.00	1172.82
2009	0.00	0.26	5.81	0.19	105.82	78.32	232.20	370.39	429.16	68.56	11.31	0.98	1303.00
2010	0.59	19.64	7.62	38.24	93.72	146.68	157.31	198.97	239.75	78.76	5.26	40.53	1027.07
2011	0.00	1.60	18.25	12.81	102.58	294.61	174.35	445.43	214.88	30.35	0.69	0.00	1296.55
2012	18.45	2.13	1.55	53.93	9.53	95.95	408.57	261.07	174.01	63.01	51.10	12.85	1152.15
2013	0.07	17.62	0.79	15.24	105.51	176.77	170.14	276.70	135.76	304.46	0.00	0.00	1203.06
2014	9.27	35.71	21.21	8.16	62.77	112.58	283.73	223.38	214.48	30.30	0.00	0.00	1001.59
2015	12.06	3.33	26.71	45.73	32.91	162.96	385.21	239.38	71.34	15.62	0.00	0.61	995.86
2016	6.16	17.59	1.73	1.33	73.90	197.34	248.86	395.33	424.81	30.45	0.00	0.00	1397.50
2017	5.12	0.00	34.96	59.89	81.01	141.66	502.58	168.84	111.95	274.18	0.64	4.12	1384.95
2018	0.00	0.06	2.90	159.52	31.22	202.84	344.59	211.91	153.63	16.31	0.04	20.99	1144.01
2019	0.00	25.18	7.24	46.99	109.43	109.11	292.02	234.65	327.95	199.63	0.10	5.13	1357.43
2020	21.14	5.94	74.96	27.94	71.32	218.12	187.01	258.74	196.87	52.23	1.23	0.00	1115.50

Rainfall Data (in mm) At Dhansar (Rescue station) Observatory Station
State Sec Deptt of Coord, BCCL

Year	January	February	March	April	May	June	July	August	Sep	Oct	Nov	Dec	Annual
2005	34.20	22.80	41.80	32.20	33.00	193.00	542.00	107.80	185.60	39.20	0.00	2.00	1233.60
2006	0.00	0.00	34.40	33.80	87.60	214.20	477.70	246.30	172.00	0.00	1.00	0.00	1267.00
2007	0.00	22.00	37.80	0.00	78.70	167.20	545.00	426.40	351.40	52.00	0.00	0.00	1680.50
2008	5.80	4.80	17.80	18.40	18.00	216.10	433.48	183.80	297.80	85.80	0.00	0.00	1281.78
2009	0.00	0.00	1.60	2.20	112.00	72.80	269.20	192.80	333.00	98.20	10.20	0.00	1092.00
2010	0.00	12.20	7.60	9.20	64.30	206.20	199.40	212.60	230.10	45.30	3.4	---	991.90
2011	7.60	0.00	18.0	11.40	121.60	344.20	163.40	452.0	374.0	41.80	0.00	0.00	1534.20
2012	17.6	13.4	1.0	9.0	6.60	52.0	328.20	315.10	367.70	11.60	61.60	18.0	1201.80
2013	0.0	32.0	3.0	33.90	190.40	244.20	192.80	364.40	304.70	233.60	0.0	0.0	1599.0
2014	12.40	36.80	21.80	2.60	79.80	217.60	305.30	315.60	178.0	6.40	0.0	0.0	1176.0
2015	23.80	0.0	6.20	76.20	35.80	122.10	407.60	244.40	145.20	25.60	0.0	6.20	1093.10
2016	3.0	20.60	5.50	0.0	99.40	181.60	248.80	456.70	443.60	50.40	0.0	0.0	1509.60
2017	8.80	0.0	3.80	17.90	33.20	120.0	533.40	284.70	247.40	207.70	3.40	0.0	1460.30
2018	0.0	0.0	0.0	102.90	76.30	270.60	382.30	338.80	159.50	38.90	2.40	37.90	1346.60
2019	0.0	49.60	10.20	54.20	132.0	188.0	319.10	343.60	403.10	156.40	3.20	10.80	1667.00
2020	22.0	7.60	77.80	76.80	86.20	214.10	296.80	351.40	214.0	92.0	0.0	0.0	1438.70
2021	0.00	0.00	21.8	12	157.4	295	382.2	130.2	451.8	285	54.4	43	1832.8
2022	12.8	85.8	0	0	61.8	130.2	104.6	350.1	172.2	64.4	0	3	984.9

Location of Hydrograph Stations (Dug Wells)

Well No	Latitude	Longitude	Well No	Latitude	Longitude
A-3	23°47'53.35" N	86°19'55.14" E	B-62A	23°45'44.15" N	86°11'27.80" E
A-12	23°48'20.31" N	86°16'51.64" E	B-64	23°48'45.58" N	86°18'31.03" E
A-16	23°46'57.00" N	86°21'38.57" E	B-65A	23°49'5.12" N	86°18'15.77" E
A-17	23°45'09.44" N	86°22'16.35" E	B-67	23°43'30.70" N	86°14'01.45" E
A-18	23°44'37.65" N	86°22'58.90" E	D-3	23°46'46.31" N	86°24'49.30" E
A-19	23°40'50" N	86°24'14" E	D-4	23°44'29.37" N	86°24'42.88" E
A-20	23°45'26.63" N	86°20'42.86" E	D-5	23°42'39.06" N	86°24'47.95" E
A-21	23°44'58" N	86°18'38" E	D-7	23°43'12.08" N	86°27'11.89" E
A-22	23°43'06.65" N	86°14'48.53" E	D-8	23°44'06.13" N	86°27'20.72" E
A-23	23°45'6" N	86°15'22" E	D-23	23°47'20.89" N	86°20'08.96" E
A-24	23°45'20.44" N	86°13'45.12" E	D-25	23°47'12.03" N	86°23'14.08" E
A-25	23°47'06.20" N	86°15'27.79" E	D-30	23°48'36.10" N	86°21'50.07" E
A-26	23°46'49.24" N	86°18'12.12" E	D-33	23°45'34.62" N	86°23'18.50" E
A-27	23°48'42.55" N	86°20'21.80" E	D-34	23°47'1.88" N	86°23'39.62" E
A-28A	23°47'34.74" N	86°18'04.18" E	D-35	23°40'46.54" N	86°25'46.33" E
A-29	23°47'08.02" N	86°16'02.72" E	D-36	23°40'19.26" N	86°25'18.98" E
A-32	23°44'15.56" N	86°20'43.80" E	D-39	23°43'28.50" N	86°26'0.10" E
A-33	23°44'32.58" N	86°16'58.28" E	D-40A	23°43'20.18" N	86°25'45.70" E
A-34	23°42'58.63" N	86°15'19.31" E	D-41	23°42'40.00" N	86°26'17.20" E
B-1	23°48'48.06" N	86°14'16.87" E	D-43	23°43'55.06" N	86°27'24.98" E
B-14	23°48'00.81" N	86°16'25.88" E	D-47	23°45'20.59" N	86°24'34.86" E
B-15	23°46'06.92" N	86°08'59.30" E	D-49	23°44'08.96" N	86°26'32.71" E
B-21A	23°45'10.50" N	86°09'38.38" E	D-51	23°44'20.88" N	86°27'11.37" E
B-23	23°44'13.05" N	86°11'46.56" E	D-66	23°43'58.37" N	86°24'07.45" E
B-24	23°44'26.80" N	86°13'09.38" E	D-74	23°41'33.66" N	86°25'06.10" E
B-25	23°44'44.98" N	86°13'57.80" E	D-77	23°41'00.74" N	86°22'25.55" E
B-32A	23°45'49.18" N	86°13'03.64" E	D-80	23°46'09.46" N	86°24'33.08" E
B-48	23°43'35.04" N	86°16'38.78" E	DB-22	23°42'49.79" N	86°45'9.97" E
B-51	23°46'58.55" N	86°09'22.18" E	DB-23	23°43'43.03" N	86°45'04.97" E
B-53	23°45'55.25" N	86°09'35.44" E	DB-24	23°43'53.00" N	86°45'03.88" E
B-59	23°47'59.87" N	86°13'37.97" E	DB-26	23°44'10.75" N	86°44'35.84" E
B-60	23°48'7.87" N	86°15'37.12" E			
B-61A	23°45'58.85" N	86°11'40.80" E			

These wells (red color) will be excluded from next assessment year.

Details of Hydrograph Stations (Dug Wells)

Well No	Location	M.P. (agl) in m	Well Dia in m	Well Depth (m bmp)	Formation	Owner	Utility
A-3	Sijua	0.53	3.00	5.20	Barakar	Govt.	Domestic
A-12	Jamua	0.80	1.90	3.30	Barakar	Govt.	Domestic
A-16	Ekra, Kalali	0.45	3.10	6.50	Barakar	Govt.	Domestic
A-17	Kachi Balihari	0.56	1.60	5.30	Barakar	Govt.	Domestic
A-18	Bhagabandh	0.61	1.45	3.37	Barakar	Govt.	Domestic
A-19	Bhaura	0.54	3.15	11.65	Barakar	Govt.	Domestic
A-20	Gorbhudih	0.43	3.30	8.30	BM	Govt.	Domestic
A-22	Nagdah, Niche	0.00	1.40	9.50	Raniganj	Govt.	Irrigation
A-23	Machhyara	0.43	1.85	12.40	Raniganj	Govt.	Domestic
A-24	Pipra Tanr	0.22	1.80	19.55	Raniganj	Govt.	Domestic
A-25	Sinidih	0.22	2.00	11.30	Barakar	Govt.	Domestic
A-26	Pasitanr	0.32	1.80	9.65	Barakar	Govt.	Domestic
A-27	Chandor	0.60	2.50	5.50	Barakar	Govt.	Domestic
A-28A	Lakarka 6 no.	0.65	1.30	5.25	Barakar	BCCL	Domestic
A-29	Aambagan	0.10	2.60	9.15	Barakar	Govt.	Domestic
A-32	Baludih	0.55	2.30	6.85	BM	Govt.	Domestic
A-33	Mahuda	0.75	2.00	10.80	BM	BCCL	Domestic
A-34	Bhatdih	0.55	3.50	24.50	Raniganj	BCCL	Domestic
B-1	Muraidih	0.47	1.80	5.35	Talchir	Govt.	Domestic
B-14	Mathadih	0.76	2.15	3.75	Barakar	Govt.	Domestic
B-15	Bera Basti	0.55	1.60	2.50	Talchir	Dhanu Roy	Domestic
B-21A	Dugcha	0.55	2.10	10.35	Metamorphics	Govt.	Domestic
B-23	Lohapati	0.26	3.60	10.85	Raniganj	Govt.	Domestic
B-24	Telmuchu	0.67	4.35	10.83	Raniganj	Govt.	Domestic
B-25	Mahuda More	0.10	2.45	8.45	Raniganj	Govt.	Domestic
B-32A	Madhuband	0.80	4.30	8.60	Barakar	BCCL	Domestic
B-48	Mahuda	0.65	2.10	11.50	Raniganj	Mosque	Domestic
B-51	Taranga	0.00	2.50	5.75	Metamorphics	Bisun	Irrigation
B-53	Karmatanr	0.58	2.70	13.25	Barakar	Govt.	Domestic
B-59	Khodovaly	0.60	2.40	9.30	Barakar	BCCL	Domestic
B-60	Bahiyardi	0.77	3.00	15.60	Barakar	BCCL	Domestic
B-61A	Kasargora	0.48	2.00	11.20	Barakar	BCCL	Domestic
B-62A	Sadariyadi	0.15	3.10	9.50	Barakar	Govt.	Domestic

Details of Hydrograph Stations (Dug Wells)

Well No	Location	M.P. (agl) in m	Well Dia in m	Well Depth (m bmp)	Formation	Owner	Utility
B-64	Keshalpur	0.65	1.10	3.40	Barakar	BCCL	Domestic
B-65A	Jhinjipahari	0.95	2.20	12.40	Barakar	Shiv Temple	Domestic
B-67	Simatanr	0.55	2.20	11.80	Raniganj	Govt	Domestic
D-3	Dhansar	0.60	1.70	8.70	Barakar	Govt	Domestic
D-4	Jharia	0.59	1.90	5.73	Barakar	Govt	Domestic
D-5	Jiyalgora	0.70	2.80	10.55	Barakar	Govt	Domestic
D-7	Golden Pahari	0.67	2.85	10.05	Barakar	BCCL	Domestic
D-8	Alokdiha	0.35	1.75	7.57	Metamorphics	BCCL	Domestic
D-23	Jogta (Sindra)	0.40	3.10	7.25	Barakar	BCCL	Domestic
D-25	Godhar More	0.60	2.75	5.60	Barakar	Govt	Domestic
D-30	Borkiboa	0.70	2.00	5.60	Talchir	H.Kumbhakar	Domestic
D-33	Kustore-4	0.55	1.85	3.45	Barakar	BCCL	Domestic
D-34	Kusunda-7	0.60	1.50	3.45	Barakar	BCCL	Domestic
D-35	Patherdih	0.40	2.00	11.20	Barakar	BCCL	Domestic
D-36	Sudamdih	0.90	2.00	6.20	Barakar	BCCL	Domestic
D-39	Tilabani	0.85	2.00	5.90	Barakar	BCCL	Domestic
D-40A	Khapra Dhaura	0.55	1.95	3.70	Barakar	Panchayat	Domestic
D-41	Joyrampur	0.50	1.80	4.00	Barakar	BCCL	Domestic
D-43	Alagrdih	0.45	2.20	8.90	Metamorphics	Govt	Domestic
D-47	Parastanr	0.45	3.20	23.80	Barakar	BCCL	Domestic
D-49	Goluckdih	0.55	1.80	6.15	Barakar	BCCL	Domestic
D-61	Chankuiya	0.55	3.70	11.80	Barakar	BCCL	Domestic
D-56	Hantadih	0.48	2.80	11.80	Barakar	Govt	Domestic
D-74	Bhulan Barari	0.10	1.60	12.80	Barakar	Govt	Domestic
D-77	Rohoniatanr	0.40	3.15	6.70	Barakar	Govt	Domestic
D-80	Bastacolla	0.70	2.50	24.95	Barakar	Govt	Domestic
DB-22	Nichebasti	0.67	2.40	10.65	Barakar	Govt	Domestic
DB-23	Dahibari OC	0.70	2.30	8.00	Barakar	BCCL	Domestic
DB-24	Dahiban	0.60	3.60	13.70	Barakar	BCCL	Domestic
DB-26	Patesya	0.37	1.65	5.25	Barakar	Govt	Domestic

These wells (red color) will be excluded from next assessment year.

MP: Measuring Point
Abn.: Abandoned
G.L.: Ground Level

R.L.: Reduced Level
b.g.l.: Below Ground Level
bmp: Below Measuring Point

W.L.: Water Level m: Meter
a.g.l.: Above Ground Level
BM: Barren Measure

Historical Water Level data of Hydrograph Stations

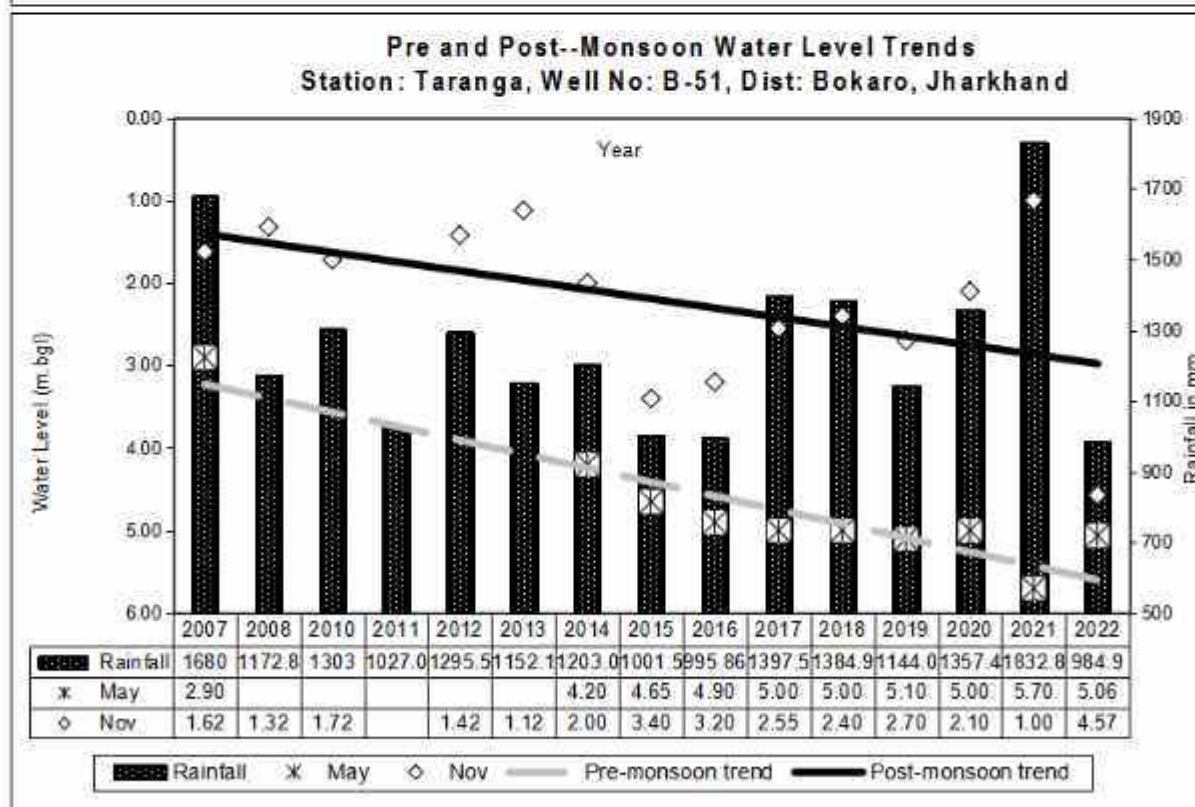
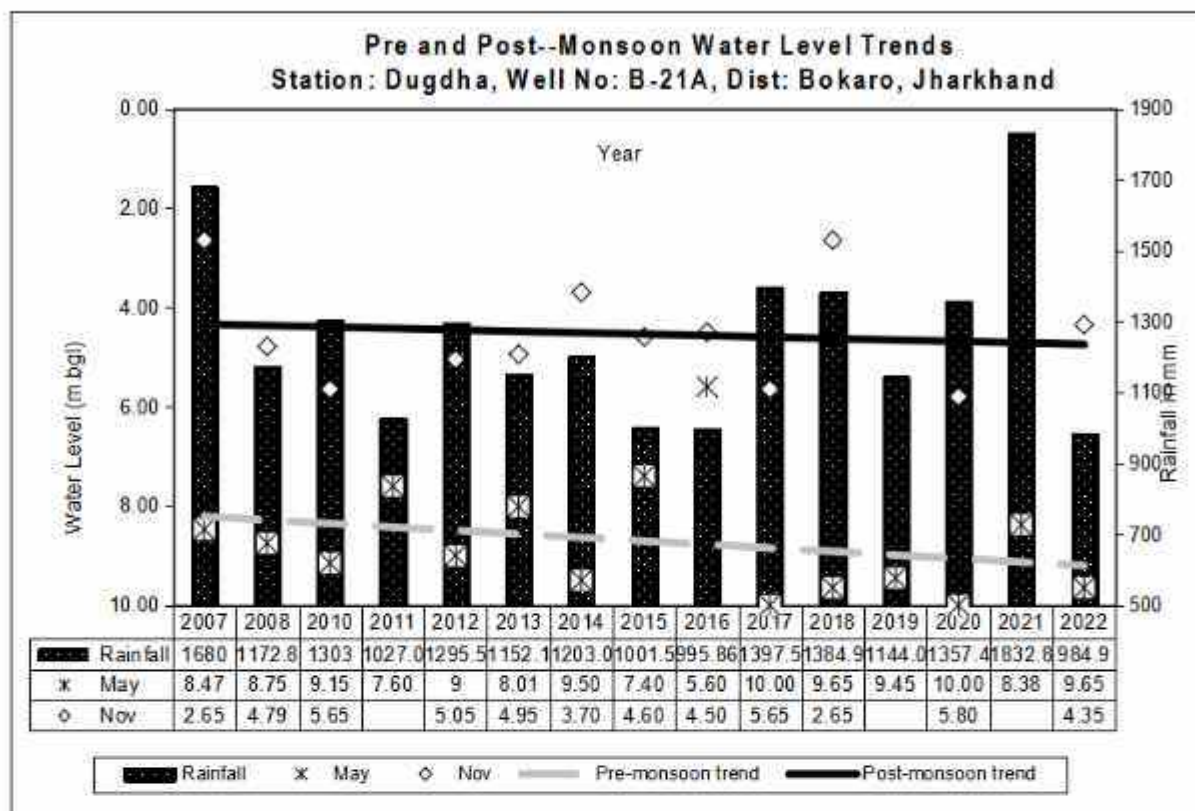
Well No	Water level below ground level (bgl) in meters															
	May 15	Nov 15	May 16	Nov 16	May 17	Nov 17	May 18	Nov 18	May 19	Nov 19	May 20	Nov 20	May 21	Nov 21	May 22	Nov 22
A-3	3.70	3.42	4.87	0.47	0.67	0.77	1.27	0.47	3.47	0.47	1.57	0.47	0.62	0.05	0.42	0.29
A-12	3.00	2.68	2.50	0.70	2.55	0.85	2.80	1.0	2.10	0.45	2.60	0.50	1.92	1.10	1.5	0.67
A-16	5.55	4.17	5.85	3.15	3.65	2.20	4.30	3.65	5.45	1.95	7.15	1.75	3.45	2.00	5.8	3.08
A-17	3.79	2.64	2.44	2.69	2.44	2.24	3.34	2.84	2.94	2.24	2.14	1.69	3.36	2.37	2.62	2.59
A-18	2.84	1.29	1.14	0.89	1.29	0.93	1.24	0.99	2.29	0.99	1.09	0.34	1.09	0.57	0.62	0.58
A-19	3.05	2.75	7.81	4.11	6.37	2.45	5.55	2.45	4.85	3.43	6.05	3.25	3.30	1.90	4.1	2.54
A-20	4.59	2.93	7.49	3.50	4.27	1.77	4.57	2.57	4.57	1.82	8.47	3.87	5.47	2.02	5.59	3.54
A22A	3.20	1.96	3.25	1.75	4.27	1.77	3.35	1.90	2.60	2.00	2.90	1.98	2.00	1.10	6.35	2.1
A-23	11.3	9.37	11.87	8.13	6.40	1.50	11.15	7.17	11.97	3.77	8.92	5.62	9.52	2.82	7.97	4.79
A-24	17.2	14.5	16.62	12.43	11.87	6.97	14.58	6.88	15.88	2.48	*4.88	4.28	10.13	2.78	7.28	4.33
A-25	7.78	5.85	7.43	4.58	6.38	2.88	6.63	3.13	6.08	1.93	2.98	1.83	5.78	2.43	3.31	2.08
A-26	7.73	3.18	8.93	4.48	5.28	2.53	6.23	3.88	6.58	3.33	6.98	3.18	6.70	2.73	6.42	4.31
A-27	4.40	3.95	4.85	1.80	2.90	1.25	2.90	1.0	2.40	0.92	2.40	1.10	1.67	0.90	1.90	1.33
A28A	4.35	3.60	3.35	1.47	4.30	1.55	4.15	2.51	2.45	3.15	4.00	3.03	6.23	3.75	4.23	3.30
A-29	4.55	4.60	5.92	6.96	4.40	1.30	6.45	2.10	4.85	3.40	6.20	3.20	6.49	5.90	4.60	1.15
A-32	4.41	2.13	4.75	2.10	3.15	1.55	2.80	0.70	2.75	0.95	1.90	1.75	2.35	0.96	2.25	1.75
A-33	4.91	1.97	5.75	2.60	6.45	1.55	4.07	2.35	3.65	1.25	4.55	1.85	2.85	0.85	3.50	2.05
A-34	8.40	4.81	4.75	4.45	12.45	4.45	5.90	3.70	6.35	3.95	8.35	3.45	5.20	3.55	8.20	6.35
B-1	3.28	2.75	3.58	1.93	2.33	0.85	2.88	2.08	3.18	1.73	3.28	1.63	2.58	1.91	2.10	1.81
B-14	2.94	2.29	2.44	0.47	2.94	1.84	3.64	2.84	2.24	0.94	2.44	1.04	2.84	2.04	3.24	2.60
B-15	1.50	0.45	1.85	0.55	4.85	0.15	1.85	0.85	1.90	1.65	3.70	1.47	1.46	0.35	3.67	1.02
B21A	7.37	4.65	5.55	4.50	8.85	5.55	9.55	2.65	9.45		10.00	5.30	8.38		9.65	4.35
B-23	7.86	4.29	6.81	2.41	7.74	2.14	6.64	2.14	2.84	1.34	3.24	1.76	4.12	1.44	2.98	1.73
B-24	10.0	5.78	10.63	4.28	10.03	4.03	9.28	4.33	4.58	2.33	5.48	3.53	5.68	2.08	5.53	3.46
B-26	6.88		7.05	1.70	6.70	1.40	6.90	3.70	4.80	1.40	7.90	2.55	6.10	2.68	6.40	3.52
B32A	7.55	3.32	6.95	3.07	6.95	2.80	6.75	3.90	5.55	1.70	3.30	2.00	7.23	6.05	4.15	2.56
B-48	7.90	5.42	9.35	4.60	7.70	4.15	7.33	3.97	7.05	4.35	8.20	3.85	7.23	6.05	6.85	6.25
B-51	4.65	3.40	4.90	3.18	4.98	2.55	5.02	2.42	5.10	2.70	5.00	2.10	5.70	1.0	5.06	4.57
B-53	5.58	2.82	4.70	1.45	4.02	1.92	3.92	1.42	3.22	1.42	3.12	1.40	4.85	1.87	4.42	3.54
B-59	4.12	1.60	4.40	0.50	5.40	0.60	5.47	1.10	6.20	0.90	5.25	1.40	5.49	0.90	4.50	1.14
B-60	9.21	5.28	10.33	5.03	13.23	3.18	13.68	4.23	8.13	3.23	10.33	3.21	11.26	2.23	10.53	5.80
B61A	6.15	4.52	6.58	3.87	2.57	0.82	2.57	2.02	3.32	0.52	3.32	1.60	4.42	0.97	1.20	0.97
B62A	9.10	5.21	9.30	4.95	8.15	4.35	8.27	4.78	7.55	3.25	6.95	3.00	6.87	4.50	6.45	4.91

Historical Water Level data of Hydrograph Stations

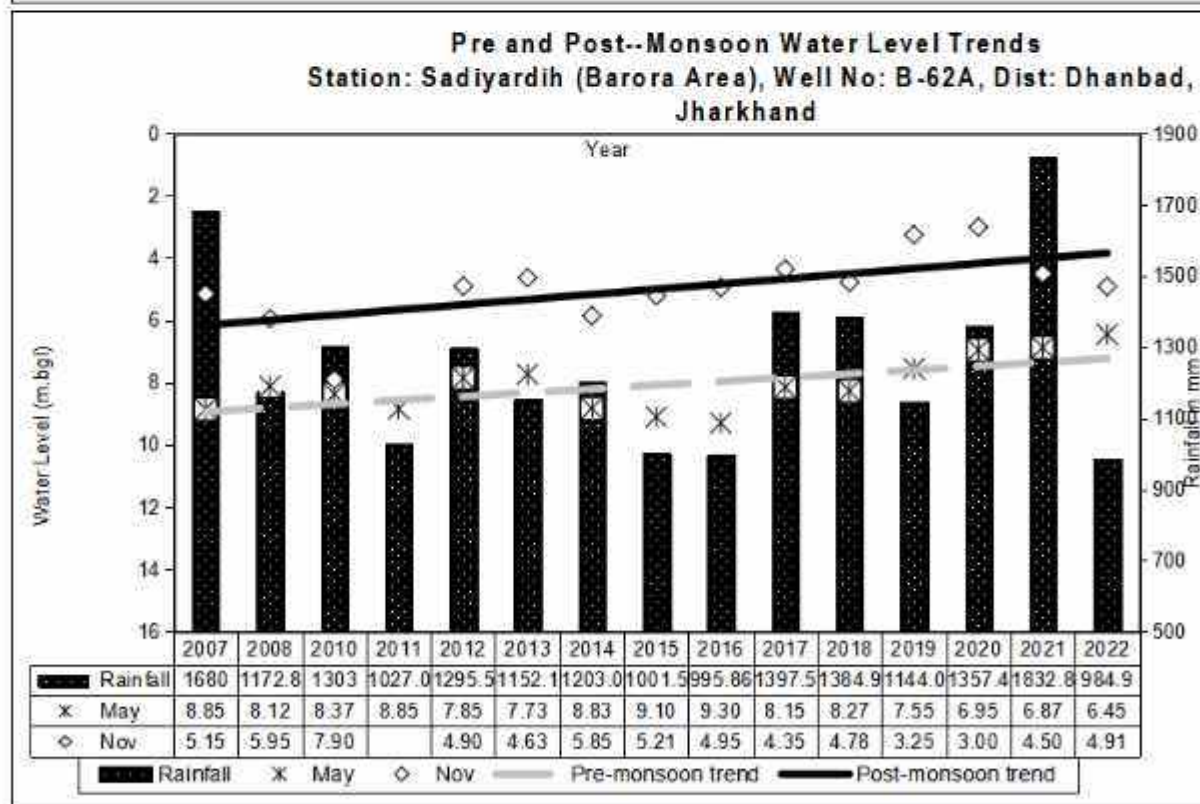
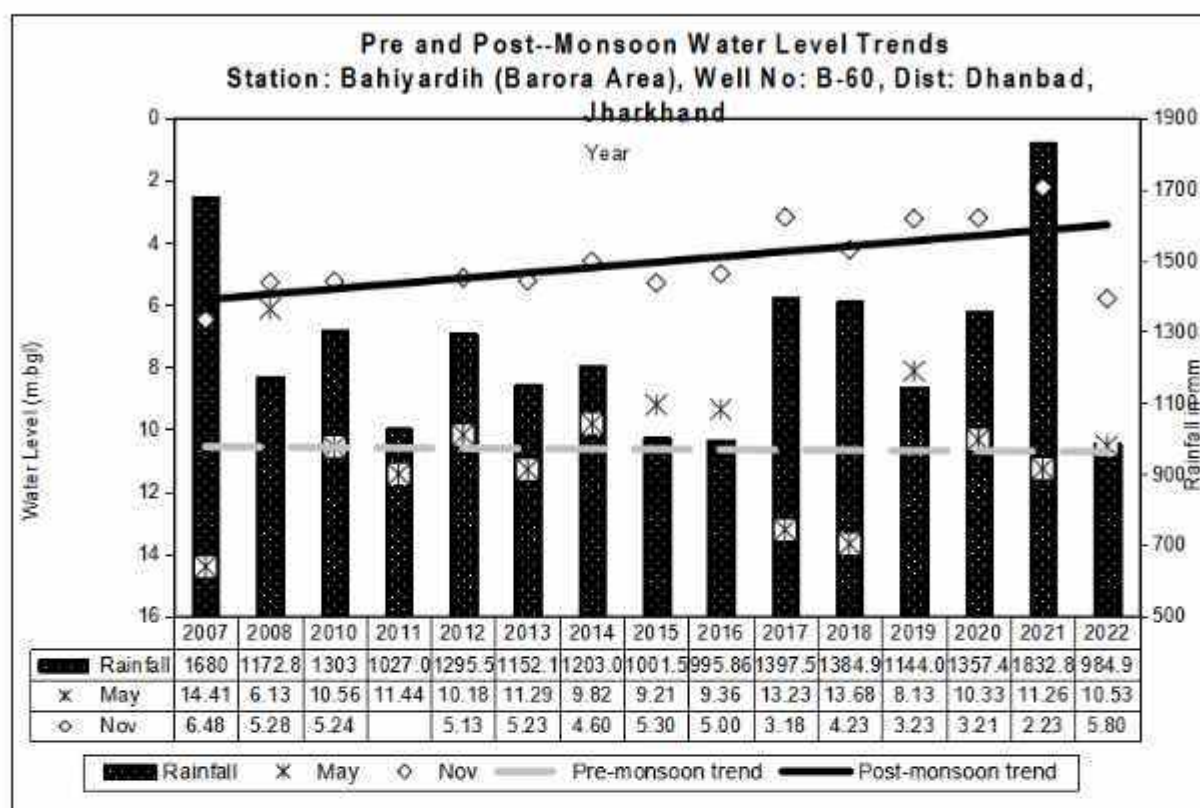
Well No	Water level below ground level (bgl) in meters															
	May 15	Nov 15	May 16	Nov 16	May 17	Nov 17	May 18	Nov 18	May 19	Nov 19	May 20	Nov 20	May 21	Nov 21	May 22	Nov 22
B-64	1.38	0.95	2.35	0.55	1.25	0.85	2.15	1.85	0.95	0.45	1.85	0.50	2.35	0.95	1.00	0.60
B65A	7.82	5.87	7.15	2.68	9.06	1.25	10.03	2.40	11.05	0.95	9.25	2.30	9.03	1.42	7.45	2.27
B-67	9.23	5.53	9.53	4.30	10.00	2.15	9.55	4.0	8.57	4.35	7.55	3.95	8.95	2.95	8.50	6.30
D-3	4.25	2.25	2.35	1.90	2.15	2.30	3.43	2.45	1.75	1.30	5.40	1.38	3.41	0.85	5.96	1.32
D-4	2.41	1.27	1.21	1.36	1.21	1.46	1.91	1.56	2.81	1.71	3.41	1.41	3.01	1.16	1.71	1.55
D-5	9.37	8.33	9.40	6.40	7.90	5.20	7.80	5.30	8.25	4.85	8.60	7.70	7.28	4.00	8.40	7.01
D-7	8.25	5.61	7.53	4.03	7.33	2.88	7.53	2.83	8.23	3.28	7.33	5.13	6.08	2.63	9.03	5.67
D-8	6.24	4.38	8.00	3.43	5.15	1.85	5.65	1.85	4.80	2.85	5.83	2.75	4.55	2.27	6.32	5.42
D-23	6.88	3.48	5.70	1.53	2.80	2.98	4.40	3.40	4.70	1.40	5.50	3.35	5.43	1.60	1.85	1.57
D-25	4.48	2.45	2.40	1.90	2.40	1.20	2.60	2.40	*9.90	*5.38	10.50	5.62	10.50	3.80	11.90	4.70
D-30	4.55	3.15	4.45	3.20	4.40	1.25	4.58	1.10	4.60	0.75	4.50	1.35	4.23	0.84	4.37	2.29
D-33	2.25	1.10	2.50	1.95	0.75	0.75	2.85	0.95	2.35	1.65	3.65	1.45	1.75	0.85	1.20	0.65
D-34	2.55	1.45	2.30	0.30	0.80	0.55	2.80	0.45	4.75	2.40	3.30	2.80	3.78	2.90	5.00	3.15
D-35	9.80	7.90	9.52	6.45	8.80	3.60	8.40	4.45	8.00	3.80	8.20	5.40	6.60	2.90	6.10	4.68
D-36	1.66	1.13	0.78	0.95	1.30	0.70	1.20	0.60	1.20	0.55	2.10	1.00	2.02	0.55	3.25	0.6
D-39	5.00	2.61	2.18	2.65	6.17	4.75	4.95	4.35	*12.60	*5.95	9.40	6.05	10.70	5.10	7.50	3.05
D40A	3.07	2.45	1.40	0.85	1.45	1.38	2.10	1.40	1.85	1.45	1.95	1.43	1.85	1.80	2.35	1.80
D-41	2.65	2.32	1.30	1.52	1.40	1.20	1.59	1.32	2.30	1.25	3.30	1.45	1.95	1.38	1.55	0.88
D-43	6.61	6.05	8.20	3.35	7.50	3.60	7.15	3.45	7.35	2.70	6.50	2.55	4.95	2.90	5.35	4.75
D-47	9.60	3.60	3.18	2.95	3.15	2.85	5.33	2.55	4.55	4.35	9.45	5.45	4.05	2.45	6.55	5.85
D-49	3.55	2.35	2.45	1.72	2.70	2.05	3.45	2.45	1.75	1.50	3.25	1.65	1.40	0.85	2.00	1.91
D-51	10.48	8.16	11.15	6.45	10.45	5.43	10.93	7.10	8.95	6.75	8.45	6.70	9.43	5.55	10.95	8.50
D-55	6.15	1.57	2.52	3.62	8.42	2.37	8.42	1.67	8.42	5.47	9.42	8.00	9.52	7.62	11.32	11.12
D-74	10.05	7.20	7.73	5.00	9.25	3.85	8.60	4.80	5.80	3.57	4.30	3.93	6.93	2.90	6.17	5.77
D-77	6.44	5.60	4.60	2.90	6.50	4.90	6.30	5.20	6.40	3.20	6.40	3.50	5.98	4.69	6.50	4.70
D-80	10.97	3.35	6.55	4.15	8.65	3.70	9.35	4.20	5.00	3.05	4.30	4.90	7.10	2.55	3.30	3.08
RCF (part)	May 15	Nov 15	May 16	Nov 16	May 17	Nov 17	May 18	Nov 18	May 19	Nov 19	May 20	Nov 20	May 21	Nov 21	May 22	Nov 22
DB22	4.59	3.53	5.38	3.33	1.93	1.63	2.34	1.93	4.93	1.63	2.63	2.25	2.31	1.38	1.73	1.63
DB23	3.38	6.04	5.30	0.90	2.05	1.90	2.85	1.75	1.60	0.80	2.50	1.95	2.00	1.10	2.68	2.20
DB24	9.32	8.20	10.65	6.50	5.80	3.78	8.25	5.70	9.35	3.38	6.70	3.60	5.20	5.25	-	-
DB25	3.83	2.68	3.61	1.98	3.28	2.58	3.93	1.83	-	-	3.98	2.63	2.80	2.03	-	-

These wells (red color) will be excluded from next assessment year.

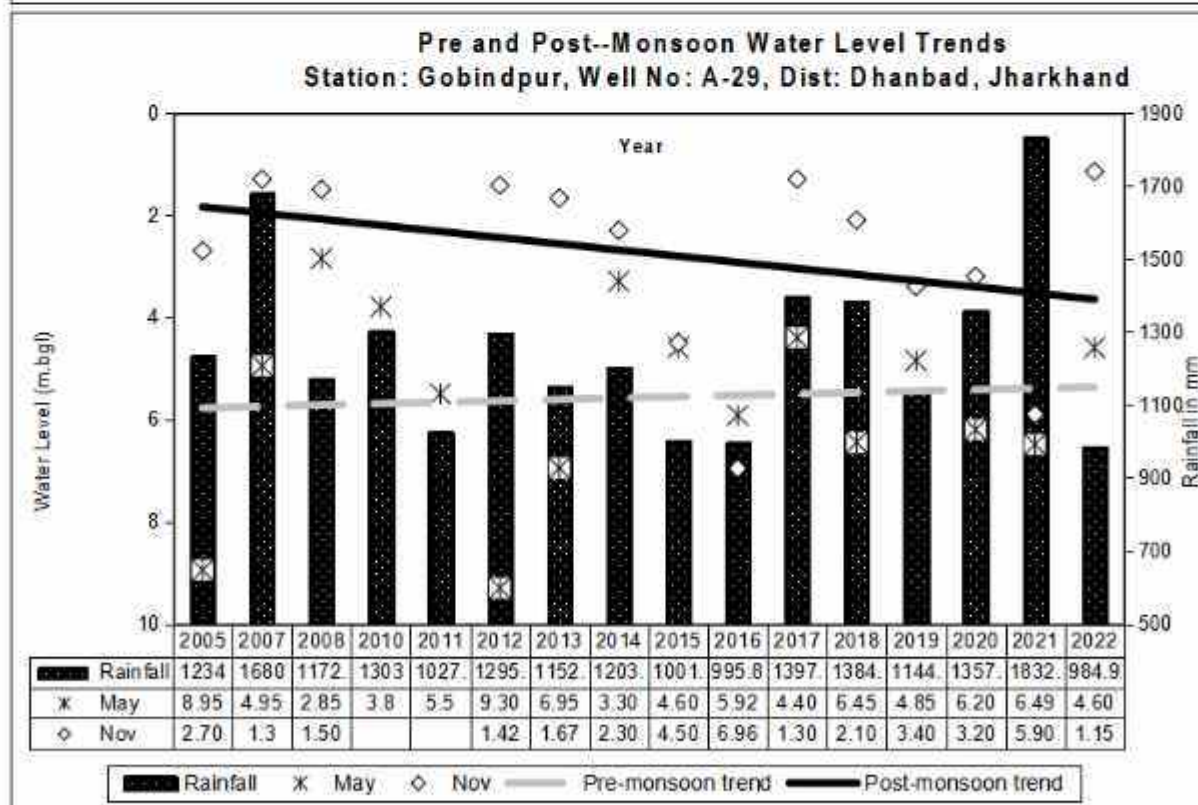
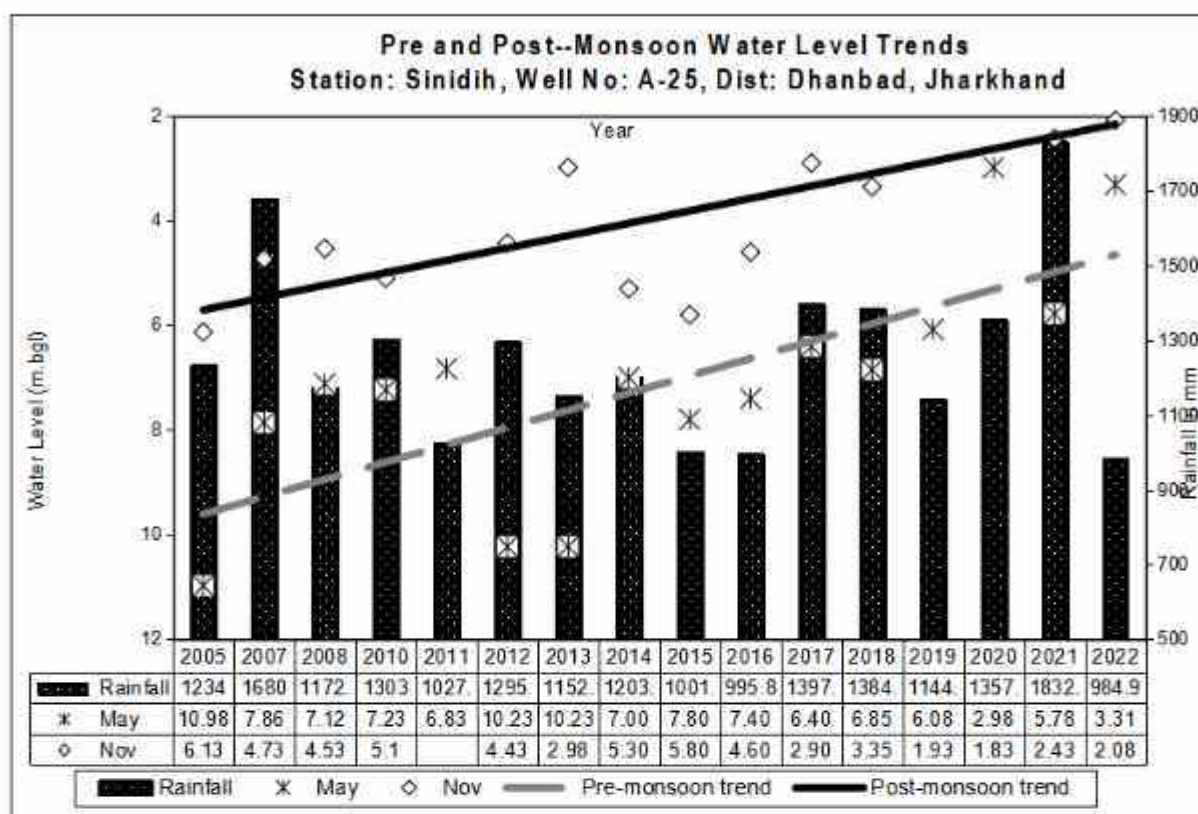
HYDROGRAPHS OF CLUSTER-I



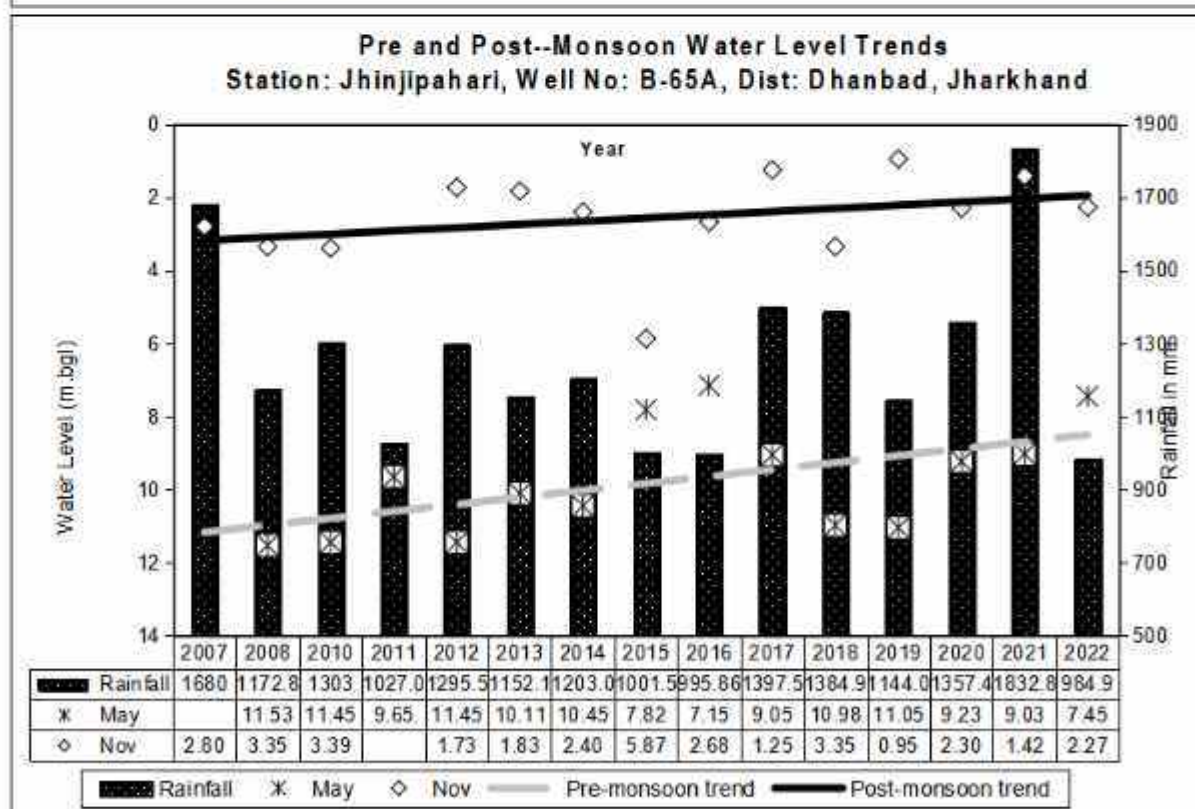
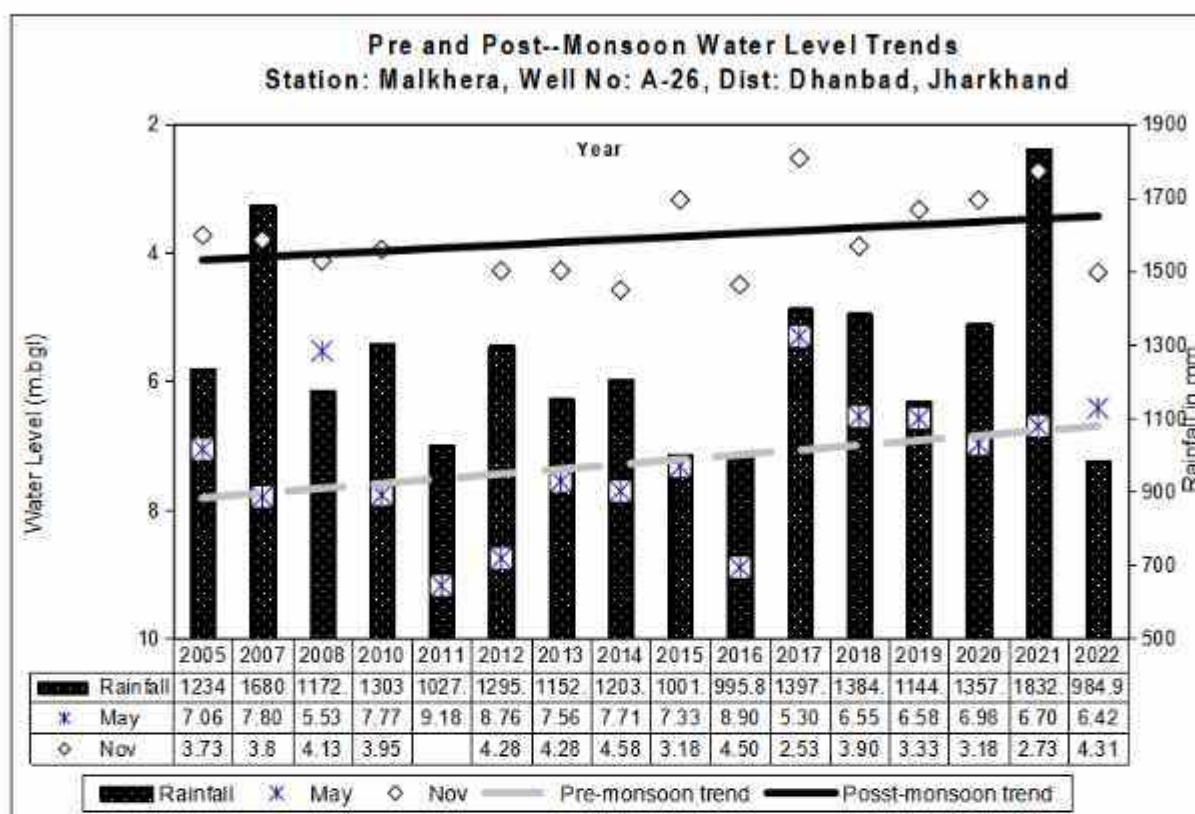
HYDROGRAPHS OF CLUSTER-II



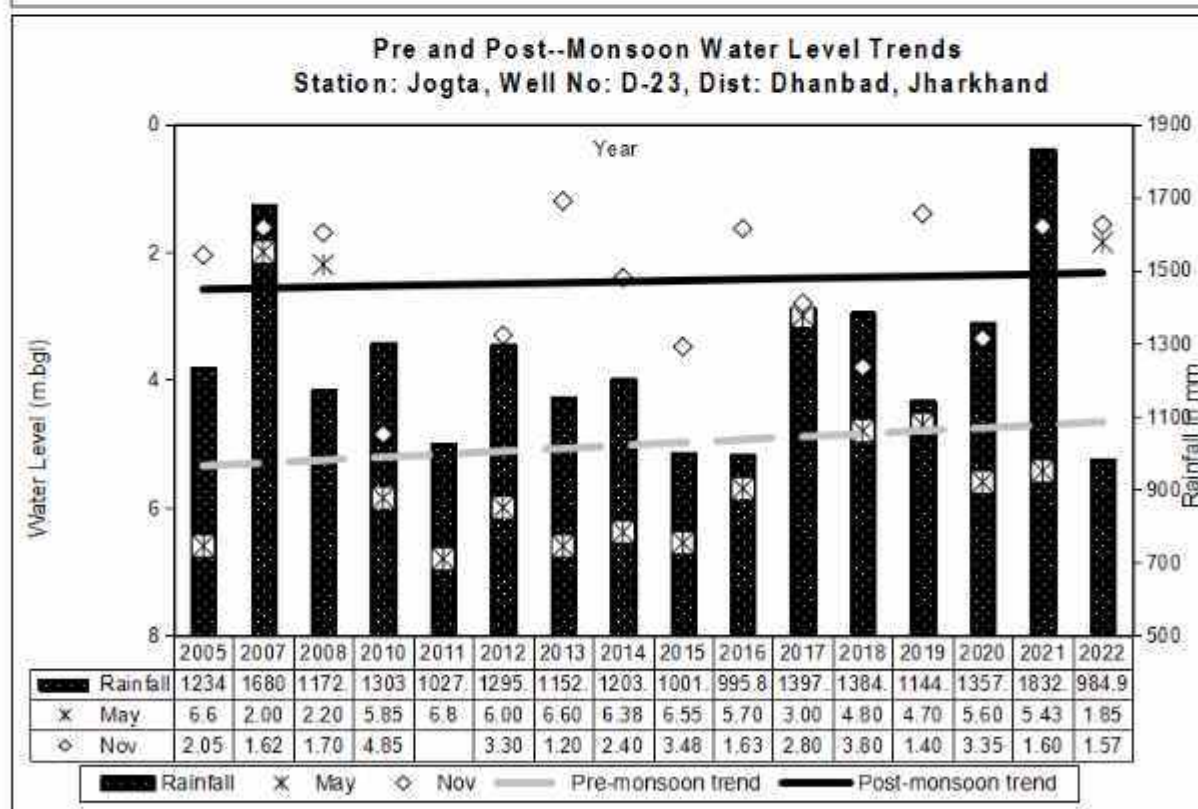
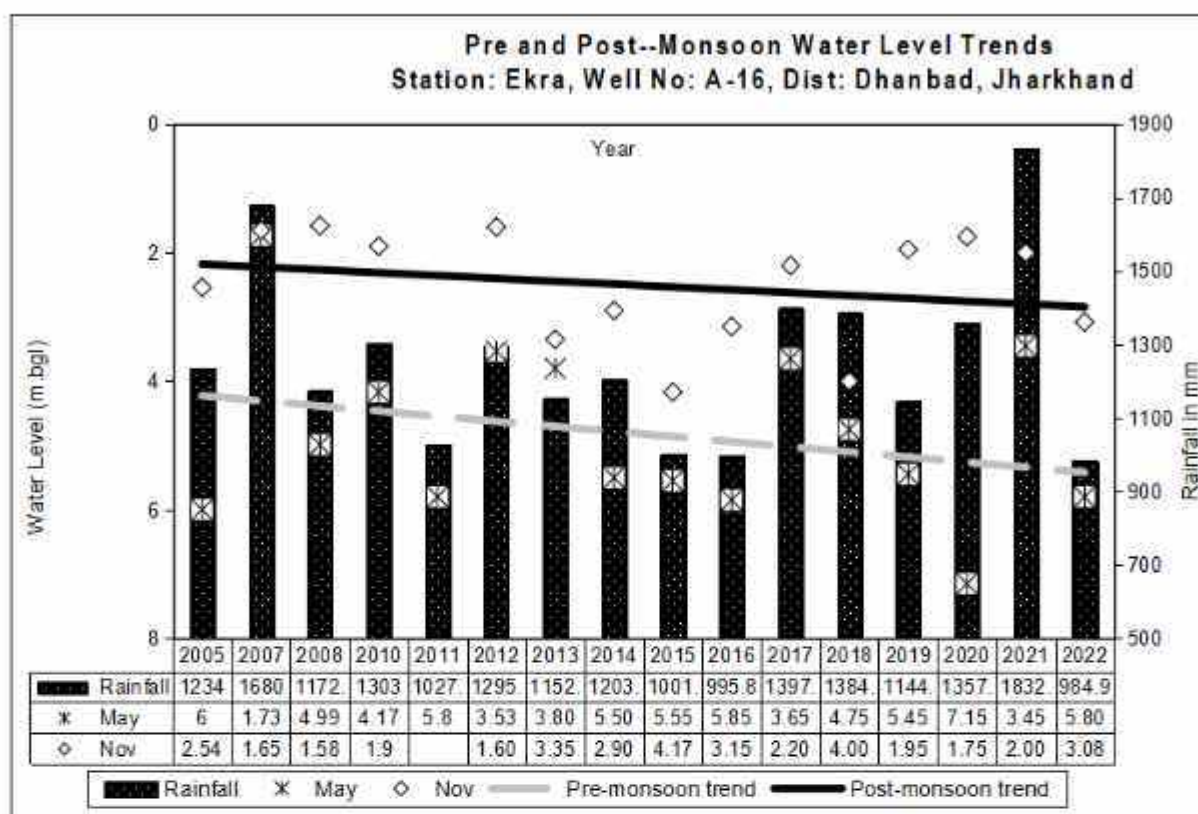
HYDROGRAPHS OF CLUSTER-III



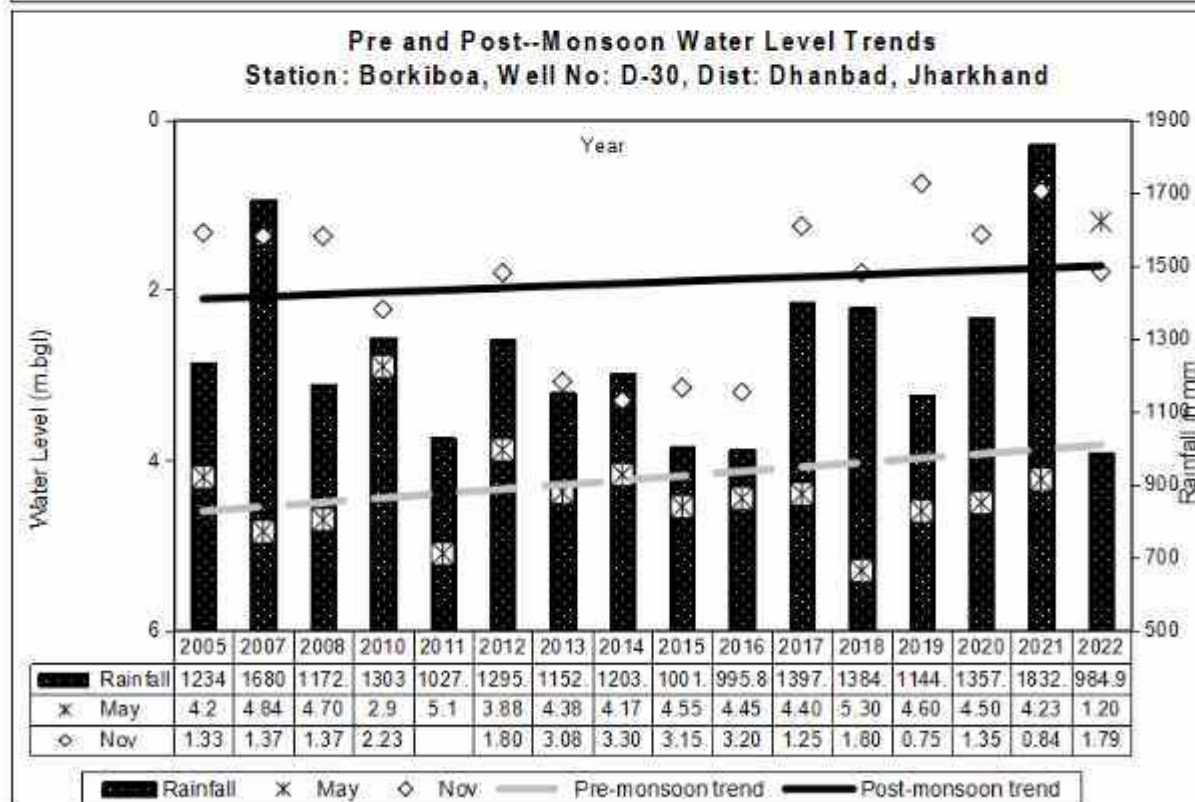
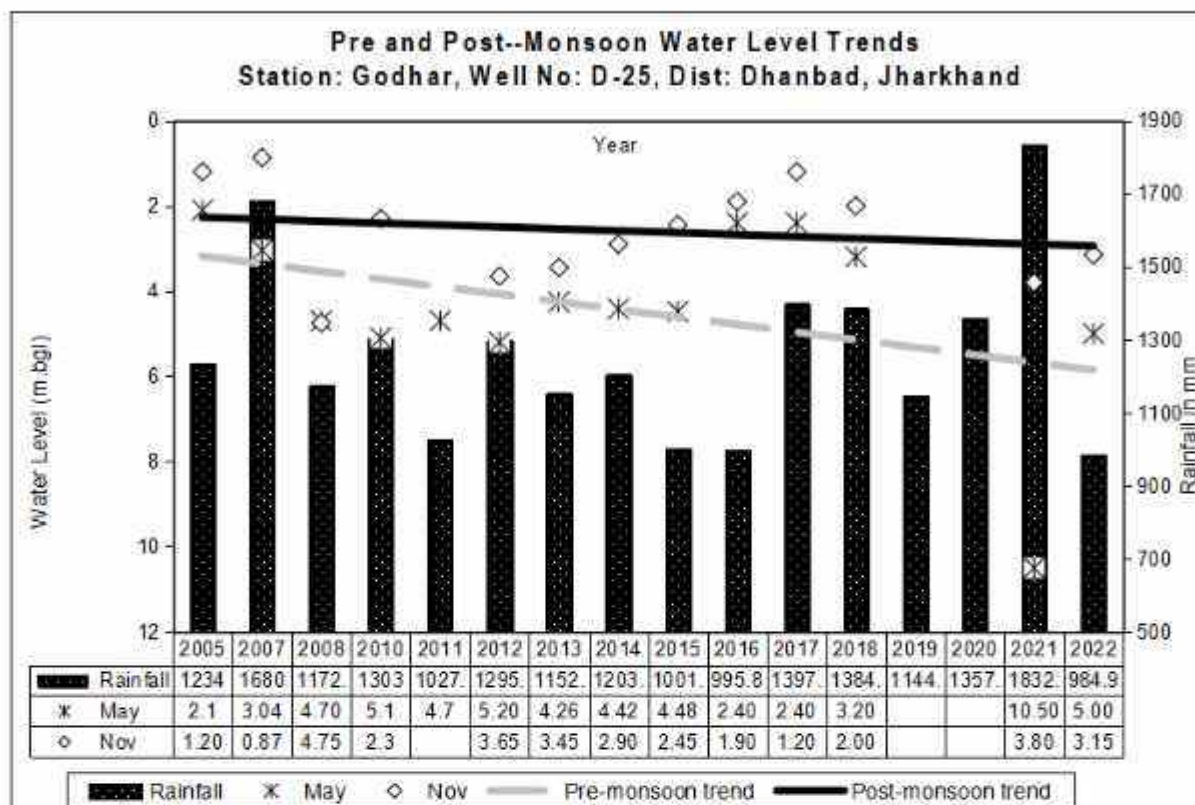
HYDROGRAPHS OF CLUSTER-IV



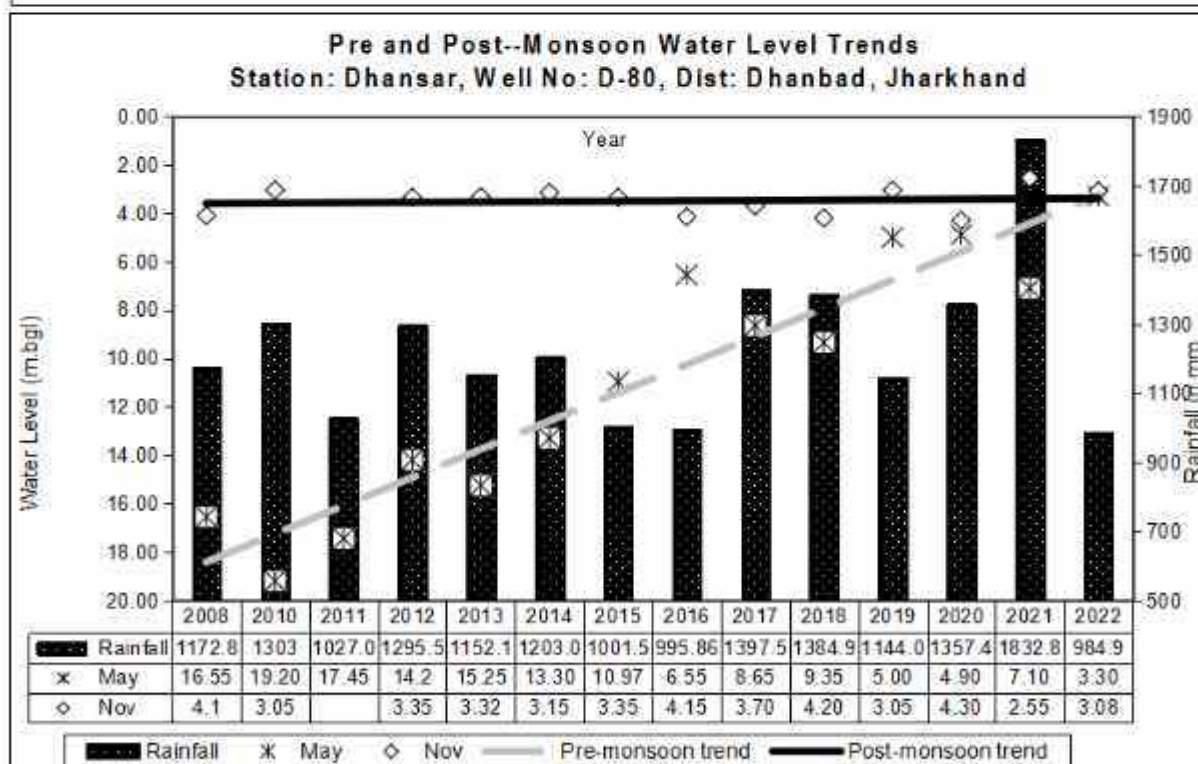
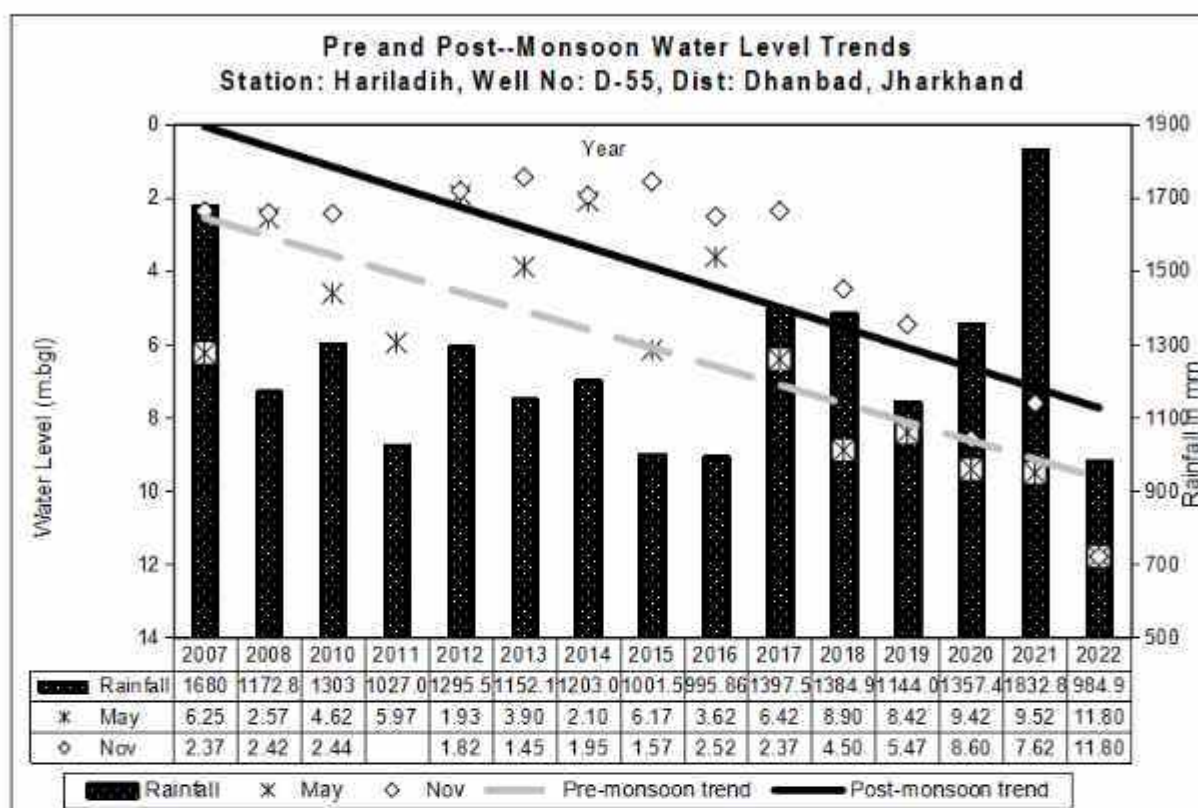
HYDROGRAPHS OF CLUSTER-V



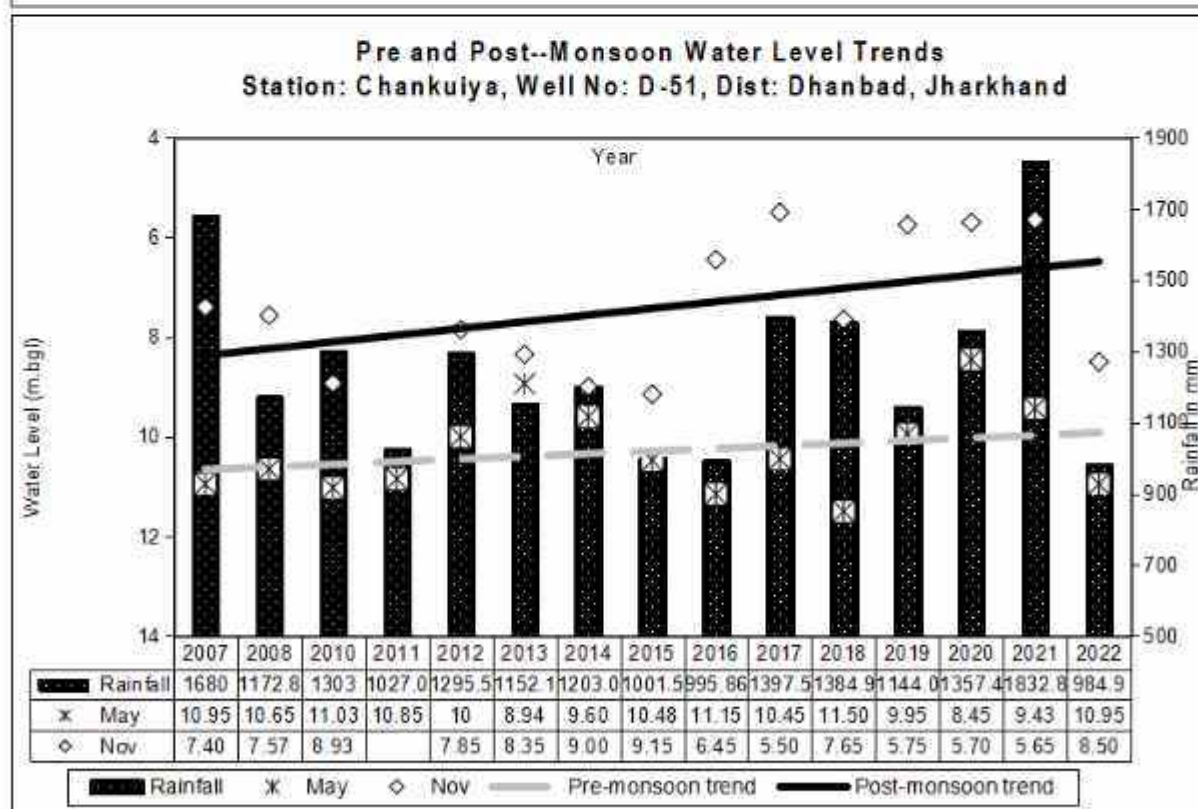
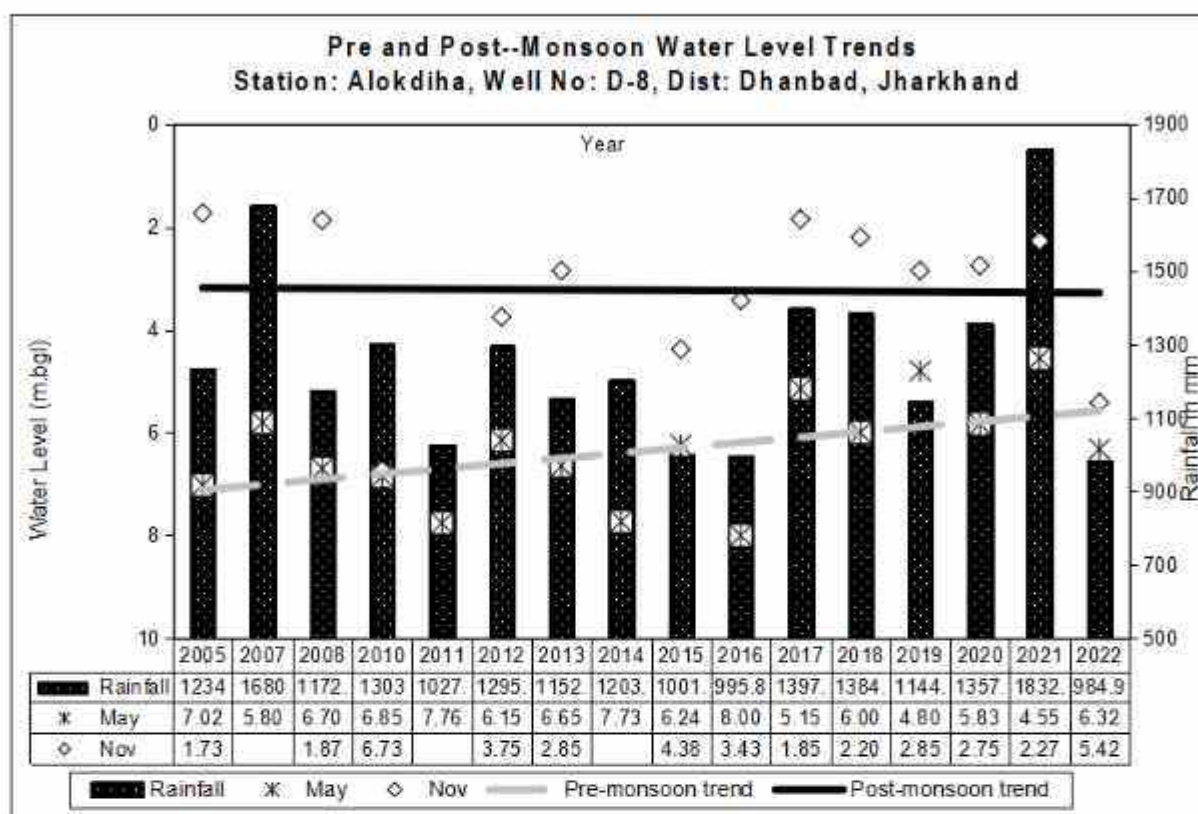
HYDROGRAPHS OF CLUSTER-VI



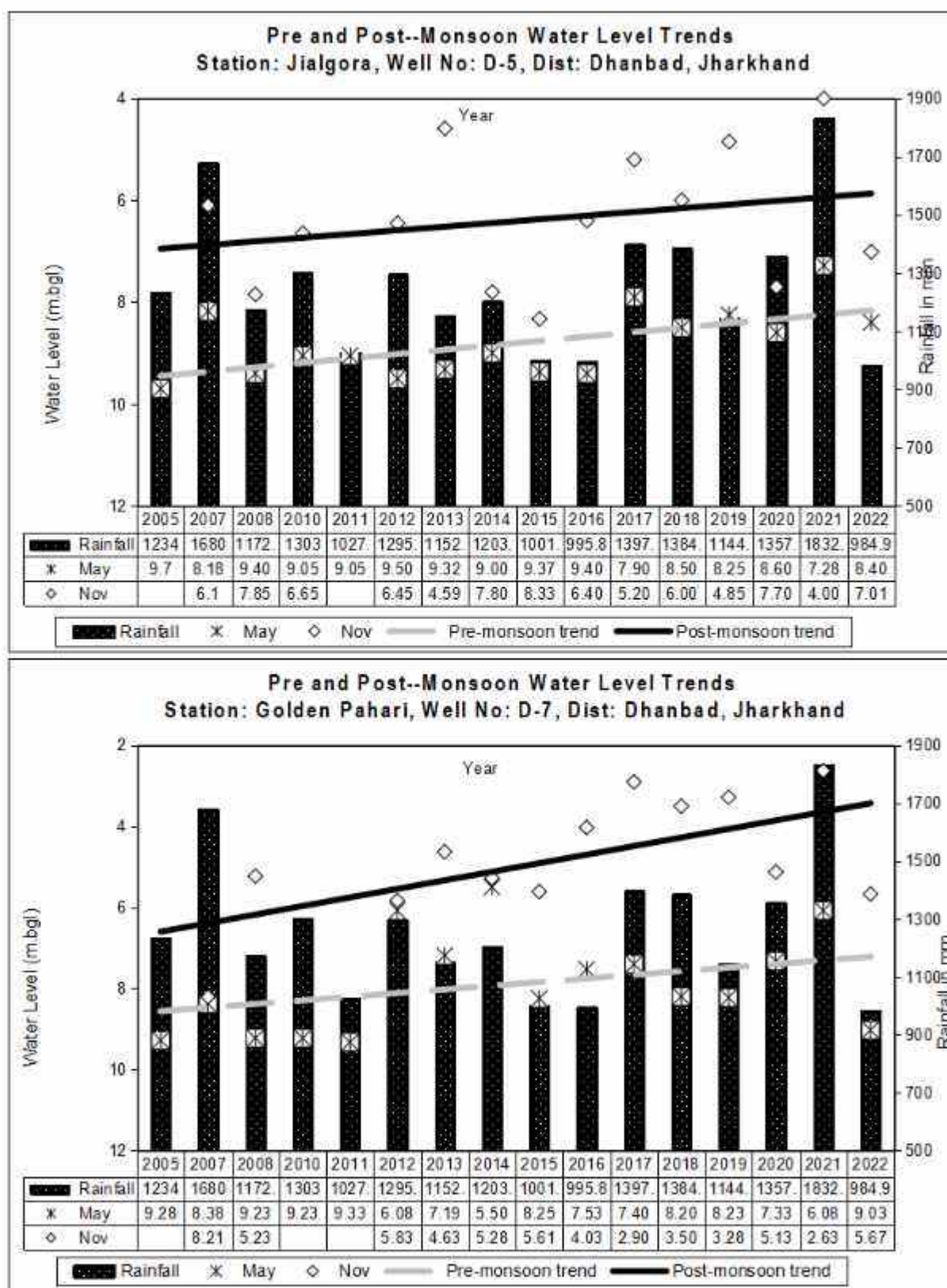
HYDROGRAPHS OF CLUSTER-VII



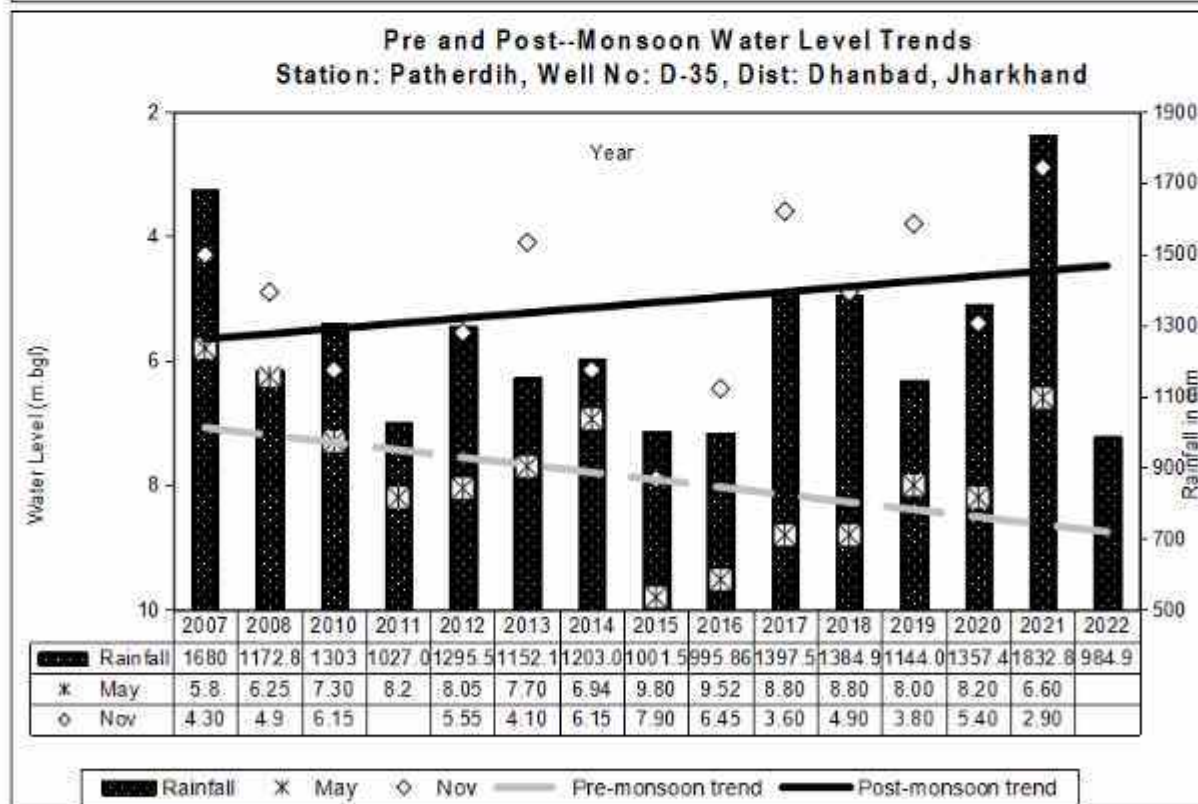
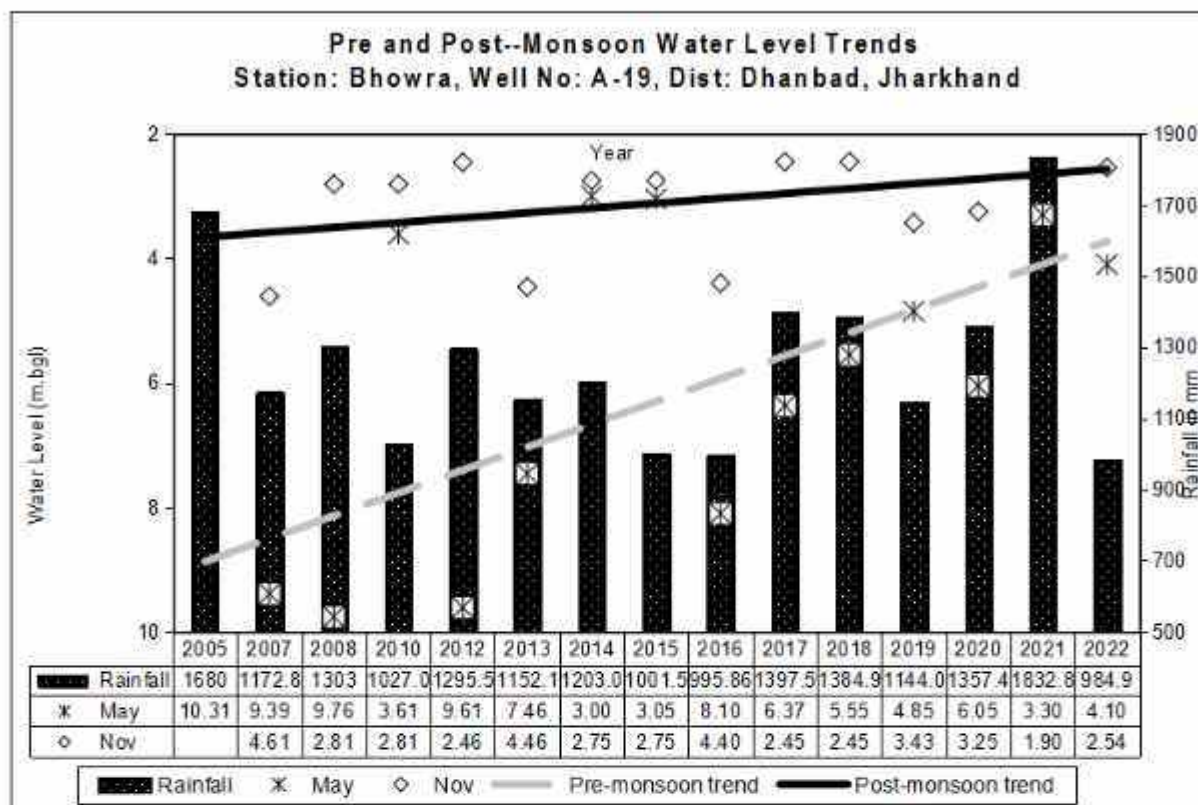
HYDROGRAPHS OF CLUSTER-VIII



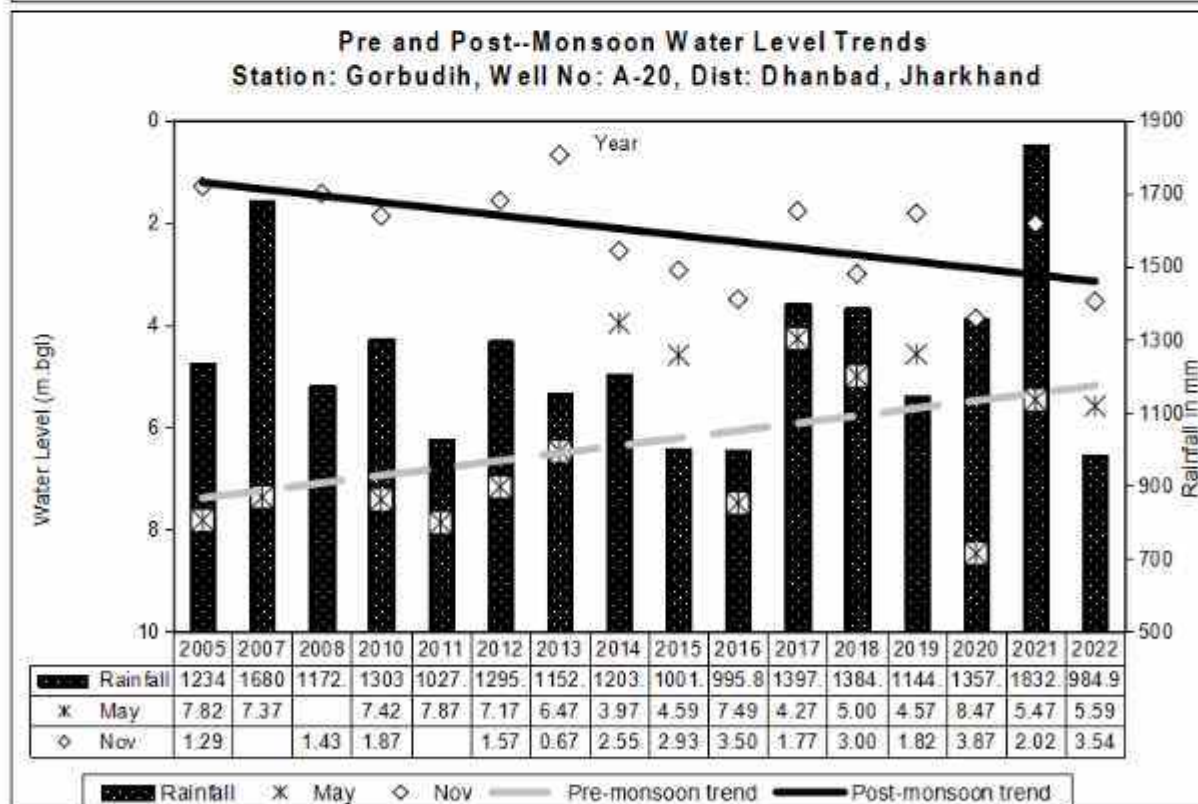
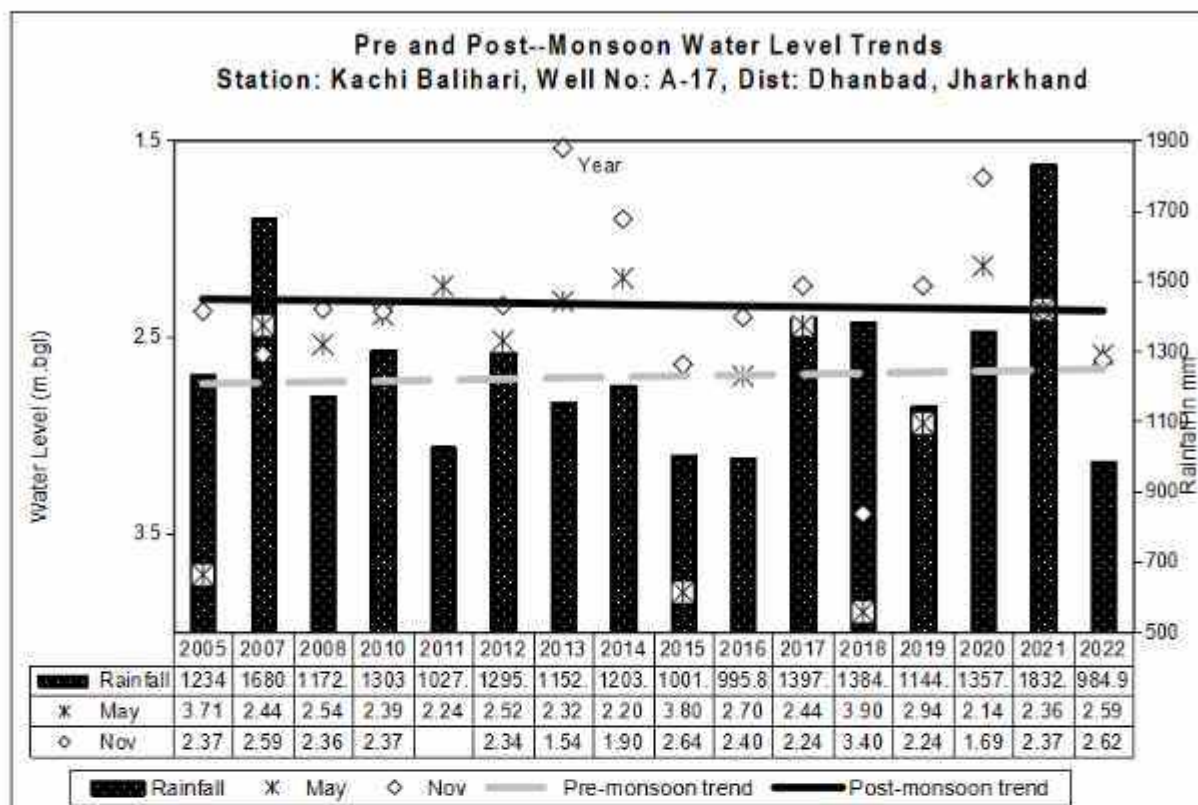
HYDROGRAPHS OF CLUSTER-IX



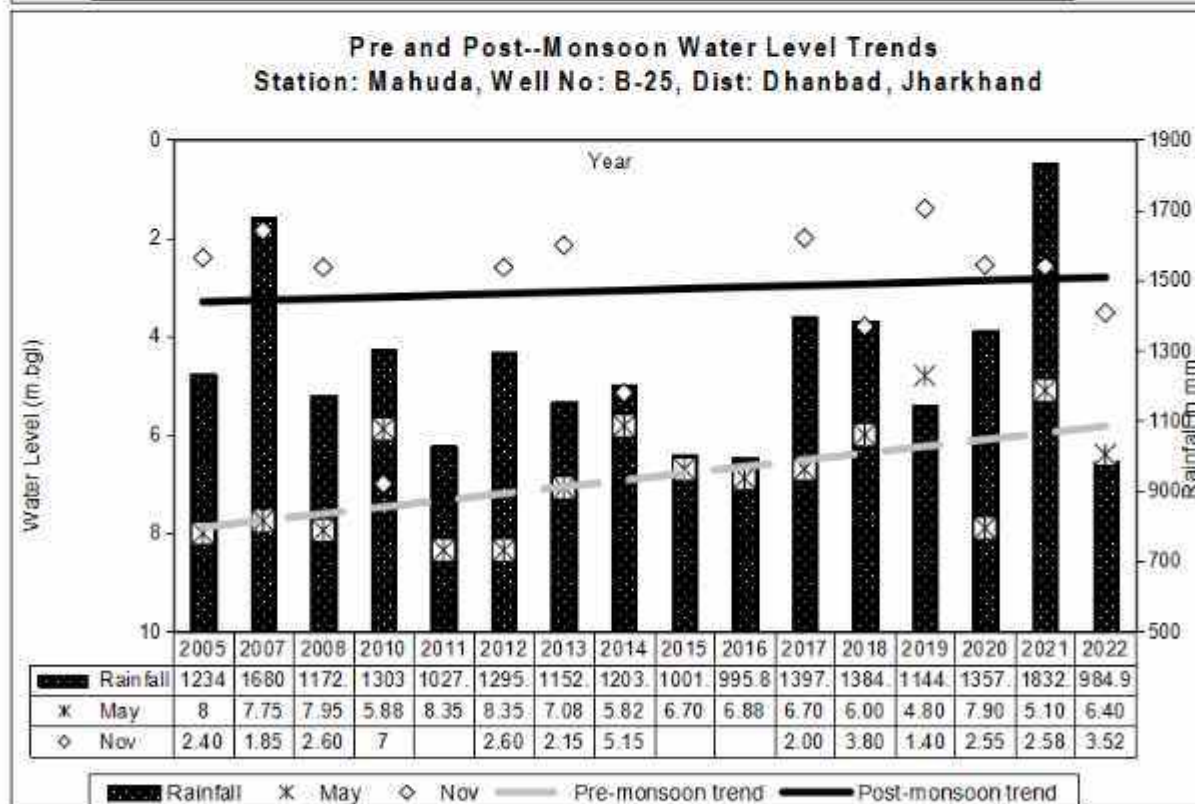
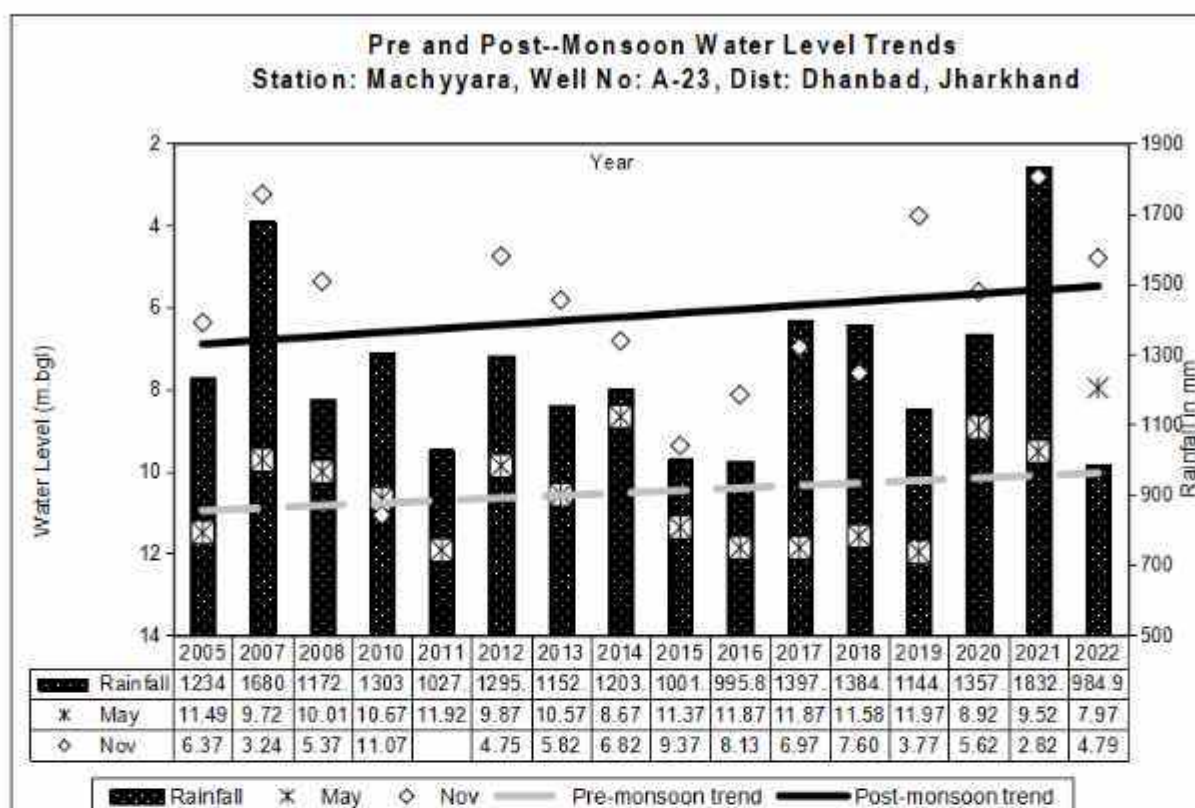
HYDROGRAPHS OF CLUSTER-X



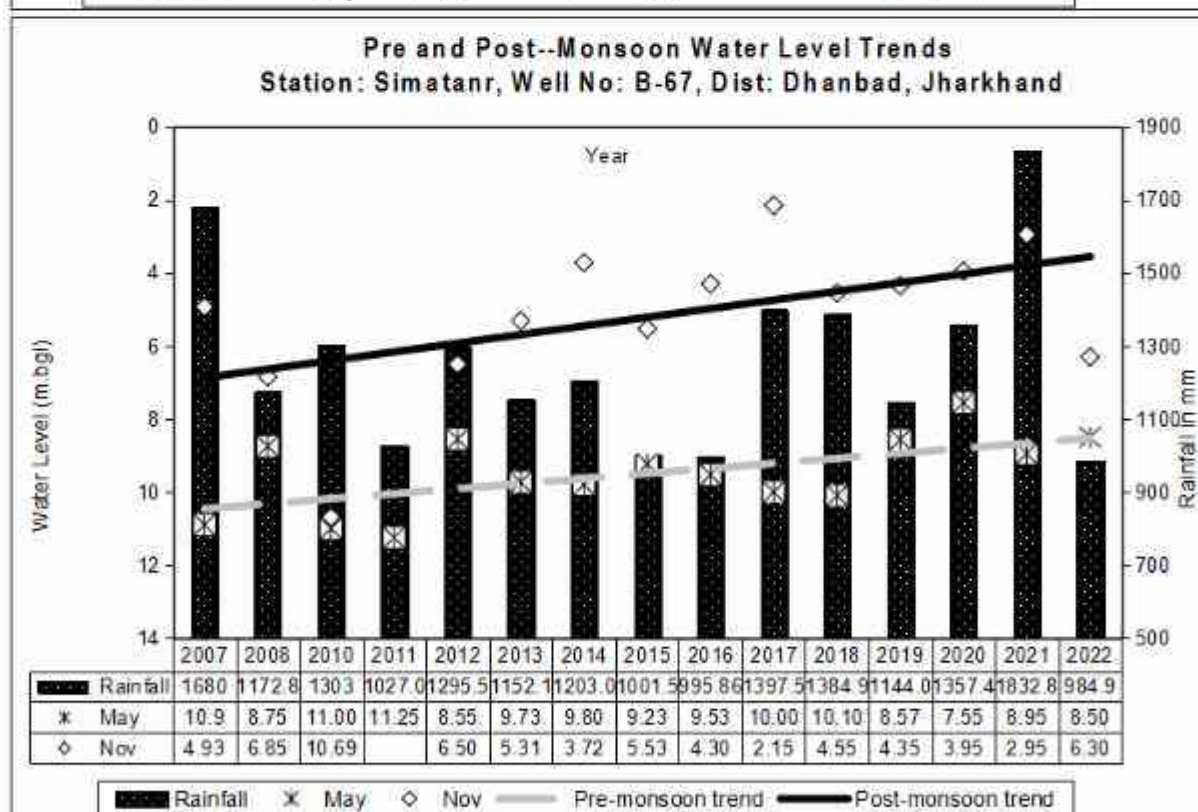
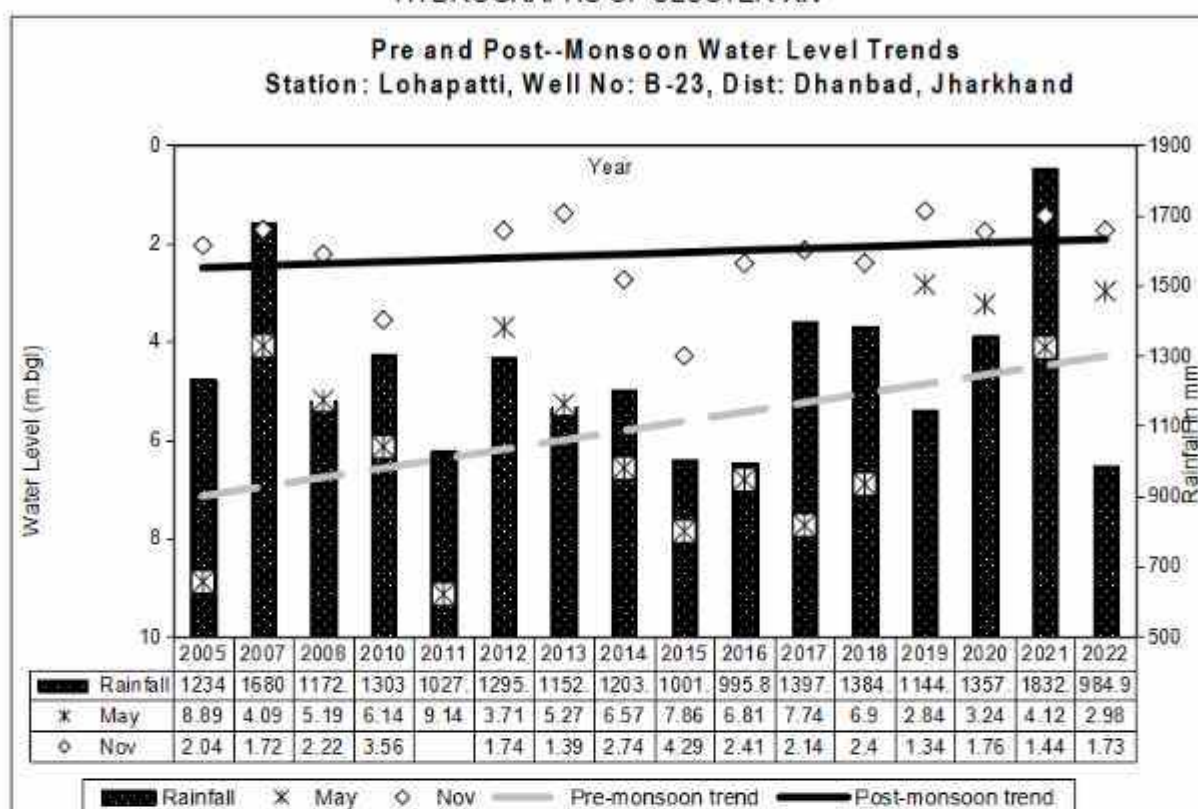
HYDROGRAPHS OF CLUSTER-XI



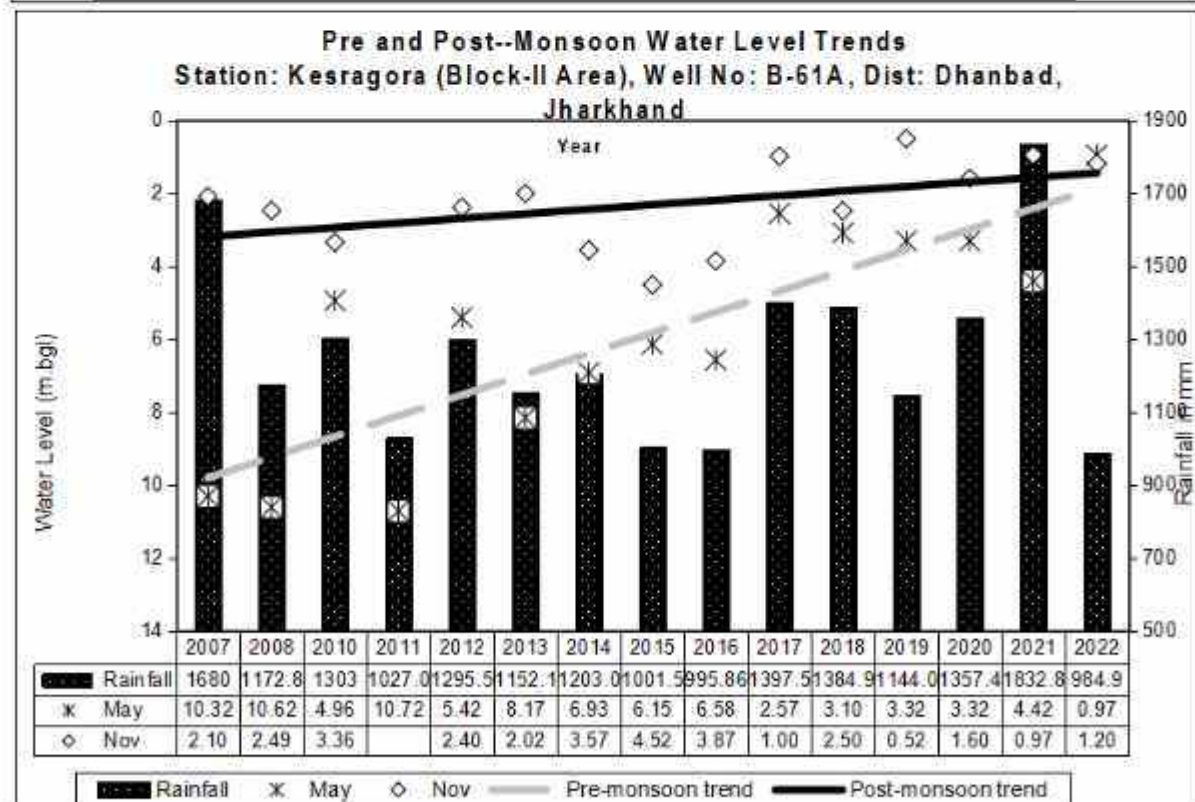
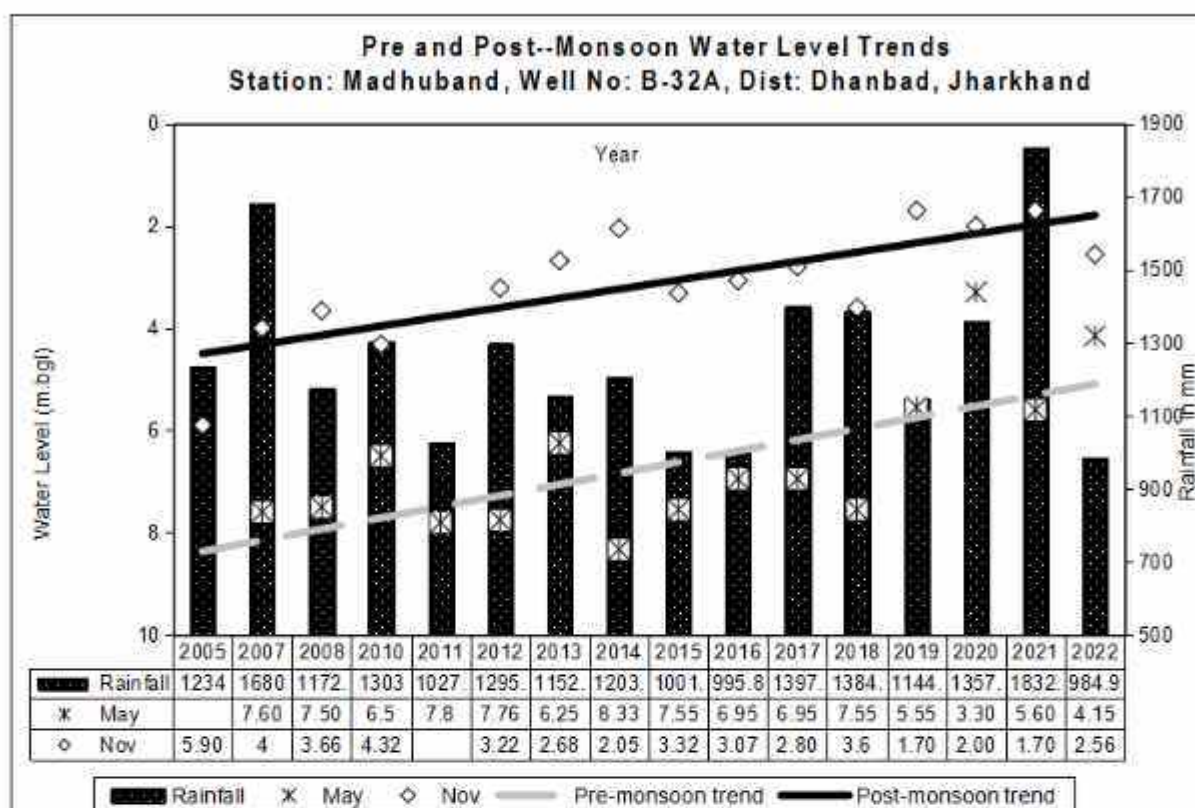
HYDROGRAPHS OF CLUSTER-XIII



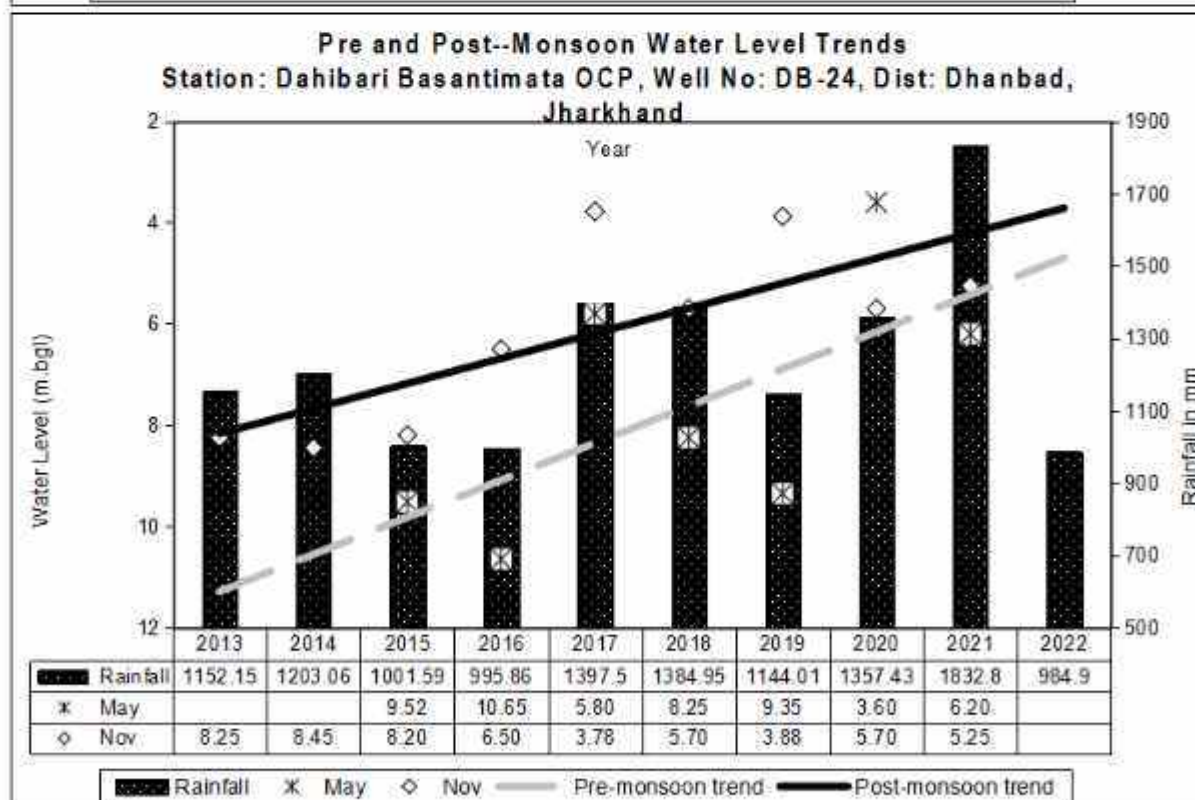
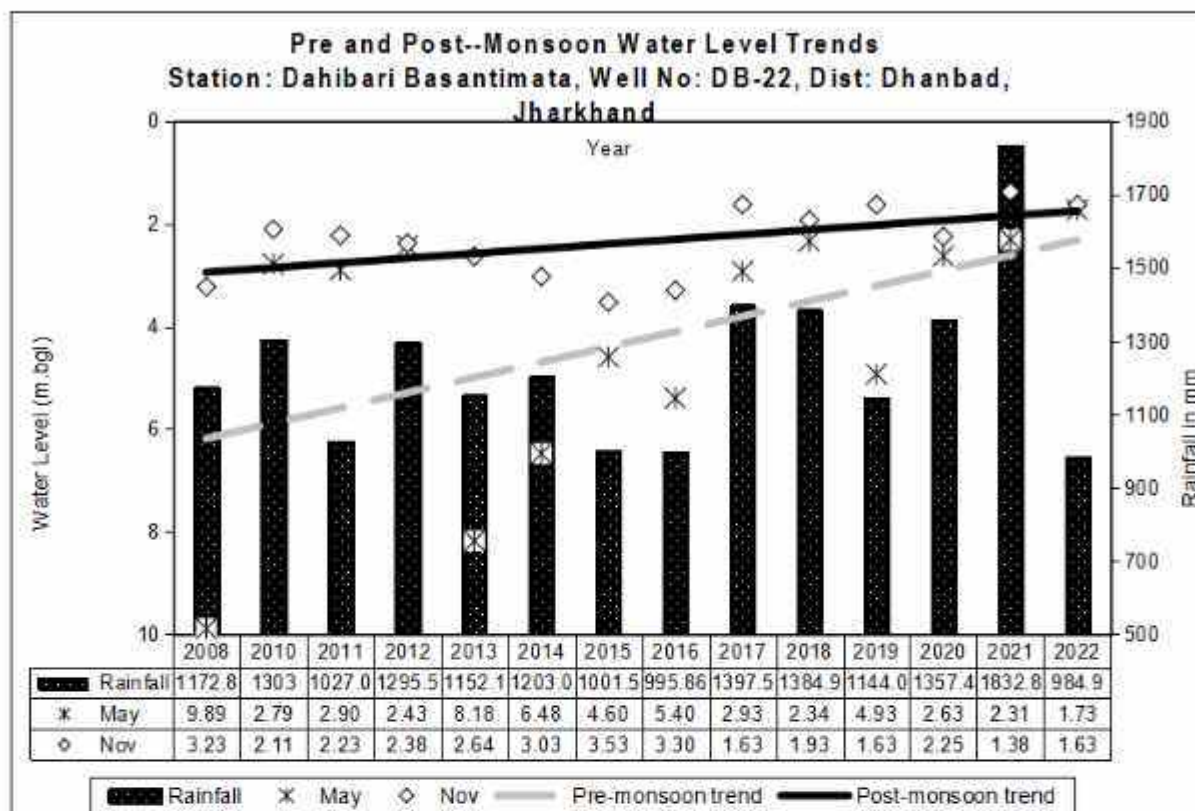
HYDROGRAPHS OF CLUSTER-XIV



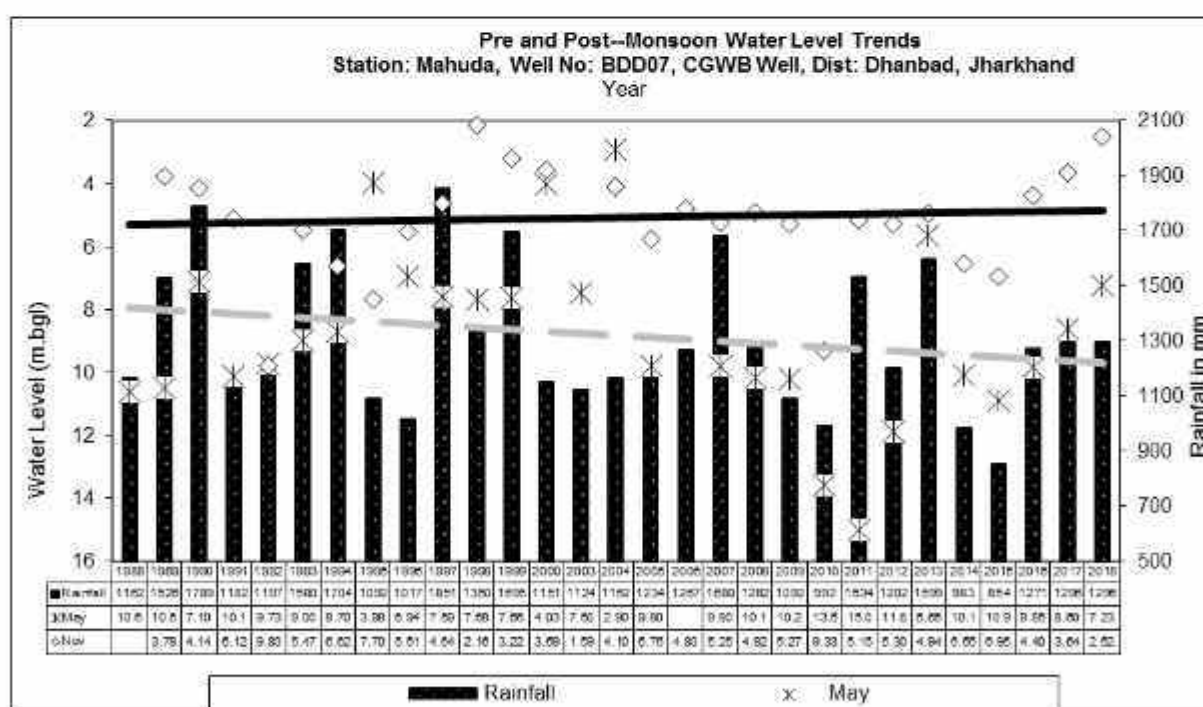
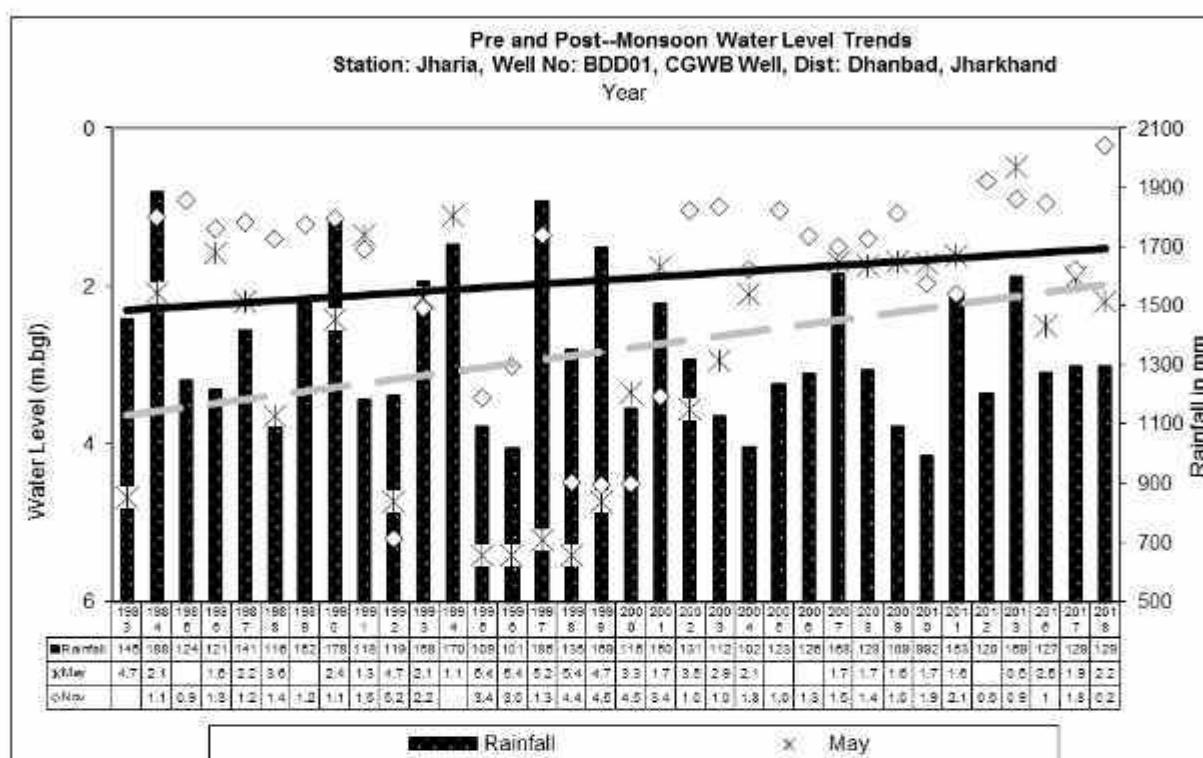
HYDROGRAPHS OF CLUSTER-XV



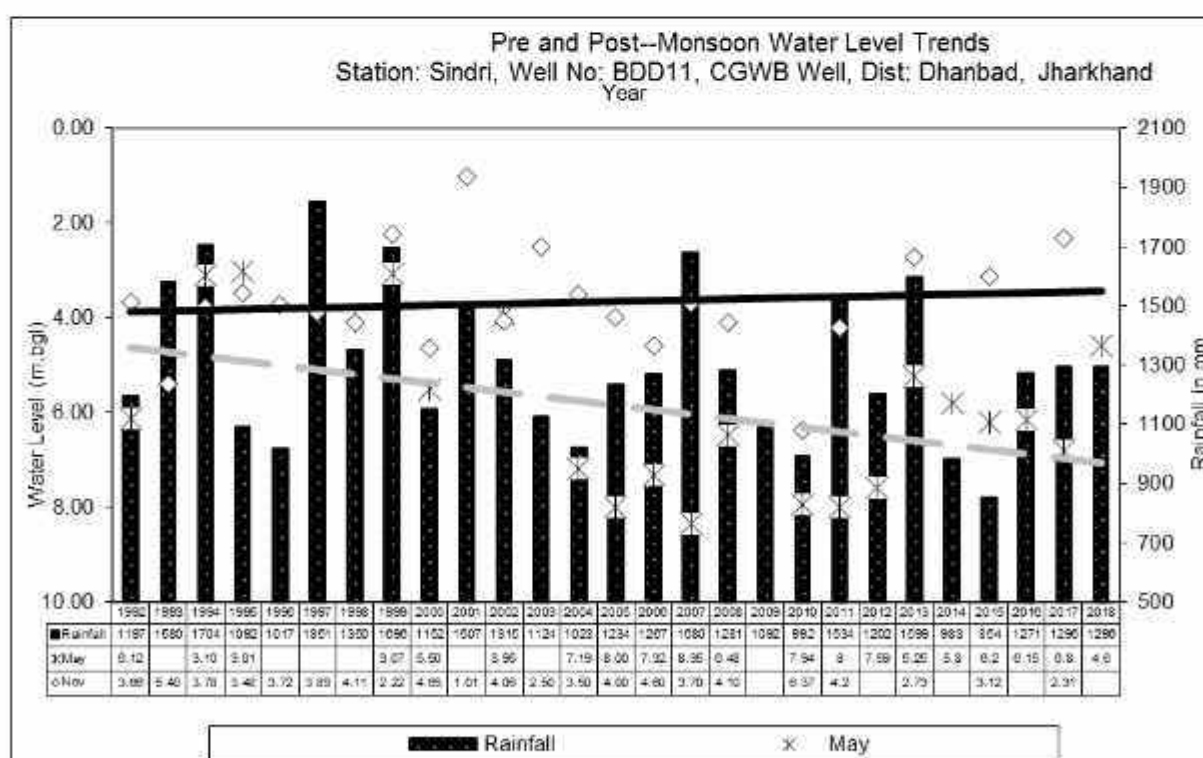
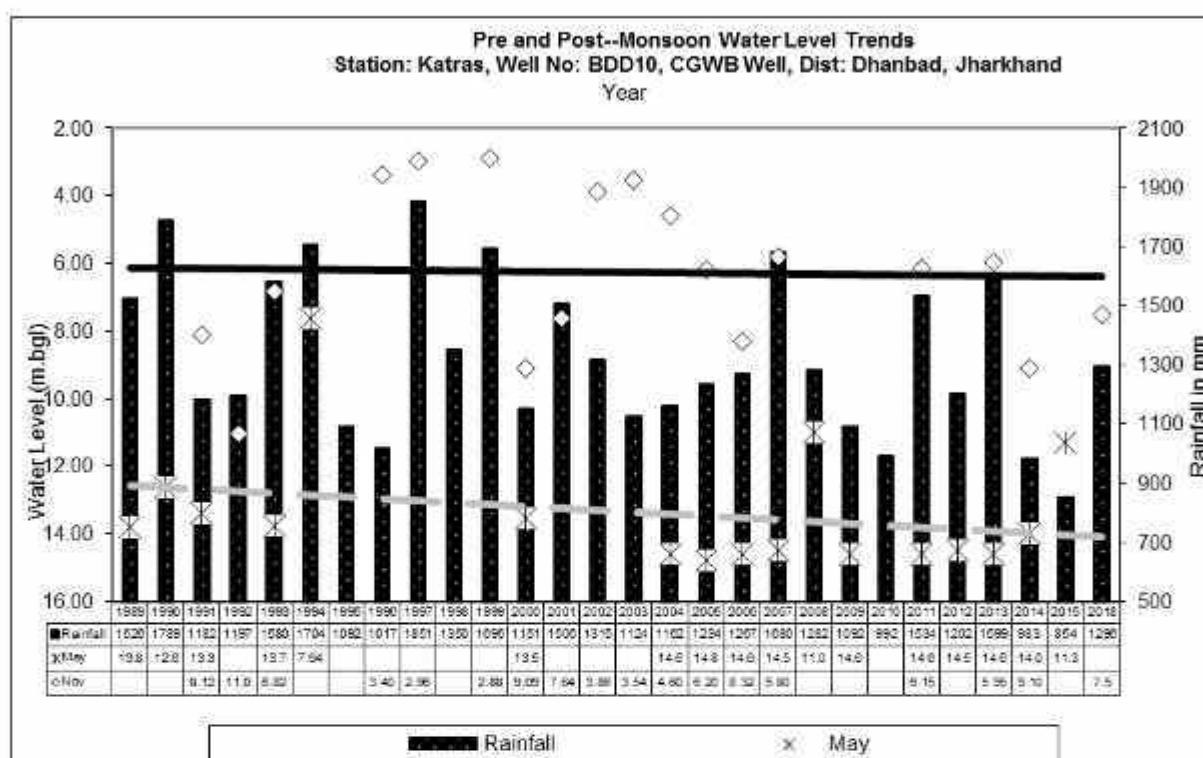
Annexure – VI
HYDROGRAPHS OF CLUSTER-XVI



HYDROGRAPHS OF CGWB PERMANENT OBSERVATION STATIONS



HYDROGRAPHS OF CGWB PERMANENT OBSERVATION STATIONS



GROUNDWATER SAMPLE LOCATION DETAILS

Sampling month: June month of the assessment year of 2021-22

SI No	Name of Cluster	Ground Water Sample	Dug well (CMPDI)	Location	Sampling Date
					May-June'2022
1	CLUSTER-I	GW-1	B-15	BERA VILLAGE	25.05.2022
2	CLUSTER-II	GW-2	B-59	KHODOVALY VILLAGE	25.05.2022
3	CLUSTER-III	GW-3	A-29	GOVINDPUR,AMBAGAN VILLAGE	26.05.2022
4	CLUSTER-IV	GW-4	B-64	KESHALPUR, BATIGHAR	26.05.2022
5	CLUSTER-V	GW-5	D-30	BORKIBOA VILLAGE	26.05.2022
6	CLUSTER-VI	GW-6	D-25	GODHUR MORE	27.05.2022
7	CLUSTER-VII	GW-7	D-80	DHANSAR MINE RESCUE STN.	27.05.2022
8	CLUSTER-VIII	GW-8	D-49	NEAR GHANOODIH OC	27.05.2022
9	CLUSTER-IX	GW-9	D-5	JEALGORA, NEAR P.O.	28.05.2022
10	CLUSTER-X	GW-10	D-35	PATHERDIH RLY. COLONY	28.05.2022
11	CLUSTER-XI	GW-11	A-32	MONNIDIH BAZAR	28.05.2022
12	CLUSTER-XIII	GW-13	A-23	MACHHAYARA	28.05.2022
13	CLUSTER-XIV	GW-14	B-23	LOHAPATTI VILLAGE	28.05.2022
14	CLUSTER-XV	GW-15	B-32A	MADHUBAND VILLAGE	25.05.2022
15	CLUSTER-XVI	GW-16	DB-22	DAHIBARI,NICHE BASTI	17.06.2022

WATER QUALITY (GROUND WATER- ALL PARAMETERS)

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW1 25.05.2022	GW2 25.05.2022	GW3 26.05.2022			
1	Colour, Hazen unit	2	2	1	1	5	APHA, 23 rd Edition, 2120-c-Spectrophotometric Wavelength Method, 2017
2	Calcium, mg/l	38	52	50	2	75	IS 3025, (Part 40): 1991 R-2019, AAS-Flame Method & EDTA Method
3	Chlorides, mg/l	24	28	26	5	250	IS-3025(Part 32):1988, R-2019, Argentometric Method
4	Fluoride, mg/l	0.64	0.72	0.56	0.2	1	APHA, 23 rd Edition, SPADNS Method
5	Iron, mg/l	<0.2	<0.2	<0.2	0.2	1	IS 3025 (Part 53): 2003, R: 2019, AAS-Flame Method
6	Manganese	<0.02	<0.02	<0.02	0.02	0.1	IS 3025 (Part 59): 2006, R: 2019, AAS-Flame Method
7	Nitrate, mg/l	6.64	5.32	10.44	0.5	45	APHA, 23 rd Edition, UV-Spectrophotometric Method
8	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	APHA, 23 rd Edition, 2150-C
9	pH value	8.13	8.07	8.20	0.1	6.5-8.5	IS 3025, Part 11 : 1983 R. 2017 Electrometric (pH Meter) Method
10	Sulphate, mg/l	48	52	42	10	200	APHA -23 rd Edition, 4500 S, Turbidity Method
11	Taste	Acceptable	Acceptable	Acceptable	Qualitative	Acceptable	APHA, 23 rd Edition, 2160-C
12	Total Alkalinity (CaCO ₃), mg/l, Max	108	136	141	4	200	IS 3025, Part 23: 1986 R. 2019 Titration Method
13	Total Dissolved Solids, mg/l	250	262	244	25	500	IS 3025, Part 16: 1984 R. 2017 Gravimetric method
14	Total Hardness, mg/l	206	215	204	4	200	IS 3025, (Part 21): 2019 EDTA Method
15	Turbidity, NTU	1	1	1	0.1	1	IS 3025, (Part 10):1984, R-2017 Nephelometric/Turbidimetric Method
16	Zinc, mg/l	<0.1	<0.1	<0.1	0.1	5	IS 3025(Part 49) : 1994,R-2019, AAS-Flame Method
17	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.2	0.5	APHA, 23 rd Edition, Carmine
18	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.01	0.05	IS 3025 Part 42 : 1992 R: 2019, AAS-Flame APHA, 23 rd Edition, AAS-GTA
19	Free Residual Chlorine, mg/l, Min	<0.04	<0.04	<0.04	0.04	0.2	APHA, 23 rd Edition, 4500-Cl- E, (Iodometric Method-I)
20	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	IS-3025(Part 47):1994 (Reaffirmed 2019) APHA, 23 rd Edition, AAS-GTA
21	Phenolic compounds (as C ₆ H ₅ OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.002	APHA, 22 nd Edition, 4-Amino Antipyrine
22	Selenium, mg/l, Max	<0.007	<0.007	<0.007	0.007	0.01	APHA 23 rd Edition IS-3025, part 56:2003, R-2019/, AAS-VGA
23	Total Arsenic (as As), mg/l, Max	<0.006	<0.006	<0.006	0.006	0.01	IS-3025, part 37:1988, R-2019/ APHA 23 rd Edition AAS-VGA
24	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.01	0.05	IS-3025 Part 52:2003, R-2019, AAS-Flame APHA, 23 rd Edition, AAS-GTA
25	Nickel as Ni, mg/l Max	<0.01	<0.01	<0.01	0.005	0.02	IS 3025 Part 54 : 2003,R: 2019, AAS-Flame APHA, 23 rd Edition, AAS-GTA

WATER QUALITY

(GROUND WATER- ALL PARAMETERS)

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW4 26.05.2022	GW5 26.05.2022	GW6 27.05.2022			
1	Colour, Hazen unit	4	1	2	1	5	APHA, 23 rd Edition, 2120-c Spectrophotometric Single Wavelength Method, 2017
2	Calcium, mg/l	38	152	60	2	75	IS 3025, (Part 40): 1991 R.2019, AAS-Flame Method & EDTA Method
3	Chlorides, mg/l	22	92	36	5	250	IS-3025(Part 32)-1988, R-2019, Argentometric Method
4	Fluoride, mg/l	0.61	0.66	0.77	0.2	1	APHA, 23 rd Edition, SPADNS Method
5	Iron, mg/l	<0.2	<0.2	<0.2	0.2	1	IS 3025 (Part 53) : 2003, R : 2019, AAS-Flame Method
6	Manganese	<0.02	<0.02	<0.02	0.02	0.1	IS 3025 (Part 59) : 2006, R : 2019, AAS-Flame Method
7	Nitrate, mg/l	12.21	34.06	15.26	0.5	45	APHA, 23 rd Edition, UV-Spectrophotometric Method
8	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	APHA, 23 rd Edition, 2150-C
9	pH value	7.82	8.06	7.84	0.1	6.5-8.5	IS 3025, Part 11 : 1983 R 2017 Electrometric (pH Meter) Method
10	Sulphate, mg/l	42	134	58	10	200	APHA -23 rd Edition, 4500 S, Turbidity Method
11	Taste	Acceptable	Acceptable	Acceptable	Qualitative	Acceptable	APHA, 23 rd Edition, 2160-C
12	Total Alkalinity (C _{CO3}), mg/l, Max	114	92	110	4	200	IS 3025, Part 23: 1986 R 2019 Titration Method
13	Total Dissolved Solids, mg/l	204	750	246	25	500	IS 3025, Part 16: 1984 R 2017 Gravimetric method
14	Total Hardness, mg/l	162	666	220	4	200	IS 3025, (Part 21): 2019 EDTA Method
15	Turbidity, NTU	3	1	1	0.1	1	IS 3025, (Part 10):1984, R-2017 Nephelometric/Turbidimetric Method
16	Zinc, mg/l	<0.1	<0.1	<0.1	0.1	5	IS 3025(Part 49) : 1994 R.2019, AAS-Flame Method
17	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.2	0.5	APHA, 23 rd Edition, Carmine
18	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.01	0.05	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 23 rd Edition, AAS-GTA
19	Free Residual Chlorine, mg/l, Min	<0.04	<0.04	<0.04	0.04	0.2	APHA, 23 rd Edition, 4500-Cl ₂ B, (Iodometric Method-I)
20	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 23 rd Edition, AAS-GTA
21	Phenolic compounds (as C ₆ H ₅ OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.002	APHA, 22 nd Edition, 4-Amino Antipyrine
22	Selenium, mg/l, Max	<0.007	<0.007	<0.007	0.007	0.01	APHA 23 rd Edition IS-3025, part 56:2003, R-2019/, AAS-VGA
23	Total Arsenic (as As), mg/l, Max	<0.006	<0.006	<0.006	0.006	0.01	IS-3025, part 37:1988, R-2019/ APHA 23 rd Edition AAS-VGA
24	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.01	0.05	IS-3025 Part 52:2003, R-2019, AAS-Flame APHA, 23 rd Edition, AAS-GTA
25	Nickel as Ni, mg/l Max	<0.01	<0.01	<0.01	0.005	0.02	IS 3025 Part 54 : 2003, R : 2019, AAS-Flame APHA, 23 rd Edition, AAS-GTA

WATER QUALITY

(GROUND WATER- ALL PARAMETERS)

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW7 27.05.2022	GW8 27.05.2022	GW9 28.05.2022			
1	Colour, Hazen unit	3	2	1	1	5	APHA, 23rd Edition, 2120-c Spectrophotometric Single Wavelength Method, 2017
2	Calcium, mg/l	56	58	132	2	75	IS 3025, (Part 40): 1991 R, 2019, AAS-Flame Method & EDTA Method
3	Chlorides, mg/l	32	28	62	5	250	IS-3025(Part 32):1988, R-2019, Argentometric Method
4	Fluoride, mg/l	0.54	0.81	0.63	0.2	1	APHA, 23rd Edition, SPADNS Method
5	Iron, mg/l	<0.2	<0.2	<0.2	0.2	1	IS 3025 (Part 53): 2003, R: 2019, AAS-Flame Method
6	Manganese	<0.02	<0.02	<0.02	0.02	0.1	IS 3025 (Part 59): 2006, R: 2019, AAS-Flame Method
7	Nitrate, mg/l	15.64	8.32	28.44	0.5	45	APHA, 23rd Edition, UV-Spectrophotometric Method
8	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	APHA, 23rd Edition, 2150-C
9	pH value	7.92	8.06	8.21	0.1	6.5-8.5	IS 3025, Part 11: 1983 R 2017 Electrometric (pH Meter) Method
10	Sulphate, mg/l	66	42	164	10	200	APHA -23rd Edition, 4500 S, Turbidity Method
11	Taste	Acceptable	Acceptable	Acceptable	Qualitative	Acceptable	APHA, 23rd Edition, 2160-C
12	Total Alkalinity (CaCO ₃), mg/l, Max	82	126	92	4	200	IS 3025, Part 23: 1986 R 2019 Titration Method
13	Total Dissolved Solids, mg/l	262	198	764	25	500	IS 3025, Part 16: 1984 R 2017 Gravimetric method
14	Total Hardness, mg/l	176	152	648	4	200	IS 3025, (Part 21): 2019 EDTA Method
15	Turbidity, NTU	2	1	2	0.1	1	IS 3025, (Part 10):1984, R-2017 Nephelometric/Turbidimetric Method
16	Zinc, mg/l	<0.1	<0.1	<0.1	0.1	5	IS 3025(Part 49): 1994 R, 2019, AAS-Flame Method
17	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.2	0.5	APHA, 23rd Edition, Carmine
18	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.01	0.05	IS 3025 Part 42: 1992 R: 2019, AAS-Flame APHA, 23rd Edition, AAS-GTA
19	Free Residual Chlorine, mg/l, Min	<0.04	<0.04	<0.04	0.04	0.2	APHA, 23rd Edition, 4500-Cl ₂ B, (Iodometric Method-I)
20	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	IS-3025(Part 47):1994 (Reaffirmed 2019) APHA, 23rd Edition, AAS-GTA
21	Phenolic compounds (as C ₆ H ₅ OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.002	APHA, 22nd Edition, 4-Amino Antipyrine
22	Selenium, mg/l, Max	<0.007	<0.007	<0.007	0.007	0.01	APHA 23rd Edition IS-3025, part 56:2003, R-2019/, AAS-VGA
23	Total Arsenic (as As), mg/l, Max	<0.006	<0.006	<0.006	0.006	0.01	IS-3025, part 37:1988, R-2019/ APHA 23rd Edition AAS-VGA
24	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.01	0.05	IS-3025 Part 52:2003, R:2019, AAS-Flame APHA, 23rd Edition, AAS-GTA
25	Nickel as Ni, mg/l Max	<0.01	<0.01	<0.01	0.005	0.02	IS 3025 Part 54: 2003, R: 2019, AAS-Flame APHA, 23rd Edition, AAS-GTA

WATER QUALITY

(GROUND WATER- ALL PARAMETERS)

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW10 28.05.2022	GW11 28.05.2022	GW13 28.05.2022			
1	Colour, Hazen unit	3	1	1	1	5	APHA, 23rd Edition, 2120-c Spectrophotometric Single Wavelength Method, 2017
2	Calcium, mg/l	48	38	172	2	75	IS 3025, (Part 40): 1991 R.2019,AAS-Flame Method & EDTA Method
3	Chlorides, mg/l	40	28	106	5	250	IS-3025(Part 32):1988, R-2019 , Argentometric Method
4	Fluoride, mg/l	0.72	0.61	0.72	0.2	1	APHA, 23rd Edition, SPADNS Method
5	Iron, mg/l	<0.2	<0.2	<0.2	0.2	1	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method
6	Manganese	<0.02	<0.02	<0.02	0.02	0.1	IS 3025 (Part 59) : 2006, R : 2019 , AAS-Flame Method
7	Nitrate , mg/l	18.92	12.03	7.77	0.5	45	APHA, 23rd Edition, UV-Spectrophotometric Method
8	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	APHA, 23rd Edition, , 2150-C
9	pH value	8.02	7.98	8.02	0.1	6.5-8.5	IS 3025, Part 11 : 1983 R 2017 Electrometric (pH Meter) Method
10	Sulphate, mg/l	82	46	178	10	200	APHA -23rd Edition, 4500 S , Turbidity Method
11	Taste	Acceptable	Acceptable	Acceptable	Qualitative	Acceptable	APHA,23rd Edition, 2160-C
12	Total Alkalinity (as CO ₃), mg/l, Max	102	142	94	4	200	IS 3025, Part 23: 1986 R 2019 Titration Method
13	Total Dissolved Solids, mg/l	264	194	764	25	500	IS 3025, Part 16: 1984 R 2017 Gravimetric method
14	Total Hardness, mg/l	188	154	656	4	200	IS 3025, (Part 21): 2019 EDTA Method
15	Turbidity, NTU	3	3	1	0.1	1	IS 3025, (Part 10):1984, R-2017 Nephelometric/Turbidimetric Method
16	Zinc, mg/l	<0.1	<0.1	<0.1	0.1	5	IS 3025(Part 49) : 1994,R-2019, AAS-Flame Method
17	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.2	0.5	APHA, 23rd Edition, Carmine
18	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.01	0.05	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 23rd Edition, AAS-GTA
19	Free Residual Chlorine, mg/l, Min	<0.04	<0.04	<0.04	0.04	0.2	APHA, 23rd Edition, 4500-Cl- B, (Iodometric Method-I)
20	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	IS-3025(Part 47):1994 (Reaffirmed 2019) APHA, 23rd Edition, AAS-GTA
21	Phenolic compounds (as C ₆ H ₅ OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.002	APHA, 22nd Edition, 4-Amino Antipyrine
22	Selenium, mg/l, Max	<0.007	<0.007	<0.007	0.007	0.01	APHA 23rd Edition IS-3025, part 56:2003, R-2019/, AAS-VGA
23	Total Arsenic (as As), mg/l, Max	<0.006	<0.006	<0.006	0.006	0.01	IS-3025, part 37:1988, R-2019/ APHA 23rd Edition AAS-VGA
24	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.01	0.05	IS-3025 Part 52:2003, R-2019,AAS-Flame APHA, 23rd Edition, AAS-GTA
25	Nickel as Ni, mg/l Max	<0.01	<0.01	<0.01	0.005	0.02	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 23rd Edition, AAS-GTA

WATER QUALITY **(GROUND WATER- ALL PARAMETERS)**

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		GW14 28.05.2022	GW15 25.05.2022	GW16 17.06.2022			
1	Colour, Hazen unit	2	2	2	1	5	APHA, 23 rd Edition, 2120-c Spectrophotometric Single Wavelength Method, 2017
2	Calcium, mg/l	40	172	103	2	75	IS 3025, (Part 40): 1991 R, 2019, AAS-Flame Method & EDTA Method
3	Chlorides, mg/l	54	102	54	5	250	IS-3025(Part 32)-1988, R-2019, Argentometric Method
4	Fluoride, mg/l	0.56	0.41	0.61	0.2	1	APHA, 23 rd Edition, SPADNS Method
5	Iron, mg/l	<0.2	<0.2	<0.2	0.2	1	IS 3025 (Part 53): 2003, R: 2019, AAS-Flame Method
6	Manganese	<0.02	<0.02	<0.02	0.02	0.1	IS 3025 (Part 59): 2006, R: 2019, AAS-Flame Method
7	Nitrate, mg/l	8.03	7.85	14.61	0.5	45	APHA, 23 rd Edition, UV-Spectrophotometric Method
8	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	APHA, 23 rd Edition, 2150-C
9	pH value	8.12	8.11	7.92	0.1	6.5-8.5	IS 3025, Part 11: 1983 R 2017 Electrometric (pH Meter) Method
10	Sulphate, mg/l	48	144	132	10	200	APHA -23 rd Edition, 4500 S, Turbidity Method
11	Taste	Acceptable	Acceptable	Acceptable	Qualitative	Acceptable	APHA, 23 rd Edition, 2160-C
12	Total Alkalinity (c,co ₂), mg/l, Max	92	122	110	4	200	IS 3025, Part 23: 1986 R 2019 Titration Method
13	Total Dissolved Solids, mg/l	296	752	520	25	500	IS 3025, Part 16: 1984 R 2017 Gravimetric method
14	Total Hardness, mg/l	218	613	440	4	200	IS 3025, (Part 21): 2019 EDTA Method
15	Turbidity, NTU	1	2	1	0.1	1	IS 3025, (Part 10):1984, R-2017 Nephelometric/Turbidimetric Method
16	Zinc, mg/l	<0.1	<0.1	<0.1	0.1	5	IS 3025(Part 49): 1994, R-2019, AAS-Flame Method
17	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.2	0.5	APHA, 23 rd Edition, Carmine
18	Copper (as Cu), mg/l, Max	<0.03	<0.03	<0.03	0.01	0.05	IS 3025 Part 42: 1992 R: 2019, AAS-Flame APHA, 23 rd Edition, AAS-GTA
19	Free Residual Chlorine, mg/l, Min	<0.04	<0.04	<0.04	0.04	0.2	APHA, 23 rd Edition, 4500-Cl- B, (Iodometric Method-I)
20	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 23 rd Edition, AAS-GTA
21	Phenolic compounds (as C ₆ H ₅ OH), mg/l, Max	<0.001	<0.001	<0.001	0.001	0.002	APHA, 22 nd Edition, 4-Amino Antipyrine
22	Selenium, mg/l, Max	<0.007	<0.007	<0.007	0.007	0.01	APHA 23 rd Edition IS-3025, part 56:2003, R-2019/, AAS-VGA
23	Total Arsenic (as As), mg/l, Max	<0.006	<0.006	<0.006	0.006	0.01	IS-3025, part 37:1988, R-2019/ APHA 23 rd Edition AAS-VGA
24	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.01	0.05	IS-3025 Part 52:2003, R:2019, AAS-Flame APHA, 23 rd Edition, AAS-GTA
25	Nickel as Ni, mg/l Max	<0.01	<0.01	<0.01	0.005	0.02	IS 3025 Part 54: 2003, R: 2019, AAS-Flame APHA, 23 rd Edition, AAS-GTA

Abbreviations

Abn.: Abandoned

AMSL: Above mean sea level

Avg.: Average

APT: Aquifer Pumping Test

BCCL: Bharat Coking Coal Ltd.

bgl: Below Ground Level

Buffer zone: periphery of the 10 km radius from the project boundary

Core zone: Project / mine / colliery boundary (leasehold area)

CMPDI: Central Mine Plan & Design Institute

DVC: Damodar Valley Corporation

DTW: Depth to water level

GW: Groundwater

IMD: Indian Meteorological Division

JCF: Jharia Coalfield

RCF: Raniganj Coalfield

MADA: Mineral Area Development Authority

MCM: Million Cubic Meter

MGD: Million Gallon per day

NTU: Nephelometric Turbidity unit

OC / UG: Opencast / Underground

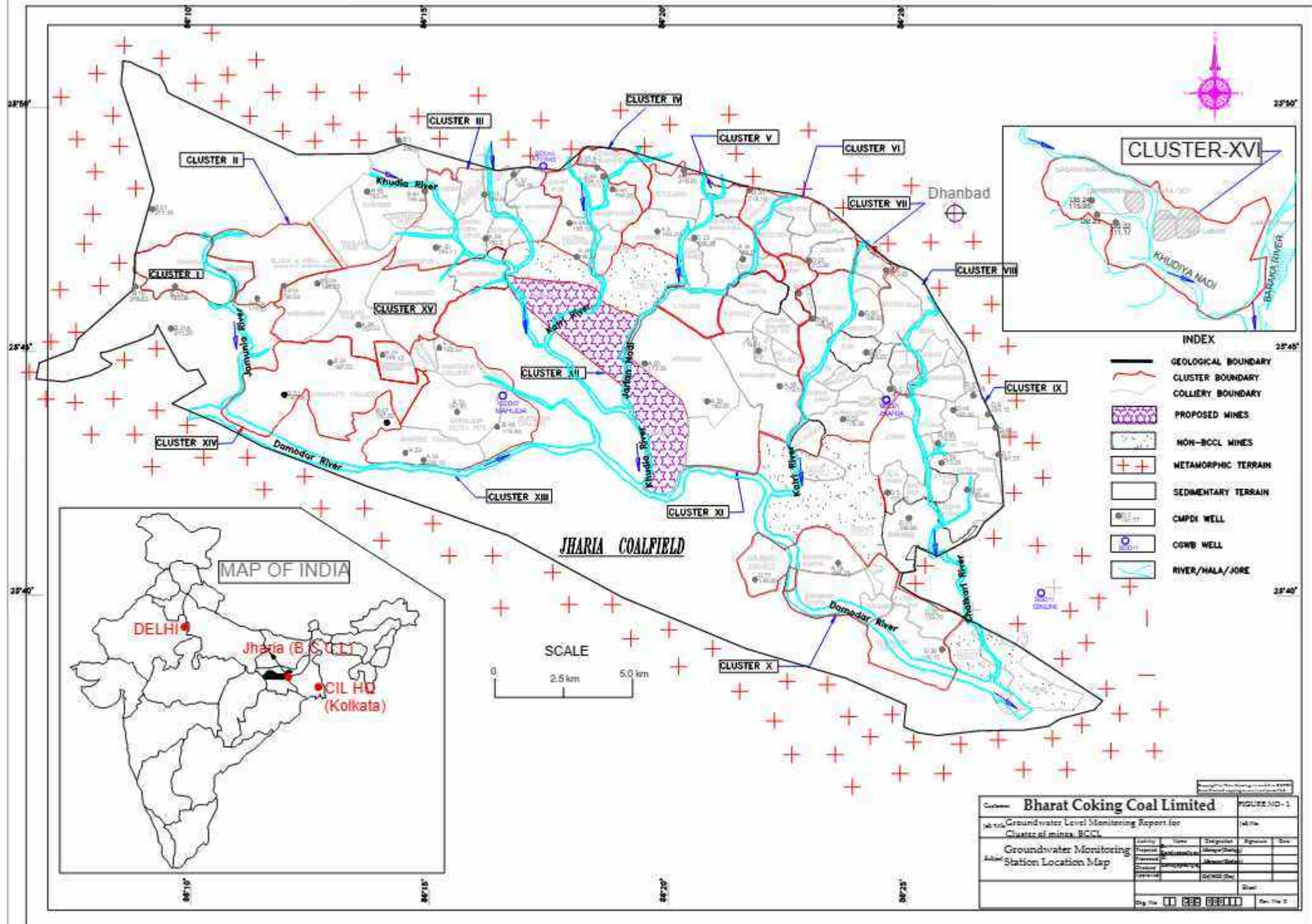
OCP / UGP: Opencast Project / Underground Project

RL: Reduced Level

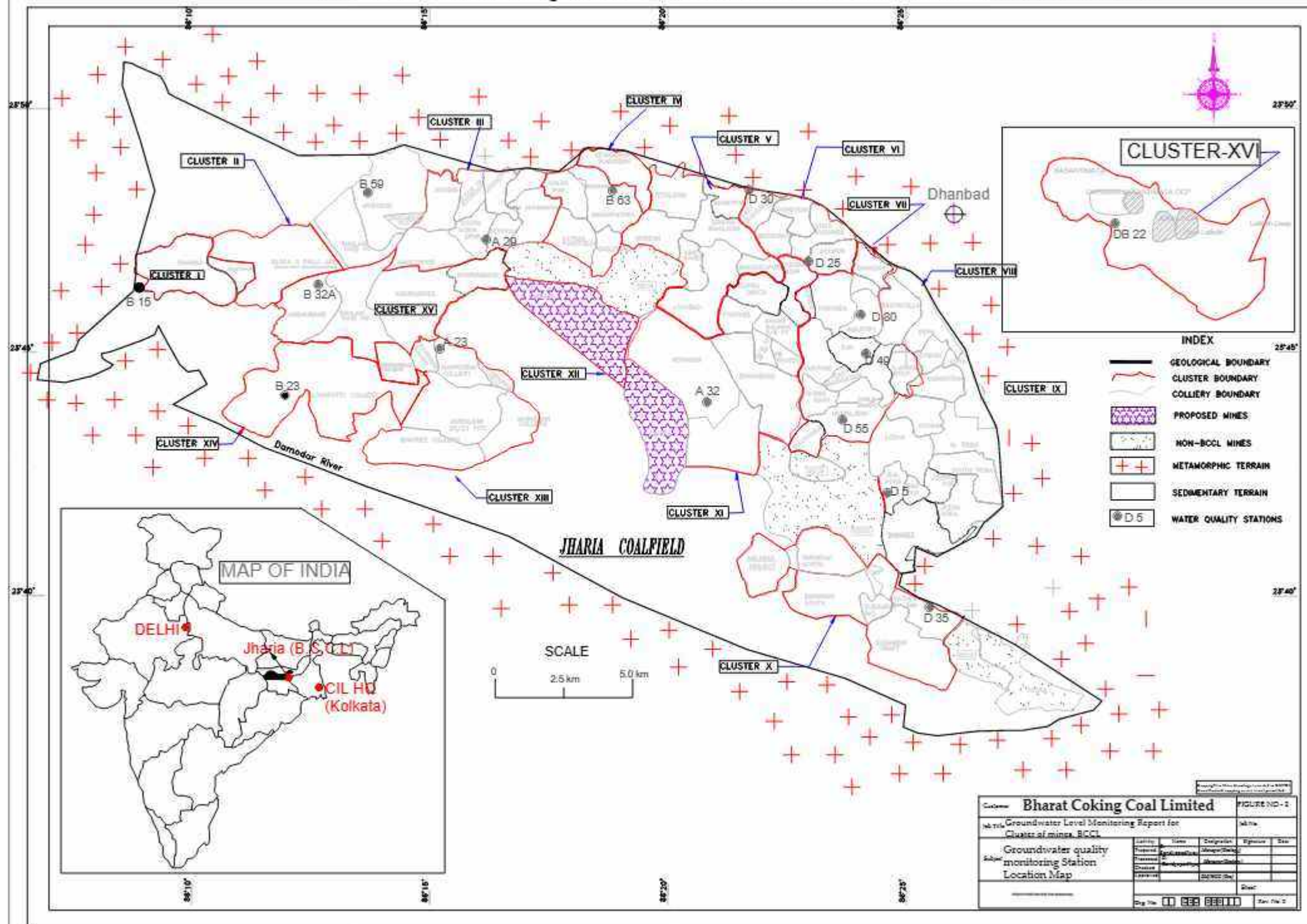
RWH: Rainwater Harvesting

FF: Fire Fighting

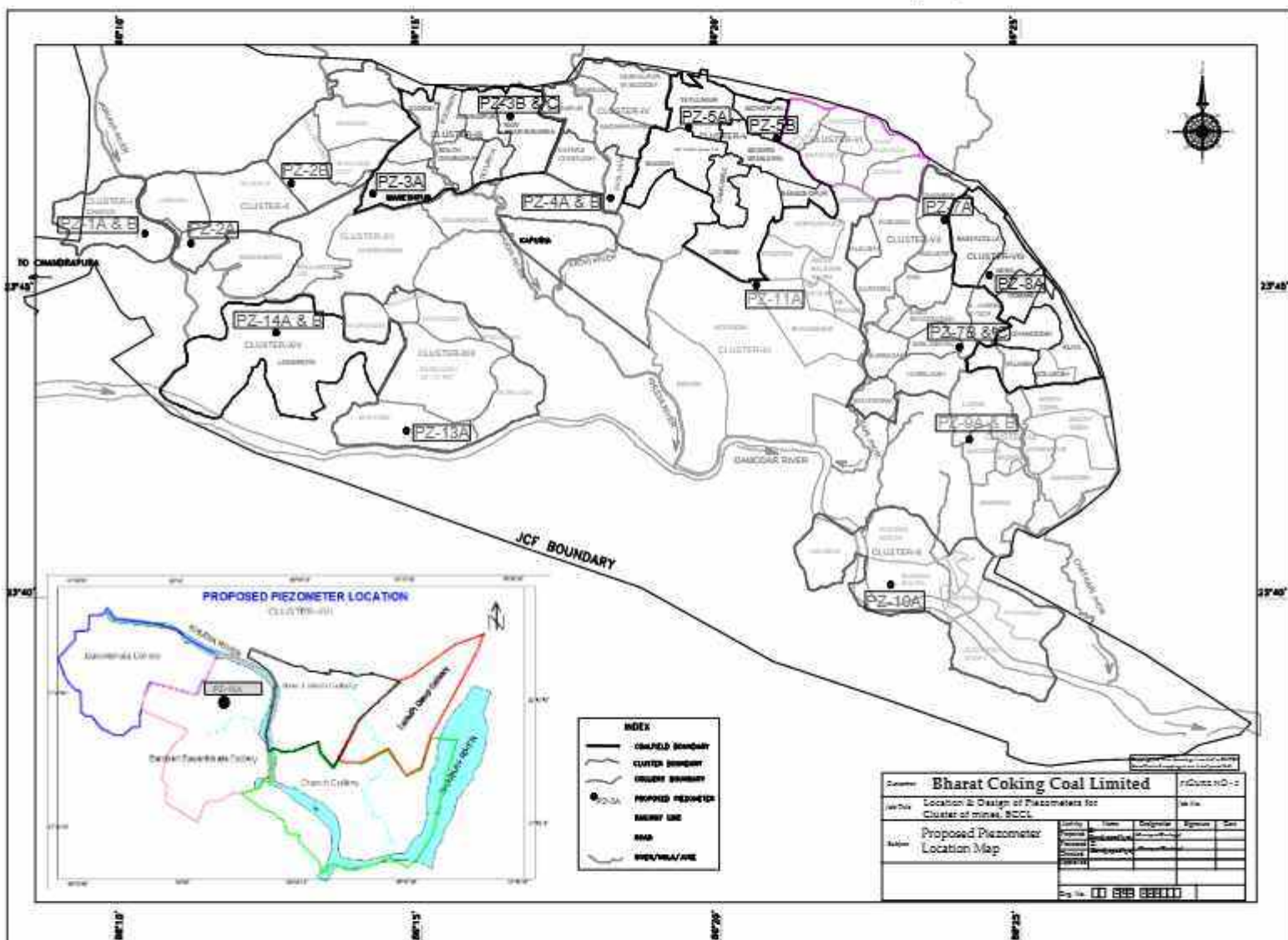
GROUNDWATER MONITORING STATION LOCATION MAP

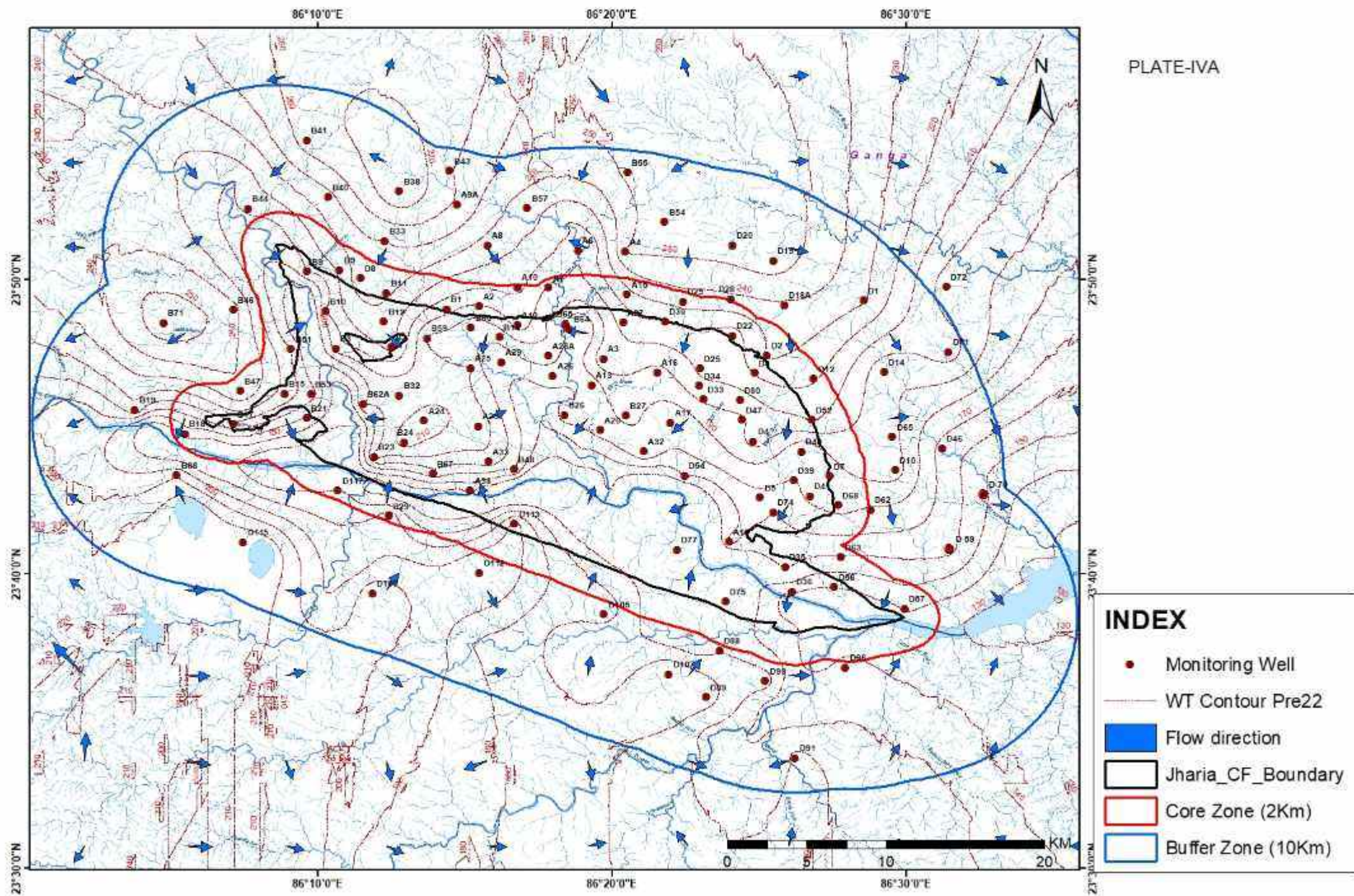


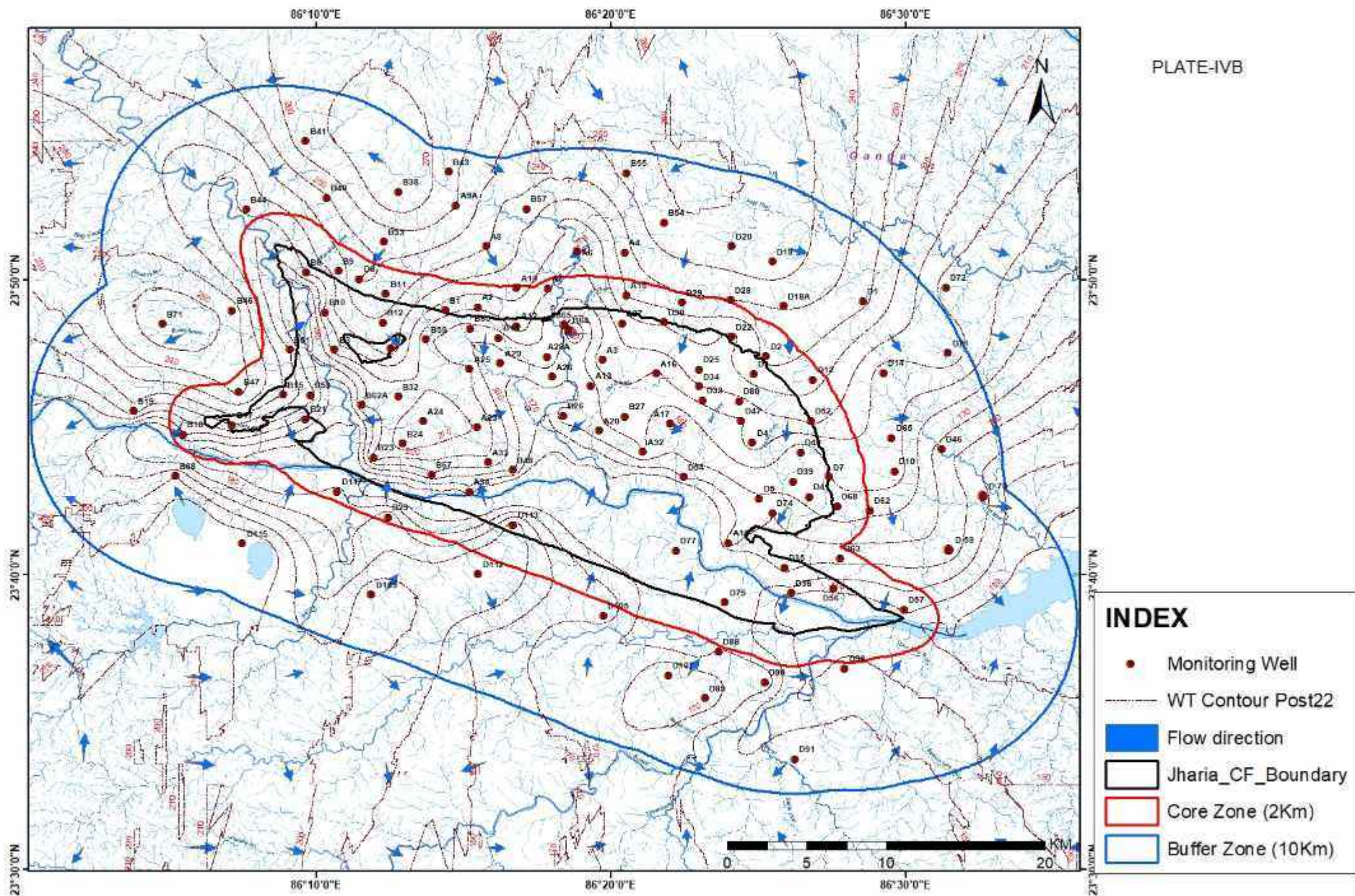
GROUNDWATER QUALITY MONITORING STATION LOCATION MAP

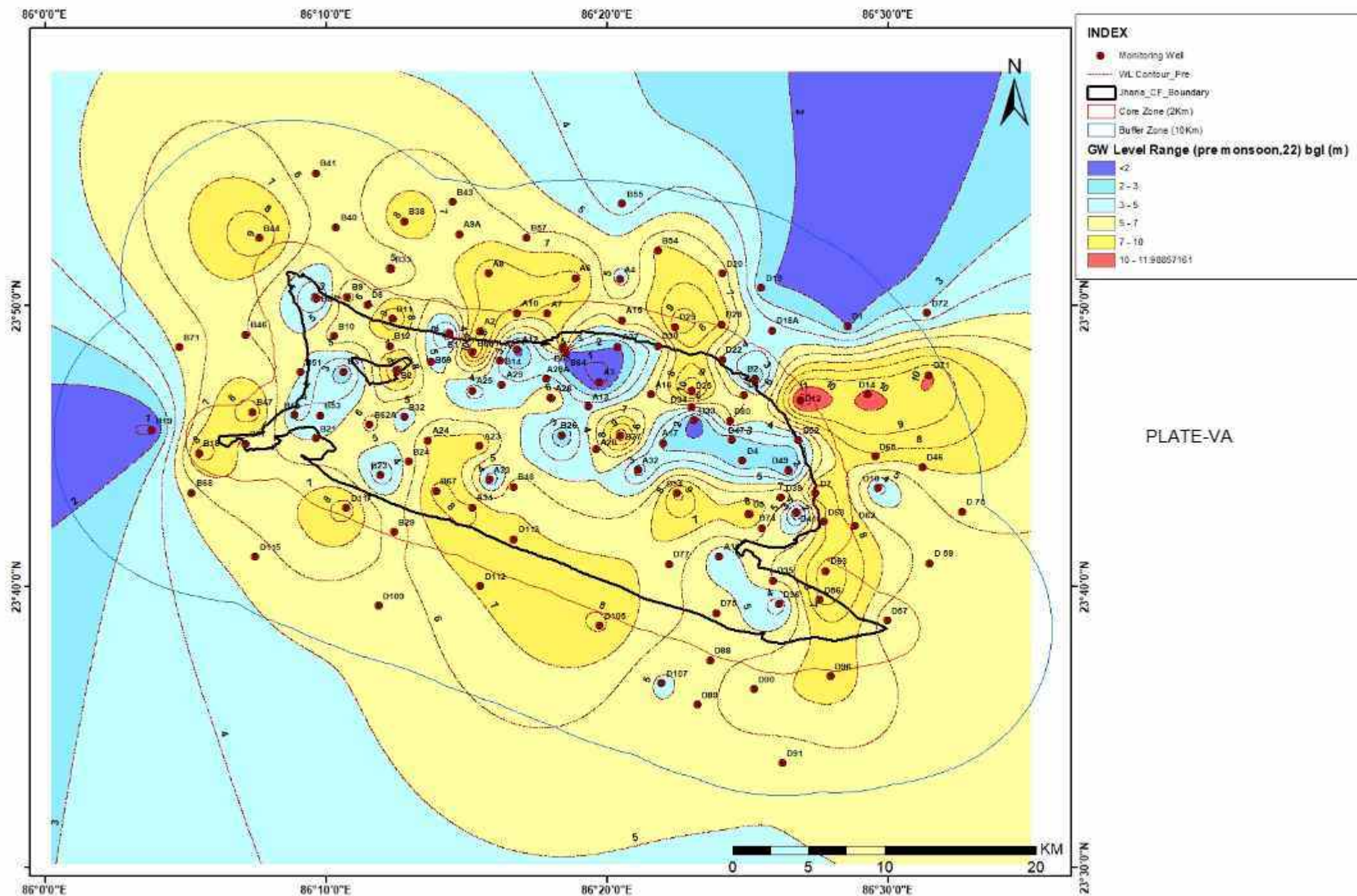


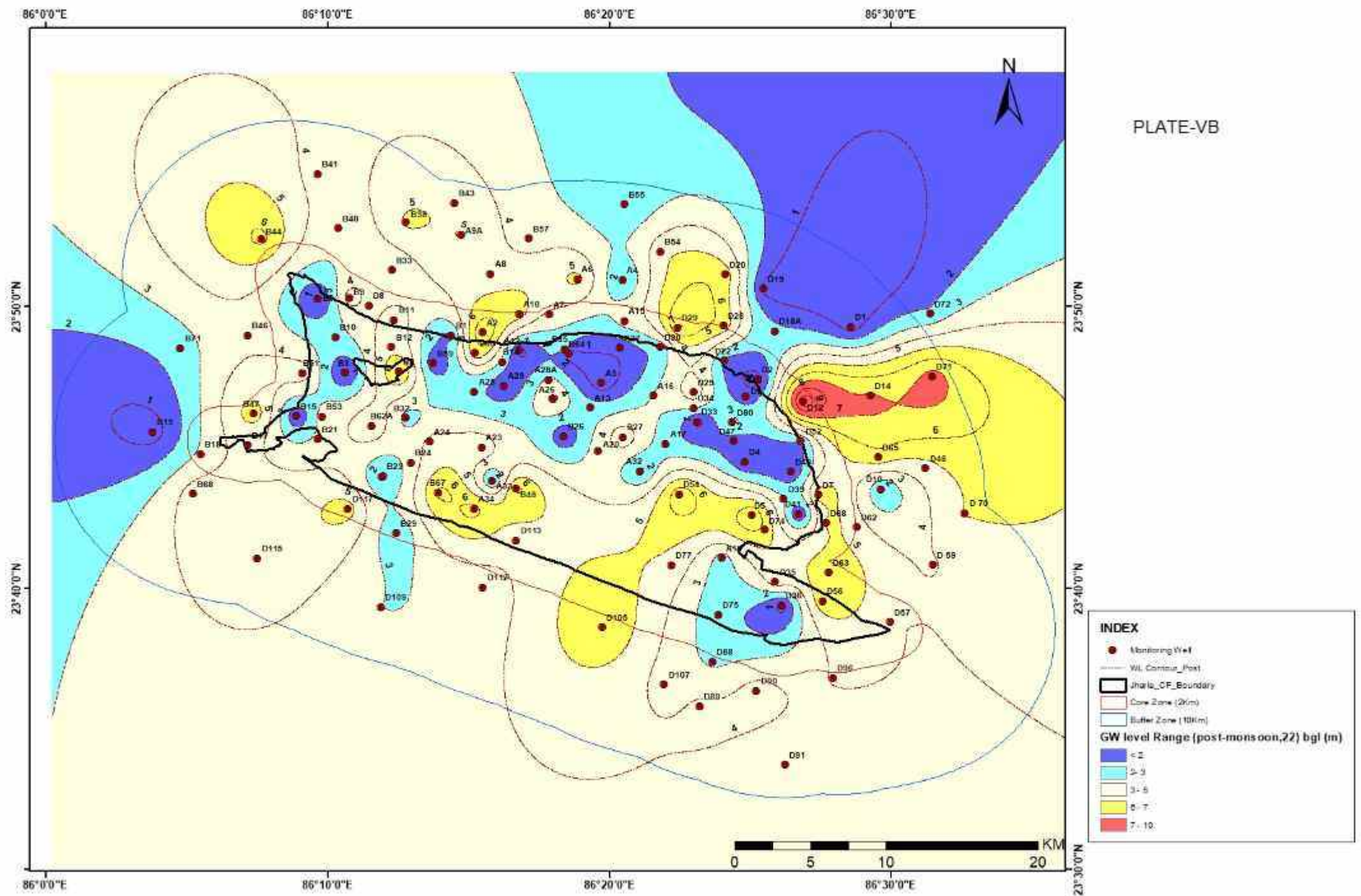
PROPOSED PIEZOMETER LOCATION MAP, JCF & RCF (part)



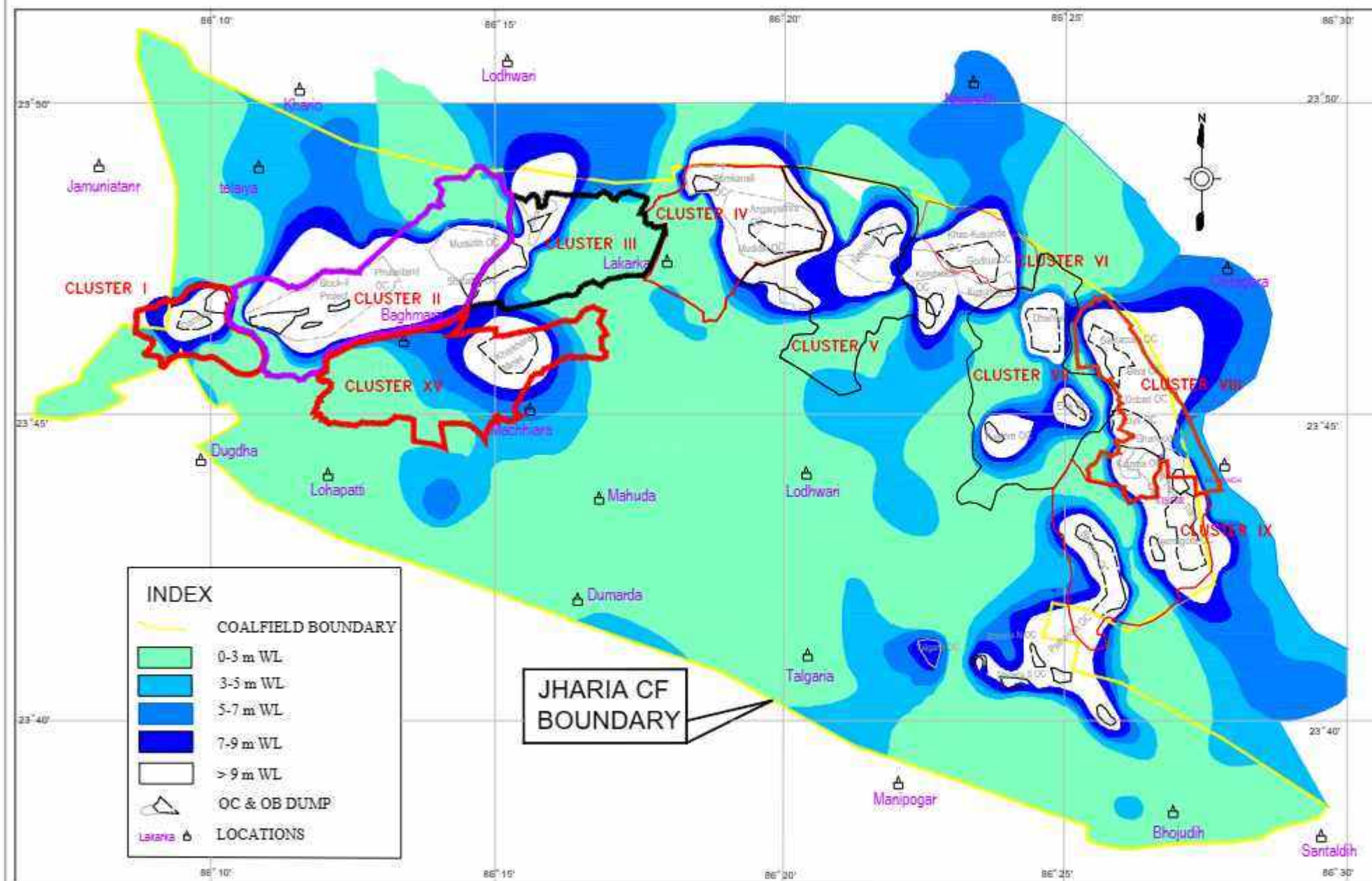




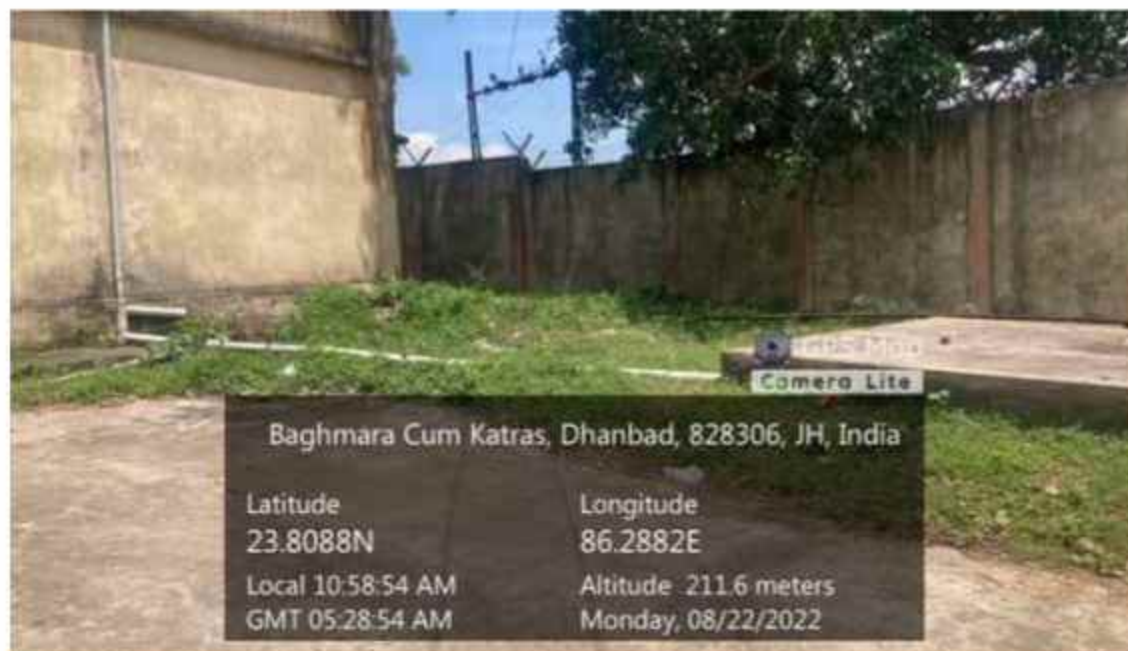




DEPTH TO WATER LEVEL MAP OF JHARIA COALFIELD



Bharat Coking Coal Limited		Jharia Coalfield	
Customer		Jharia CF	
Job No.		10000000000000000000	
Subject		HYDROGEOLOGICAL STUDIES FOR BCCL CLUSTERS	
Prepared by		Geological Department	
Checked by		Geological Department	
Approved by		Geological Department	
Scale		1:5000	
Date		10/01/2023	
Sheet		1 of 1	
Customer Signature		CMPDI	
Customer Name		Bharat Coking Coal Limited	
Customer Address		Jharia Coalfield, West Singhbhum District, Jharkhand	
Customer Contact		0354-2630000	



Rain Water Harvesting Structure at CISF Campus , New Akashkinaree Colliery

Annexure-XII

Water Supply to nearby villagers

Treated mine water is being supplied through water pipelines and water tankers to the nearby villagers, from the different collieries of Govindpur Area under Cluster III.

There is a central water treatment plant at Sinidih with a capacity 1.3MLD. Apart from this collieries have their own water treatment plants as well to supply the water to nearby 29 villages. Details of villages, where water is being supplied and corresponding nos. of beneficiaries (Family) are given below:

Sl. No.	Colliery name	Name of beneficiary villages	No. of Beneficiaries (Family)
1.	New Akashkinaree Colliery	Behrakudar, Bahiyardih, Jogidih Basti, Bhatmorna, Maheshpur Basti, Kharkharee Basti,	Approx. 1,03,000
2.	Block-IV/Kooridih Colliery	Deoghara, Premnagar, Sinidih village, Mathadih basti, Dharmabandh basti, chanchani colony,	
3.	Maheshpur Colliery	majhlitand, khash Tundoo, Narayan Dhowrah,	
4.	Jogidih Colliery	Madhuban thana, Tundoo village, Jogidih	
5.	Teturiya Colliery	village, chitahi basti, barmasiya etc.	

In addition to this Cluster-III (Govindpur Area), BCCL is paying to **MADA** as well for the supply of water to localities in Govindpur Area. The details of payment made are given as below:

Financial Year	Amount paid (Rs.)
2013-14	84,00,275
2014-15	76,77,525
2015-16	39,35,600
2016-17	36,14,075
2017-18	29,03,400
2018-19	38,71,200
2019-20	70,88,190
2020-21	51,87,080

**STRICTLY RESTRICTED -
FOR COMPANY USE ONLY RESTRICTED**

The information given in this report is not to be
communicated either directly or indirectly to the
public or to any person not holding an official
position in the CIL. (27/9/2020/5/1)

Annexure-XIII

**WATER QUALITY REPORT
OF
BHARAT COKING COAL LIMITED,
CLUSTER – III
(FOR THE Q.E. DECEMBER, 2022)**

E. C. no. J-11015/213/2010-IA.II (M) dated 06.02.2013



CMPDI

ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CLUSTER - III

(FOR THE Q.E. DECEMBER, 2022)

CONTENTS

SL. NO.	CHAPTER	PARTICULARS
1		EXECUTIVE SUMMARY
2	CHAPTER -I	INTRODUCTION
3	CHAPTER-II	WATER SAMPLING & ANALYSIS
4	Plates: Plate No. -I	SURFACE PLAN SHOWING WATER MONITORING LOCATIONS

STRICTLY RESTRICTED
FOR COMPANY USE ONLY RESTRICTED

The information given in this report is not to be communicated either directly or indirectly to the public or to any person not holding an official position in the CIL / GOVERNMENT.

WATER QUALITY REPORT
OF
BHARAT COKING COAL LIMITED
CLUSTER – II
(FOR THE Q.E. DECEMBER, 2022)
E. C. no. J-11015/213/2010-IA.II (M) dated 06.02.2013



CMPDI

ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the environment around us. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. One of these major attributes is water.

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°37' N to 23°52' N latitudes and 86°09' E to 86°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 Water sampling stations

The Water sampling stations were selected for mine sump water, drinking water supply, well/ Hand pump water also surface water samples.

3.0 Methodology of sampling and analysis

3.1 Water quality

Water samples were collected as per standard practice. Effluent samples were analyzed for 25 parameters on quarterly basis and for 27 parameters on half yearly basis. The drinking and Surface water samples were collected and analyzed for 25 and 17 parameters respectively, on quarterly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory at CMPDI, RI-II, Dhanbad.

4.0 Results and interpretations

4.1 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, IS:10500/2012 (Drinking water) and IS: 2296 (Surface water), are with in permissible limits.

CHAPTER - I

INTRODUCTION

1.0 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.

Bharat Coking Coal Limited (BCCL), a subsidiary company of Coal India Limited (CIL) is operating UG Mines and Opencast Mines in Jharia Coalfield (JCF). The Jharia Coalfield (JCF) having an area of 450 Sq.KM.

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.

1.1 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 Akashkinaree Mine and Block IV Kooridih Mixed Mine. 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 Khudis and Bagdighi Nala.

1.2 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.

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

CHAPTER – II

WATER QUALITY MONITORING

3.1 Location of sampling sites (Refer Plate No. - I)

- i) Drinking water quality at Jogidih Village (DW3)
- ii) Surface water quality at U/S of Khudia Nala (SW4)
- iii) Surface water quality at D/S of Khudia Nala (SW5)
- iv) Surface water quality at U/S of Bagdighi Nala (SW6)
- v) Surface water quality at D/S of Bagdighi Nala (SW7)
- vi) Mine water discharge of Govindpur Colliery(MW3)

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. Effluent samples were analyzed for 25 parameters on quarterly basis and for 27 parameters on half yearly basis. The drinking and Surface water samples were collected and analyzed for 25 and 17 parameters respectively, on quarterly basis. Thereafter the samples were preserved and analyzed at the Environmental Laboratory at 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.



cmpdi
Central Mine Planning and Design Institute Limited

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

CHPDI, RI-II
KOYLA SHAWAN COMPLEX
CHANDABAD - 506005
Phone: 0524-223-050
mail: rri2cmpdi@coalindia.in

Month & Year	QUARTER ENDING DEC 2022	Cluster	III			Report No.	RI-2/CH/22-23/24/23
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Singhbhum, Jharkhand (E-mail: ggram-bcl@coalindia.in)					Date of Issue	01.01.23
Project	Singbhum Village		Sample Ref. No.	BBCL/BCL/22-23/CH		Sampling Method	CHPDI RI-II LPM 12/25/2022 Para-01
Sampling Station	Singbhum Village	Date of Sampling	04.12.2022	Sample Collected in 2 Ltr Nertopane. Color as observed is transparent			
		Period of Analysis			Nov 22	Jan 23	
Sl. No.	Parameter	Method of Analysis	Observed Values		IS 15559:2015		
			Obs'd	Range Or Tasting	LDL	Acceptable Limit (ppm)*	Permissible limit as the maximum of (Permissible limit & LDL)
1.	Codm. Water unit	APHA, 12th Edition, 2120-C Spectrophotometric, 510nm wavelength Method 2121*	3	1-5000	1	3	3
2	Turbid. mg/l	IS 3025, (Part 4C) 1991 & 2014, AAS Flame Method & EDTA Method	24	10-4000	2	15	200
3	Chloride, mg/l	IS 3025 (Part II) 1984 & 2015, Argentometric Method	46	1.5-12000	6	240	1000
4	Sulphate, mg/l	APHA, 12th Edition, 2142-H Method	0.11	0.1-200	0.2	3	1.5
5	Iron, mg/l	IS 3025 (Part 4C) 2005 & 2019, AAS-Flame Method	<0.2	0.1-10	0.2	1	No relaxation
6	Magnesium	APHA, 12th Edition, 2106-B & Titrimetric Method	87	40-700	6	30	100
7	Fluoride, mg/l	APHA, 12th Edition, 2107-B Spectrophotometric Method	18.00	0.2-400	0.5	40	No relaxation
8	Cadmium	APHA, 12th Edition, 2110-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part II - 1985 & 2017 Electrode method, pH Meter Method	7.23	1-14	0.1	6.5-8.5	No relaxation
10	Ammonia, mg/l	APHA - 12th Edition, 4500 N, Turbidity Method	128	100-4000	10	300	<100
11	Taste	APHA 12th Edition, 2140-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total alkalinity (as CaCO ₃) mg/l	IS 3025, Part II - 1985 & 2019 Titrimetric Method	132	40-50000	6	300	600
13	Total Dissolved Solids, mg/l	IS 3025, Part II - 1984 & 2017 Gravimetric method	146	10.0-50000	25	500	1000
14	Total Hardness, mg/l	IS 3025 (Part II) 2019 EDTA Method	433	40-50000	9	300	600
15	Turbidity, NTU	IS 3025, (Part 4C) 1994 & 2017 Nephelometric Turbidity method	1.4	1-500	0.1	1	1
16	Iron, mg/l	IS 3025 (Part 4C) 1994 & 2019, AAS-Flame Method	<0.1	0.1-10	0.1	1	1

*All units in mg/L unless specified otherwise.

*Crab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BCL indicates Below Detection Limit.

(Signature)

(Kumar Vaibhav)
CHECKED BY

(Signature)

(Anuraj Mishra)
HOD's Signature

ANALYSED BY

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.



cmpdi
A Whol. Sales Company

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

CMPDIL RI-II
KOTLA BHAWAN COMPLEX
DHANBAD, -830005
Phone: 3326-223-858
email: rri2@cmpdi.co.in

Block & Year	QUARTER EXHIB 2002-2003	Client	II	Report No.	RI-2-TH, T7-T9, 18/12		
Customer	Electronics Department, Bharat Ironing Co. Ltd. (BCL), Kalya Nagar, Chanda (2nd fl) gpran@bclindia.in			Date of Issue	18-02-2013		
Project	Jagdish Village	Sample Ref. No.	BCL/2012/12-23/TH	Sampling Method	CMPDI/RI-II/LPH 12/12 (2012 Part-4)		
Sampling Station	Jagdish Village	Date of Sampling	14.11.2012	Sample Collected in 2 Lit Jar/containers. Color as observed is transparent			
		Period of Analysis		Run-12	Run-13		
		Observed Values		IS 15000: 2003			
S. No.	Parameter	Method of Analysis	Obs	Range Of Testing	LDL	Acceptable Limit (mg/L)	Acceptable Limit in the Maximum Allowable Concentration (MAC)
1	Iron (as Fe, mg/L) Max	APHA, 12th Edition, Colorimetric	<0.2	0.1-0.2	0.2	0.2	1
2	Copper (as Cu, mg/L) Max	IS 2002 Part 42: 1992 & 1018, AAS-Flame APHA, 12th Edition, AAS-ETA	<0.01	0.01-0.2	0.01	0.01	1.5
3	Free Radical Chlorine, mg/L Min	APHA, 12th Edition, 8000-C1 & (colorimetric HACHDRI)	<0.04	0.04-4	0.04	0.2	1
4	Lead (as Pb, mg/L) Max	IS 2012 (Part 47) 1994 (Spectrophotometric) APHA, 12th Edition, AAS-ETA	<0.005	0.005-0.5	0.005	0.01	No reduction
5	Phosphate (as PO4), mg/L Max	APHA, 12th Edition, 4-Amino Antiquinone	<0.001	0.001-0.2	0.001	0.002	0.002
6	Selenium, mg/L Max	APHA 12th Edition IS-2012, 8000-10, 8000-10, 8000-10, AAS-ETA	<0.007	0.007-0.2	0.007	0.01	No reduction
7	Total Arsenic (as As), mg/L Max	IS-2012 Part 57: 1994 & 1019 / APHA 12th Edition AAS-ETA	<0.004	0.004-0.2	0.004	0.01	0.05
8	Total Chromium (as Cr), mg/L Max	IS-2012 Part 52: 1994 & 1019, AAS-Flame APHA, 12th Edition, AAS-ETA	<0.01	0.01-0.2	0.01	0.01	No reduction
9	Manganese (Mn, mg/L) Max	IS 2012 Part 14: 1000 & 1019, AAS-Flame APHA, 12th Edition, AAS-ETA	<0.02	0.02-0.5	0.02	0.01	No reduction
10	Fluoride (as F), mg/L Max	IS 2012 (Part 22) 1004 & 1006, AAS-Flame Method	0.04	0.02-0.5	0.02	0.1	0.3

**All units in mg/L unless specified otherwise.

**Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BCL indicates Below Detection Limit.

(Signature)

(Kumar Vaibhav)
CHECKED BY

(Signature)

(Amit Raj Mishra)

HOD's Signature

ANALYSED BY

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.



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

CMPDI, R-II

CPFLA BHAWAN COERPLEX

DHANBAD - 826003

Phone: 2223-223-853

Email: rrii2.cmpdi@coelindia.in

Month & Year	QUARTER ENDING DATE		Cluster	H All		Report No.	RI-2/SW/22-23/QE/03
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bcl@coellindia.in)					Date of Issue	16.03.2023
Project	Sample Ref. No.		REM/BCL/2022/SW/		Sampling Method	(IS 3025, Part-1) CMPDI/RI-II/LPM 13	
Sampling Stations	(i)	Downstream in Khudla Nala(SW4)	Date of Sampling		12.12.22	Period of Analysis	
	(ii)	Downstream of Khudla Nala (Downstream with cluster III (SW5))	Date of Sampling		12.12.22	Nov/22 TO Jan 23	
Sl. No.	Parameter	Method of Analysis	Observed Values		IS 3025 (PART 1) SURFACE WATER (1992) Class 'C'	Range of Testing	LDL
			SW4	SW5			
1	BOD (3 days IT+C), mg/l	IS 3025 (Part 44) : 1993, B-2019, 3 day incubation at 27°C	<1.0	<1.0	3	1-100.0	1
2	Colour,Hazen Units	APHA 23rd Edition, 2120-B-2017	4	4	10	1-100.0	1
3	Chlorides, mg/l	IS-3025(Part 31): 1988, B-2019 Argentometric Method	44	39	600	10-1500.0	3
4	Copper, mg/l	IS 3025 (Part 47) : 1992 B-2019, AAS-Flame Method	<0.2	<0.2	1.5	0.2-10.0	0.2
5	Dissolved Oxygen, mg/L	IS 3025 (Part 38) : 1989, B-2003 Winkler Azide Method	6.3	6.3	4	0.1-10.0	0.0
6	Fluoride, mg/l	APHA, 23rd Edition, 18403-B Method	0.4	0.43	1.5	0.1-2.00	0.2
7	Hexavalent Chromium, mg/l	APHA 23rd Edition, 18-019, Diphenylcarbohydrazide Method	<0.01	<0.01	0.05	0.01-1.4	0.01
8	Iron, mg/l	IS 3025 (Part 53) : 2003, B-2019, AAS-Flame Method	<0.2	<0.2	30	0.2-10	0.2
9	Nitrate, mg/l	APHA, 23rd Edition, UV Spectrophotometric Method	4.29	2.19	30	0.1-45.0	0.3
10	pH value	IS 3025, (Part 11) : 1985 B-2017 Electrode (pH Meter) method	8.01	7.81	8.5-8.5	1.0-12.0	1
11	Sulphate, mg/l	APHA - 23rd Edition, 4500-S, Turbidity Method	43	36	400	10.0-400.0	10
12	Total Dissolved Solids, mg/l	IS 3025, (Part 16) : 1994 B-2017 Gravimetric method	310	617	1500	25.0-5000.0	25
13	Zinc, mg/l	IS 3025(Part 49) : 1994, B-2019, AAS-Flame Method	0.1	<0.1	1.5	0.1-1.0	0.1

*Oral sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit

**All units in mg/L unless specified otherwise. Sample Collected in 5 Ltr Jerrycane. Color as observed is transparent.

(Signature)

Analysed by

(Signature)
(Kumar Vaibhav)

CHECKED BY

(Signature)
(Amit Raj Mishra)

HOD's Signature

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, R-II.

--- End of Report ---

Page -1 of 2



CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

SURFACE WATER ANALYSIS TEST REPORT

CMPDI, B-4
KOTVA GURUKHAN COMPLEX
DHANBAD, JHARKHAND
Phone: 0328-223-403
Email: rtri2.cmpdi@coalindia.in

Month & Year	QUARTER ENDING DEC 2023	Cluster	II & III			Report No.	RI-2/SW/23-23/QE/03
Customer	Environment Department, Bharat Coking Coal Limited (BCEL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bcel@coalindia.in)					Date of Issue	16.03.2023
Project	Sample Ref. No.			223/BCEL/1021/SW /	Sampling Method	(IS 3025, Part-1) CMPDI/RI-II/LPM 13	
Sampling Stations	I	Downstream in Khudia Nala (SWA)		Date of Sampling	12.12.22	Period of Analysis	
	II	Downstream of Khudia Nala (Downstream with cluster II) (SWS)		Date of Sampling	17.12.22	Nov'22 to Jan'23	
Sl. No.	Parameter	Method of Analysis	Observed Values		IS-3025 (2003) STANDARD (WATER QUALITY) CLASS 'C'	Range of Testing	LDL
			SWA	SWS			
1	Arsenic (as As), mg/l Max	IS-3025, Part 37, 1968, E-2019/ APHA 23rd Edition AAS-VGA	<0.006	<0.006	0.2	0.005-10	0.006
2	Lead (as Pb), mg/l Max	APHA, 23rd Edition, AAS-GTA	<0.005	<0.005	0.1	0.005-10	0.005
3	Phenolic compounds (as C6H5OH), mg/l Max	APHA, 22nd Edition 4-Amino Antipyrine	<0.002	<0.002	0.005	0.002-10	0.002
4	Selenium, mg/l Max	IS-3025, Part 56, 2003, R-2019/ APHA 23rd Edition, AAS-VGA	<0.003	<0.003	0.05	0.007-10	0.007

**Only sampling carried out for water sampling. LDL indicates Lower Detection Limit & SDL in Cases Below Detection Limit.

***All units in mg/l unless specified otherwise Sample Collected in 5 Ltr ferricure, Color as observed is transparent

[Signature]
16.3.23

(Rumar Vaidhar)

(Amit Raj Nishra)

Analysed by

CHECKED BY

HOD's Initial/Signature

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 2 of 2



CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

SURFACE WATER ANALYSIS TEST REPORT

CMPDI, R-II

COYLA BHAWAN COMPLEX

GHANSHYAM, -420003

Phone: 0662-224-493

Email: rrii2.cmpdi@coalindia.in

Month & Year	QUARTER ENDING DEC 2022	Cluster	III & XV			Report No.	RJ-3/SW/22-23/QE/03
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bcl@coalindia.in)					Date of Issue	16.01.23
Project	Sample Ref. No.		REV/BCL/2022/017		Sampling Method	(IS 3025, Part-1) CMPDI/R-II/LPM 15	
Sampling Stations	(i)	Upstream in Bagtigi Kales(SW1)	Date of Sampling		26.12.22	Period of Analysis	
	(ii)	Downstream in Bagtigi Kales(SW2)	Date of Sampling		26.12.22	Nov/22 to Jan 23	
Sl. No.	Parameter	Method of Analysis	Observed Values		IS 3025 (Part 35) SURFACE WATER (1989) Class C	Range of Testing	LDL
			(i)	(ii)			
1	BOD (3 days 20°C), mg/l	IS 3025 (Part 44) : 1993, R: 2019, 3 day incubation at 20°C	<1.0	<2.0	3	2.00-10.00	1
2	Colour, Hazen Units	APHA 23rd Edition, 2120-B-2017	1	1	10	1-1000	1
3	Chlorides, mg/l	IS 3025 (Part 31) : 1988, R: 2019, Argentometric Method	78	50	500	50-1500.0	5
4	Copper, mg/l	IS 3025 (Part 42) : 1993 R : 2019, AAS-Flame Method	<0.1	<0.1	1.0	0.1-10.0	0.1
5	Dissolved Oxygen, mg/L	IS 3025 (Part 35) : 1989, R: 2002, Winkler Azide Method	8.6	8.8	6	0.1-10.0	0.1
6	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.48	0.53	1.5	0.1-2.00	0.1
7	Hexavalent Chromium, mg/l	APHA 23rd Edition, 1,5-Diphenylcarbohydrazide Method	<0.01	<0.01	0.05	0.01-1.4	0.01
8	Iron, mg/l	IS 3025 (Part 53) : 2003 R: 2019, AAS-Flame Method	<0.1	<0.2	50	0.2-10	0.1
9	Nitrate, mg/l	APHA, 23rd Edition, UV-Spectrophotometric Method	1.06	4.16	50	0.5-45.0	0.5
10	pH value	IS 3025 (Part 11) : 1983 R: 2017, Electronic (pH Meter) method	8.09	8.07	6.5-8.5	7.0-12.0	1
11	Sulphate, mg/l	APHA -23rd Edition, 4300-S, Turbidity Method	36	41	400	100-400.0	10
12	Total Dissolved Solids, mg/l	IS 3025 (Part 16) : 1984 R: 2017, Gravimetric method	383	429	1500	150-5000.0	25
13	Zinc, mg/l	IS 3025 (Part 49) : 1994, R: 2019, AAS-Flame Method	<0.1	0.12	15	0.1-30	0.1

***Good sampling protocol apt for water samples. LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit

***All units in mg/L unless specified otherwise. Sample Collected in 5 Ltr ferricune. Color as observed is transparent

Analysed by

(Kumar Vaibhav)

CHECKED BY

(Amit Raj Mishra)

HOD's Initial/Signature

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, R-II.

— End of Report —

Page -1 of 2



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

CMPDI, R-II
 KINRA BANGALUA COMPLEX,
 DHANBAD - 826005
 Phone: 0328-222-800
 Email: ror2.cmpdi@coalindia.in

Month & Year	QUARTER ENDING DATE 2023		Cluster	III & IV		Report No.	RI-2/SW/23- 23/QE/03
Customer	Environment Department, Biharat Colliery Coal Limited (BCL), Koya Bhawan, Dhanbad (E-mail: gmenv.bcl@coalindia.in)					Date of Issue	16.01.23
Project	Sample Ref. No.			REN/BCL/2022/SW/	Sampling Method	(IS 3025, Part-1) CMPDI/RI-II/LPM 13	
Sampling Stations	(i)	Upstream in Bagdi Nala(SW6)		Date of Sampling	26.12.22	Period of Analysis	
	(ii)	Downstream in Bagdi Nala(SW7)		Date of Sampling	26.12.22	Nov/22 to Jan 23	
Sl. No.	Parameter	Method of Analysis	Observed Values		IS 3025, Part-1 SURFACE WATER (1992) Class 'C'	Range of Testing	LDL
			(i)	(ii)			
1	Arsenic (as As), mg/l Max	IS-3025, Part 37-1988, R-2019/ APHA 23rd Edition AAS-VGA	<0.006	<0.006	0.3	0.006-10	0.006
2	Lead (as Pb), mg/l Max	APHA 23rd Edition, AAS-GTA	<0.005	<0.005	0.1	0.005-10	0.005
3	Phenolic compounds (as C6H5OH), mg/l Max	APHA 23rd Edition 4-Amino Antipyrine	<0.002	<0.002	0.005	0.002-10	0.002
4	Selenium, mg/l Max	IS-3025, Part 56-2003, R-2019/ APHA 23rd Edition, AAS-VGA	<0.007	<0.007	0.05	0.007-10	0.007

**Grid sampling carried out for water samples. *LDL indicates Lower Detection Limit & PCL indicates Below Detection Limit.

***All units in mg/l unless specified otherwise. Sample Collected in 5 Lit. ferricane. Color as observed is transparent.

[Signature]

(Kumar Vaibhav)

[Signature]
 (Amit Raj Mishra)

Analysed by

CHECKED BY

HOD's Initial/Signature

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, R-II.

— End of Report —

Page-2 of 2



cmpdi
A Thin Client Company

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

CMPPOL, 83-4
KOTLA BHAWAN COMPLEX
DHANBAD - 826005
Phone 0326-223-850
E-mail: ip2cmppol@comline.in

mailto:prajampati@cominil.in

Month & Year	QUARTER ENDING Dec 2022	Cluster	CHERPARHI			Report No.	M-2-WW/2022-22/CE-34
Customer	Environment Department, Bharat Coling Coal Limited (BCL), Kurla Shivan, Shantard (E-mail: gpatel.bcl@gmail.com)					Date of Issue	
Project	Corindagar Ciliary	Sample Ref. No.	SEN/WCL/DOE/WW/	Sampling & Method	CISPH/SEN/LFW 11, (D 2022, Part-4)		
Sampling Station	WCL	Date of Sampling	26.12.2022	Sample Collected in 2 Lit. jar/containers. Color as observed is transparent			

Sl. No.	Parameter	Method of Analysis	Period of Analysis			
			MSD	Range of Testing	LDC	IS027-SCM-V3 ST-33-LSDC Ann. V
1	pH (5 days 20°C), mg/l, Max	IS 3000 (1st/2nd/3rd/4th/5th edn) Hooker et al. 17°C	<1.0	3-10000	3	30
2	Colour	IS 3043 12th Edition 2003-6-2007	5	10-10000	5	10
3	ODC, mg/l, Max	IS 3043 12th Edition 2003-6-2007	15	40-10000	6	100
4	Copper (as Cu), mg/l, Max	IS 3000 Part 1: 1981 & 2003 1st/2nd Edn	<0.1	0.1-100	0.1	1
5	Dissolved Phosphate (as P), mg/l, Max	IS 3000 1st/2nd Edn 1981 & 2003	<0.1	0.1-1	0.1	1
6	Nitrite (as N), mg/l, Max	IS 3000 12th Edition 2003-6-2007 1st/2nd Edn	<0.1	0.1-1	0.1	1
7	Nitrate (as N), mg/l, Max	IS 3000 12th Edition 2003-6-2007 1st/2nd Edn	<0.1	0.1-100	0.1	1
8	Iron (as Fe), mg/l, Max	IS 3000 Part 1: 1981 & 2003 1st/2nd Edn	<0.1	0.1-100	0.1	1
9	Manganese (as Mn), mg/l, Max	IS 3000 12th Edition 2003-6-2007	<0.1	0.1-100	0.01	0.1
10	Alkalinity (as CaCO ₃), mg/l, Max	IS 3000 Part 1: 1981 & 2003 1st/2nd Edn	<0.1	0.1-100	0.1	1
11	Free Ammonia, mg/l, Max	IS 3000 12th Edition 2003-6-2007 1st/2nd Edn	<0.1	0.1-100	0.1	10
12	Oil & Grease, mg/l, Max	IS 3000 12th Edition 2003-6-2007 1st/2nd Edn	<0.1	0.1-1000	0	10
13	pH Value	IS 3000 12th Edition 2003-6-2007 1st/2nd Edn	7.0	0-14	0.1	0.2 to 9.0
14	Temperature (°C)	IS 3000 12th Edition 2003-6-2007 1st/2nd Edn	15.0	1-100		Should not exceed 30°C above the testing temp.
15	Total Chlorine (as Cl ₂), mg/l, Max	IS 3000 Part 1: 1981 & 2003 1st/2nd Edn	<0.1	0.1-1	0.1	1
16	Total Suspended Solids, mg/l, Max	IS 3000 12th Edition 2003-6-2007 1st/2nd Edn	17	10-1000	10	100
17	Zinc (as Zn), mg/l, Max	IS 3000 12th Edition 2003-6-2007 1st/2nd Edn	<0.1	0.1-100	0.1	1
18	Colour	IS 3043 12th Edition 2003-6-2007	Agreeable	Qualitative	Qualitative	Qualitative

***all prices in m\$AL unless collected otherwise

^aSoil sampling carried out for winter samples. ^bChlorophylls Lower Unsaturation Index & Fv/Fm indicates Total Carotenoid Level

ANALYSED BY

(Kumar Valimov)
CHECKED BY

(Amit Raj Mishra)

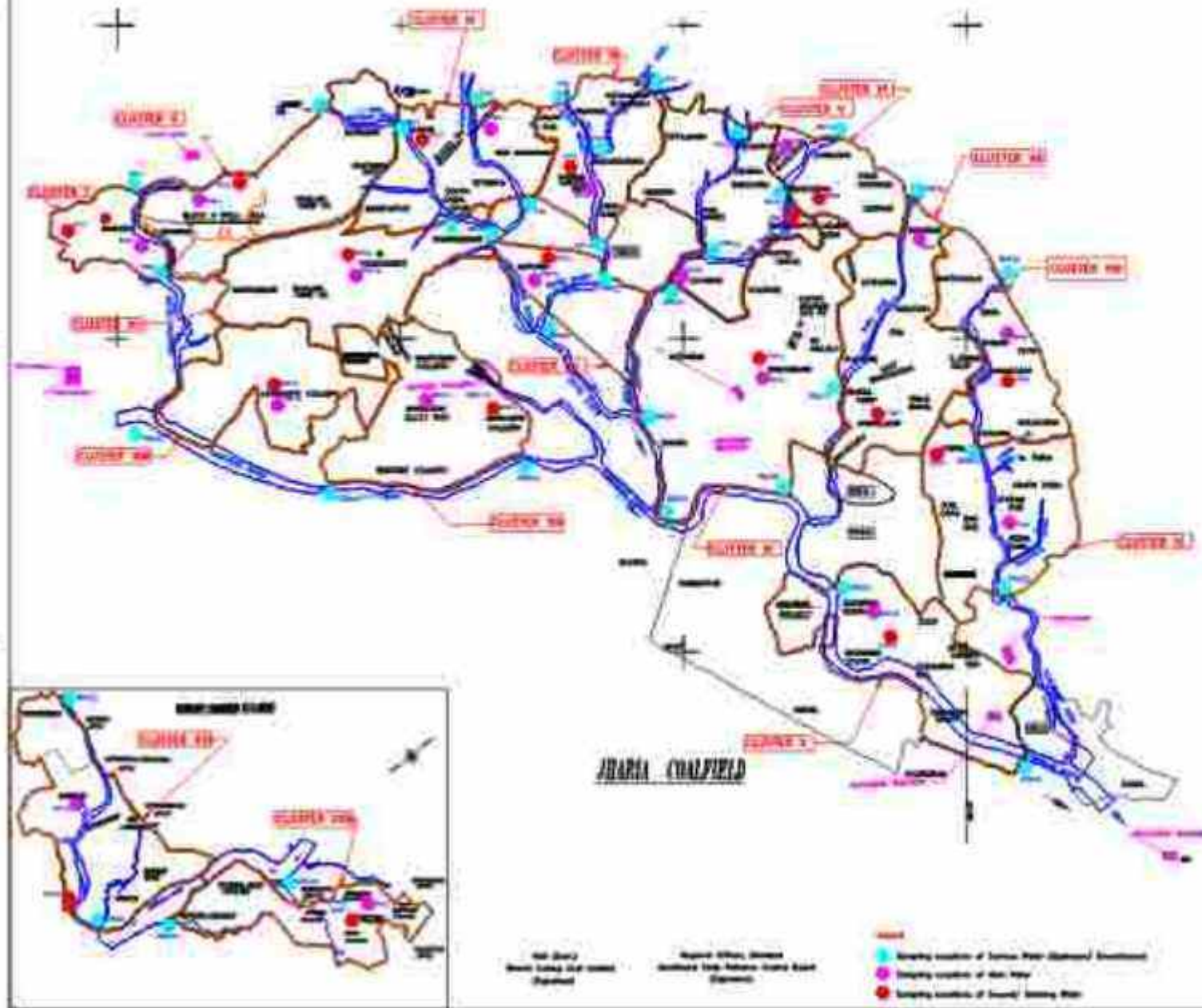
KOD's Signature

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 HCD(Env), CMFDD, RI-II.

—End of Report—

Page 1 of 2

Water Sampling Locations in BCCL



Cluster	Location	Latitude	Longitude	Altitude (m)	Area (km ²)	Population	Water Body	Sampling Location	Sampling Date	Sampling Time	Sampling Method	Sampling Result
Cluster I	...	...	...	...	...	...	...	...	...	...	...	...
Cluster II	...	...	...	...	...	...	...	...	...	...	...	...
Cluster III	...	...	...	...	...	...	...	...	...	...	...	...
Cluster IV	...	...	...	...	...	...	...	...	...	...	...	...
Cluster V	...	...	...	...	...	...	...	...	...	...	...	...
Cluster VI	...	...	...	...	...	...	...	...	...	...	...	...
Cluster VII	...	...	...	...	...	...	...	...	...	...	...	...
Cluster VIII	...	...	...	...	...	...	...	...	...	...	...	...
Cluster IX	...	...	...	...	...	...	...	...	...	...	...	...
Cluster X	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XI	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XII	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XIII	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XIV	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XV	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XVI	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XVII	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XVIII	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XIX	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XX	...	...	...	...	...	...	...	...	...	...	...	...

Prepared by	...
Checked by	...
Approved by	...
Date	...

STRICTLY RESTRICTED
FOR COMPANY USE ONLY RESTRICTED

The information given in this report is not to be
 commercialized either directly or indirectly in the
 press or by any person not holding an official
 position in the CIL GOVERNMENT

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

(FOR THE MONTH FEBRUARY, 2023)

E. C. no. J-11015/213/2010-IA.II (M) dated 06.02.2013.



CMPDI

ISO 9001 Company
 Regional Institute-II
 Dhanbad, Jharkhand

CONTENTS

SL. NO.	CHAPTER	PARTICULARS	PAGE NO.
1.	CHAPTER - I	EXECUTIVE SUMMARY	3-5
2.	CHAPTER-II	INTRODUCTION	6
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°37' N to 23°52' N latitudes and 86°09' E to 86°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 (PM₁₀), Fine Particulate Matter (PM_{2.5}), Sulphur Di-oxide (SO₂) 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 Koordih Mixed Mine. 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.

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 PM₁₀, PM_{2.5}, SO₂, NO_x 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) Govindpur Village (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



cmpdi
A Mine Rules Company

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

CMPDI, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD - 828005
Phone: 0326-225-890
email: info@cmpdi.coalindia.in

Test Report for Ambient Air Samples

Month & Year		02/2023	Cluster	Cluster III		Report No.		RI-II/AIR/2022-23/11							
Customer		Environment Department, Bharat Coling Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gmanr.bcl@coalindia.in)					Date of Issue		31.03.2023						
Project				Sample Ref. No.		REM/BCL/2023/11		Sampling Method		CMPDI/RI-II/LPM 13, (IS 5182)					
Date of Sampling		07-02-2023		22-02-2023		Period of Analysis		01.03.2023		15.03.2023		Zone of Station		Core Zone	
Sl. No.	Parameter	Method Analysis	of	Observed Values (in $\mu\text{g}/\text{m}^3$)		Range Of Testing	LDL	MoEF Standards Notification dated 25th September, 2000 (GSR 742 E)	NAAQS, 2009						
				1st FN	2nd FN										
1	PM_{10}	IS -5182(Part-23) 2006, R-2017		118	88	$10 \mu\text{g}/\text{m}^3 - 1000 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	300	100						
2	$\text{PM}_{2.5}$	IS -5182(Part-24) 2019		62	34	$10 \mu\text{g}/\text{m}^3 - 400 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	Not Specified	60						
3	SO_2	IS-5182(Part-I), 2001, R-2017		<10	<10	$10 \mu\text{g}/\text{m}^3 - 1000 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	120	80						
4	NO_2	IS-5182 (Part-6) 2006, R-2017		24	25	$05 \mu\text{g}/\text{m}^3 - 420 \mu\text{g}/\text{m}^3$	$06 \mu\text{g}/\text{m}^3$	120	80						

* LDL indicates Lower Detection Limit.

** All units are in $\mu\text{g}/\text{m}^3$, 24 hourly Average.

[Signature]

ANALYSED BY

[Signature]

(Gaurav Kant)
REVIEWED BY

[Signature]

(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



cmpdi
A Mine Related Company

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

CMFDIL RI-II
KOYLA SHAWAN COMPLEX
DHANBAD - 826005
Phone: 0326-223-890
email: rdi2@cmpdi.coalindia.in

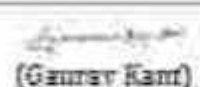
Test Report for Ambient Air Samples

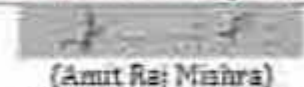
Month & Year		02/2023	Cluster		Cluster III	Report No.		RI-II/AIR/2022-23/11
Customer		Environment Department, Bharat Coking Coal Limited (BCL), Koyla Shawan, Dhanbad (E-mail: gmenv.bcl@coalindia.in)				Date of Issue		31.03.2023
Project		Nuraidih	Sample Ref. No.		REM/BCL/2022/11	Sampling Method		CMPDI/RI-II/LPM 12, (IS 5182)
Date of Sampling		10-09-2023	24-09-2023	Date of Sampling		01-10-2023	05-10-2023	Zone of Station: Buffer Zone
Sl. No.	Parameter	Method Analysis of	Observed Values (in $\mu\text{g}/\text{m}^3$)		Range Of Testing	LDL	MoEF Standards Notification dated 25th September, 2000 (GSR 742-E)	NAAQS, 2009
			1st FN	2nd FN				
1	PM_{10}	IS 5182(Part 23) 2006, R-2017	93	95	$10 \mu\text{g}/\text{m}^3 - 1200 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	300	100
2	$\text{PM}_{2.5}$	IS 5182(Part 24) 2019	45	44	$10 \mu\text{g}/\text{m}^3 - 400 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	Not Specified	60
3	SO_2	IS-5182(Part-2) 2001, R-2017	<10	<10	$10 \mu\text{g}/\text{m}^3 - 1250 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	120	80
4	NO_2	IS-5182 (Part-6) 2006, R-2017	26	24	$06 \mu\text{g}/\text{m}^3 - 420 \mu\text{g}/\text{m}^3$	$06 \mu\text{g}/\text{m}^3$	120	80

* LDL indicates Lower Detection Limit.

** All units are in $\mu\text{g}/\text{m}^3$, 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 ---
Page -1 of 1



cmpdi
A World Mined Company

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

CMPDIL RI-II
KOYLA SHAWAN COMPLEX
DHANBAD - 826005
Phone: 0226-223-850
email: rri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year		02/2023	Cluster		Cluster III		Report No.		RI-II/AIR/2022-23/11		
Customer		Environment Department, Bharat Coking Coal Limited (BCL), Koyla Shawan, Dhanbad (E-mail: gmanv.bcl@coalindia.in)					Date of Issue		31.03.2023		
Project				Sample Ref. No.		REM/BCL/2023/11		Sampling Method		CMPDI/RI-II/LPM 13, (IS 5182)	
Date of Sampling		06.02.2023		23.02.2023		Period of Analysis		01.03.2023		15.03.2023	
								Zone of Station:		Buffer Zone	
SL No.	Parameter	Method of Analysis	Observed Values (in $\mu\text{g}/\text{m}^3$)		Range Of Testing	LDL	MoEF Standards Notification dated 25th September 2000 (CSR 742 E)	NAAQS, 2009			
			1st FN	2nd FN							
1	PM ₁₀	IS-5182(Part-2): 2006, R-2017	37	34	10 $\mu\text{g}/\text{m}^3$ - 1000 $\mu\text{g}/\text{m}^3$	10 $\mu\text{g}/\text{m}^3$	300	100			
2	PM _{2.5}	IS-5182(Part-2): 2019	52	49	10 $\mu\text{g}/\text{m}^3$ - 400 $\mu\text{g}/\text{m}^3$	10 $\mu\text{g}/\text{m}^3$	Not Specified	60			
3	SO ₂	IS-5182(Part-2): 2001, R-2017	<10	<10	10 $\mu\text{g}/\text{m}^3$ - 1090 $\mu\text{g}/\text{m}^3$	10 $\mu\text{g}/\text{m}^3$	120	80			
4	NO ₂	IS-5182 (Part-6): 2006, R-2017	24	25	06 $\mu\text{g}/\text{m}^3$ - 420 $\mu\text{g}/\text{m}^3$	06 $\mu\text{g}/\text{m}^3$	120	80			

* LDL indicates Lower Detection Limit.

** All units are in $\mu\text{g}/\text{m}^3$, 24 hourly Average.

[Signature]

ANALYSED BY

[Signature]
(Gaurav Kant)

REVIEWED BY

[Signature]
(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



cmpdi
A Mine Rules Company

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

CMPDI, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD - 826005
Phone: 0326-223-890
Email: rii@cmpdi.coalindia.in

Test Report for Ambient Air Samples

Month & Year		02/2023	Cluster	Cluster III		Report No.		RI-II/AIR/2022-23/11	
Customer		Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)				Date of Issue		31.03.2023	
Project				Sample Ref. No.		REM/BCCL/2023/11		Sampling Method	
Date of Sampling		08-03-2023		22-03-2023		Period of Analysis		01.03.2023 15.03.2023	
								CNIPDL RI-II/LPM 13, (IS 5102)	
								Zone of Station	
								Buffer Zone	
Sl. No.	Parameter	Method Analysis	of	Observed Values (in $\mu\text{g}/\text{m}^3$)		Range Of Testing	LDL	MoEF Standards Notification dated 25th September, 2000 (GSR 742 E)	NAAQS, 2009
				1st FN	2nd FN				
1	PM ₁₀	IS-5182(Part-23), 2006, R-2017		98	121	10 $\mu\text{g}/\text{m}^3$ - 1000 $\mu\text{g}/\text{m}^3$	10 $\mu\text{g}/\text{m}^3$	300	100
2	PM _{2.5}	IS-5182(Part-24), 2019		53	69	10 $\mu\text{g}/\text{m}^3$ - 400 $\mu\text{g}/\text{m}^3$	10 $\mu\text{g}/\text{m}^3$	Not Specified	60
3	SO ₂	IS-5182(Part-2), 2001, R-2017		<10	<10	10 $\mu\text{g}/\text{m}^3$ - 1000 $\mu\text{g}/\text{m}^3$	10 $\mu\text{g}/\text{m}^3$	120	80
4	NO ₂	IS-5182 (Part-6), 2006, R-2017		27	29	06 $\mu\text{g}/\text{m}^3$ - 420 $\mu\text{g}/\text{m}^3$	06 $\mu\text{g}/\text{m}^3$	120	80
**All units are in $\mu\text{g}/\text{m}^3$, 24 hourly Average. * LDL indicates Lower Detection Limit									

**All WTL/DLE in $\mu\text{g}/\text{m}^3$, 24 hourly Average. * LDL indicates Lower Detection Limit.

[Signature]

ANALYSED BY

[Signature]
(Gaurav Kant)
REVIEWED BY

[Signature]

(Amit Raj Mishra)
Authorised Signatory

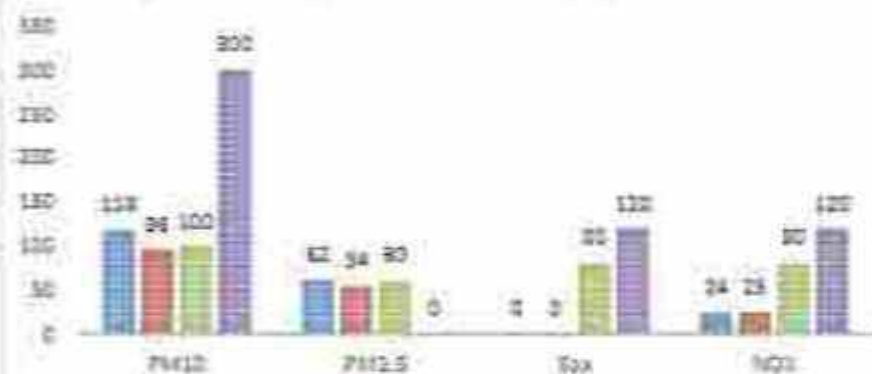
Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env), CMPDI RI-II.

— End of Report —

Page-1 of 1

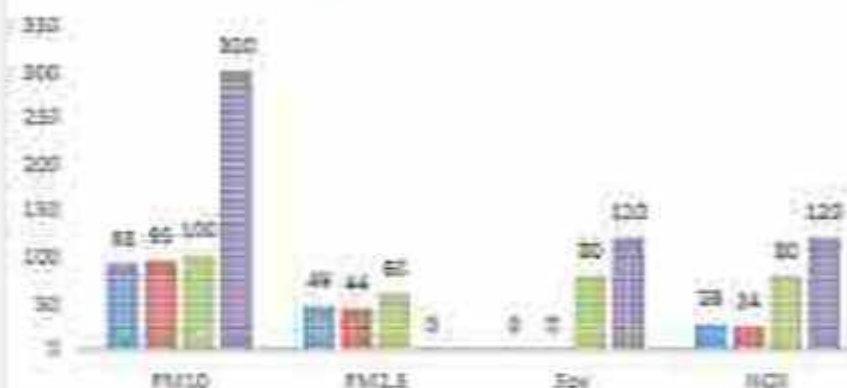
AMBIENT AIR QUALITY AT BLOCK IV KOORIDIH

■ 07-02-2013 ■ 17-02-2013 ■ NAAQS ■ BGR Standards



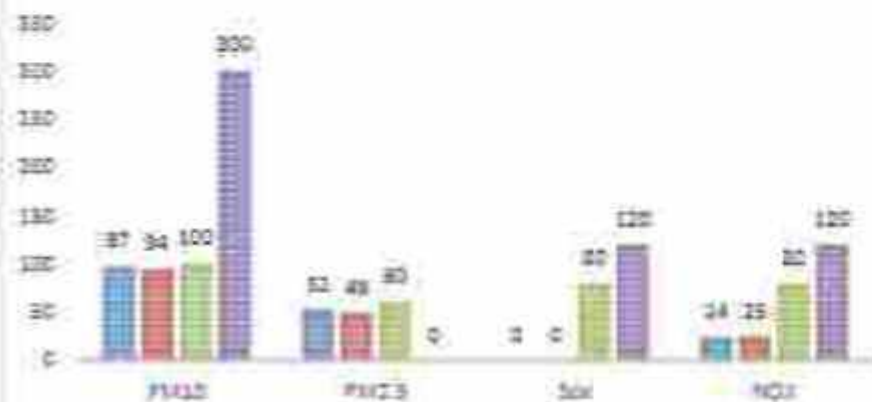
AMBIENT AIR QUALITY AT MURAIIDH OCP

■ 09-02-2013 ■ 14-02-2013 ■ NAAQS ■ BGR Standards



AMBIENT AIR QUALITY AT GOVINDPUR VILLAGE

■ 04-02-2013 ■ 12-02-2013 ■ NAAQS ■ BGR Standards



AMBIENT AIR QUALITY AT KHARKHAREE

■ 08-02-2013 ■ 11-02-2013 ■ NAAQS ■ BGR Standards



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 Khuttia 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

CMPDI, RI-II
 KOTLA BHAWAR COMPLEX
 DHANBAD - 826005
 Phone 0328-223-050
 email: rci2cmpdi@coalindia.in

Test Report for Mine Effluent samples

Month & Year	02/2023	Cluster	Cluster III		Report No.	RI-II/WATER/2022-23/11	
Customer	Environment Department, Bharai Coking Coal Limited (BCCL), Kotla Bhawan, Dhanbad (E-mail: gma@bccl.coalindia.in)					Date of Issue	31.03.2023
Project		Sampling Ref. No.	REM/BCCL/2023/11		Sampling Method	IS 3025 (Part-1) CMPDI/RI-II/LPH 13	
Sampling Stations	(i)	Govindpur	Sample Collected in 2.5 ltr jerrycan. Color as observed is transparent			Period of Analysis	06.03.2023 to 24.03.2023
			Date of Sampling		06.02.23		
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. 25.09.2008)	LOL	
			First Fortnight	Second Fortnight			
1	Total Suspended Solids	IS 3025/17:1984, R-2017, Gravimetric	32	44	100 (Max)	10	
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.81	7.71	5.5 - 9.0	9.2	
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	32	28	250 (Max)	4	

**All units in mg/l, unless specified otherwise. "LOL" indicates Lower Detection Limit & BDL indicates Below Detection Limit.

**Grab sampling carried out for water samples

[Signature]

ANALYSED BY

[Signature]

REVIEWED BY

[Signature]

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 —

NOISE LEVEL QUALITY MONITORING

4.1 Location of sampling sites

- i) Basseriya Managers Office (N9)
- ii) Nichitpur (N8)
- iii) Kusunda / Dhansar OCP (N10)
- i) Pootki Balihari Office (N16)

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 integration 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.



CENTRAL POLICE PLANNING AND DESIGN INSTITUTION LIMITED
 Environmental Laboratory, Regional Institute of
 Advanced, Noise Level Test Report

**CMPDI, E-4
 KOYLA BHAWAN COMPLEX
 DHANBAD - 826005
 Phone: 0326-223-250
 email: ndr@cmpdi.coalindia.in**

Month & Year	02-2023	Cluster	Cluster III	Report No.	RI-01/NOISE/2023-22/11				
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gpran@coalindia.in)				Date of Issue	01.02.2023			
Project		Sample Ref. No.	BCL/BCL/2023/11	Sampling Method	CMPDI/RI-III/LPM 12				
Sampling Station		Block No.		Date of Sampling					
Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Passage	Observed Values (in Leq dB(A)) Second Passage	Method of Analysis	Range of Testing	Leq	Zone Category of Station	Zone Noise
1	Noise Level dB(A) Leq - Day	06:00 - 07:00	55.4	55.1	CPCR Protocol for Ambient Noise Noise Monitoring - 2012	55 dB - 100 dB	55 dB(A)	Industrial Commercial Residential Silence	70 55 55 50
2		07:00 - 08:00	57.6	56.1					
3		08:00 - 09:00	58.2	57.1					
4		09:00 - 10:00	61.7	60.9					
5		10:00 - 11:00	61.8	61.1					
6		11:00 - 12:00	60.5	60					
7		12:00 - 13:00	62.1	60.8					
8		13:00 - 14:00	61.5	60.1					
9		14:00 - 15:00	61.8	60.8					
10		15:00 - 16:00	62.7	62.9					
11		16:00 - 17:00	68.1	66.1					
12		17:00 - 18:00	67.1	67.1					
13		18:00 - 19:00	66	61.8					
14		19:00 - 20:00	60.0	60.8					
15		20:00 - 21:00	59.3	58.1					
16	21:00 - 22:00	57.6	57.8						
17	Leq 24Hr	60.7	60.1						
18	Noise Level dB(A) Leq - Night	23:00-24:00	55.1	55	CPCR Protocol for Ambient Noise Noise Monitoring - 2012	55 dB - 100 dB	55 dB(A)	Industrial Commercial Residential Silence	70 55 55 50
19		25:00-00:00	57.6	56.6					
20		00:00-01:00	58.9	57.8					
21		01:00-02:00	57.7	56					
22		02:00-03:00	58.9	58.1					
23		03:00-04:00	59.4	58.8					
24		04:00-05:00	58.1	58.1					
25		05:00-06:00	62.8	62.8					
26	Leq NIGHT		57.7	58.1					

Leq: Leq (A-weighted) Level (dB(A))

dB: decibel (sound pressure level) (dB) (A-weighted) (dB(A))

Sampling Assistant
ANALISED BY

Signature of
(Country Head)
KATUNDA AT

Signature of
Authorized Signature

Note: The results shown relate to the samples tested as required. This report can not be reproduced in part or full without the written permission of the CMPDI, E-4.

End of Report
Page 1 of 1

  cmpdi <i>A New Vision, Same Quality</i>		CENTRAL POLLUTION CONTROL BOARD Environmental Laboratory, Regional Station-III Andhra Pradesh State Level Report				CMPDI, B-4 SOVIKASHAW COMPLEX CHANDRABAGH, VISAKHAPATNAM Phone: 0831-233-833 email: cmpdi@vsnl.com			
Month & Year	1/2022	Cluster	Cluster III	Customer	Government Department, Bharat Coking Coal Limited (BCCL), Rayu Sharma, Chakradhar (E-mail: gprashr.bcl@bccl.co.in)	Report No.	BC-III/2022/22-12	Date of Issue	22.02.2022
Project		Sample Ref. No.	BCCL/BCCL/2022/19	Sampling Method		CMPDI/BC-III/LPH-12			
Sampling Station	1	Surrounding DOF		Date of Sampling	14.02.2022	14.02.2022	Zone Category of Station	Surveillance Zone	
Sr. No.	Parameter	Time (Time of day)	Observed Value (in $\mu\text{g}/\text{m}^3$) First Reading	Observed Value (in $\mu\text{g}/\text{m}^3$) Second Reading	Method of Analysis	Range of Testing	ISL	HOUSE POLLUTION (REGULATION AND CONTROL) 2018 Standards	Surveillance Zone
1	Total Lead (Pb) (Lug - Day)	06:00 - 07:00	11.5	11.5	CPCB Protocol for Ambient Lead, House Monitoring - 2018	11.5-121.59	11 (Pb(A))	Industrial Commercial Residential School	73 93 91 90
2		07:00 - 08:00	12.3	17.1					
3		08:00 - 09:00	13.3	18.9					
4		09:00 - 10:00	13.5	20					
5		10:00 - 11:00	12.1	22.2					
6		11:00 - 12:00	11.5	21.8					
7		12:00 - 13:00	14.8	24.2					
8		13:00 - 14:00	11	21.8					
9		14:00 - 15:00	12.1	21.2					
10		15:00 - 16:00	11.2	23.8					
11		16:00 - 17:00	12.8	18.2					
12		17:00 - 18:00	12.1	15.1					
13		18:00 - 19:00	12.2	12.2					
14		19:00 - 20:00	11.1	12.8					
15	Total Lead (Pb) (Lug - Night)	20:00 - 21:00	12.3	12.8	CPCB Protocol for Ambient Lead, House Monitoring - 2018	11.5-121.59	11 (Pb(A))	Industrial Commercial Residential School	73 93 91 90
16		21:00 - 22:00	12.7	12.1					
17		22:00 - 23:00	12.3	10.3					
18		23:00 - 24:00	11.8	11.1					
19		00:00 - 01:00	11.8	11.2					
20		01:00 - 02:00	11.1	11.1					
21		02:00 - 03:00	11.3	12.1					
22		03:00 - 04:00	12.3	11.8					
23	Lug (BRT)	04:00 - 05:00	12.8	12.1					
24		05:00 - 06:00	11.2	10.2					

*All values must be reported in $\mu\text{g}/\text{m}^3$ for a 24 hour period, if with a unit.

Sampling Stations: ANALYZED BY:  (Analyst Name)  (Supervisor Name)

Page 3 of 3



CENTRAL POLLUTION CONTROL BOARD
Environmental Laboratory, Regional Institute-II
Address: Kalyan Nagar, Lucknow

CPCB, W-4
KOLLA BHAWAN COMPLEX
DHANBAD - 826005
Phone: 2225-223-850
email: cpcb@compdi.coalindia.in

Month & Year	01/2023	Cluster	Cluster III	Customer	Environment Department, Bharat Coking Coal Limited (BCCL), Kalyan Nagar, Dhanbad (Email: gm@bccl.coalindia.in)	Report No.	01/1/00111/2023/23/11		
Project		Sample Ref. No.	BCCL/BCCL/2023/11	Sampling Method		Date of Issue	21.02.2023		
							CPCB/BII-II/LPH-12		
Sampling Station		Grindapur Village		Date of Sampling	16.02.2023	17.02.2023	Zone Category of Station	Buffer Zone	
Sl. No.	Parameter	Hour / Time of Day	Observed Value (in Lag dB(A)) First Reading	Observed Value (in Lag dB(A)) Second Reading	Method of Analysis	Range of Testing	LLO	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zone Limits in dB	
1	Noise Level dB(A) (Lag - Day)	06:00 - 07:00	41.8	42.8	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	55 dB (L10) dB	55 dB (A)	Industrial Commercial Residential Others	70 60 50 50
2		07:00 - 08:00	43.8	43					
3		08:00 - 09:00	44.3	44					
4		09:00 - 10:00	45.8	45.8					
5		10:00 - 11:00	46.3	46.2					
6		11:00 - 12:00	46.8	46.8					
7		12:00 - 13:00	46.7	47.1					
8		13:00 - 14:00	47.2	46.3					
9		14:00 - 15:00	47.3	47.3					
10		15:00 - 16:00	48.8	48.2					
11		16:00 - 17:00	48.8	48.8					
12		17:00 - 18:00	48.3	48.3					
13		18:00 - 19:00	48.8	47.1					
14		19:00 - 20:00	47.3	46.8					
15	Noise Level dB(A) (Lag - Night)	20:00 - 21:00	47.3	48.3	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	55 dB (L10) dB	55 dB (A)	Industrial Commercial Residential Others	70 60 50 50
16		21:00 - 22:00	48	48.1					
17		Lag DAY	47.1	47.3					
18		22:00 - 23:00	46.8	46.1					
19		23:00 - 00:00	46.7	46.3					
20		00:00 - 01:00	46.8	46.1					
21		01:00 - 02:00	46.1	46.1					
22		02:00 - 03:00	46.3	46.3					
23	Lag NIGHT	04:00 - 05:00	46	47.2					
24		05:00 - 06:00	46	46.8					

Sampling Station

GRINDAPUR VILLAGE

Reported By

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

Signature

(Cooper Name)

Authorised Signatory

<

"All noise measurement and data are subject to the CPCB, BII-II/LPH-12"

Sampling Stations

01/1/2023/23

(Date)

SATISFIED BY

Rd (Mitra)

Authorized Signatory

Note: The results given relate to the sample tested or received. This report can not be reproduced in part or full without the written permission of the BII-II/LPH-12, CPCB, BII-II.

Page 1 of 1



cmpdi
Central Noise Planning and Design Institute Limited

CENTRAL NOISE PLANNING AND DESIGN INSTITUTE LIMITED

Environmental Laboratory, National Institute of

Ambient Noise Level Test Report

Month & Year	02/2023	Cluster	Cluster III	Report No.	EN/II/NOISE/2023-28/11
Customer	Securamex Department, Bharat Coking Coal	Licensed (BCCL), Bara Bhevon, Chhindwad (E-mail: gpran.bh@bharatcoal.co)	Date of Issue	31.03.2023	
Project		Sample Ref. No.	ENM/BCCL/2022/11	Sampling Method	CMPDI/EN/II/LPW 1.2
Sampling Stations	S	Observation	Date of Sampling	06.02.2023	11-02-2023
St. No.	Parameter	Time / Time of day	Observed Values (in Leq dB(A)) First Porting	Observed Values (in Leq dB(A)) Second Porting	Method of Analysis
1	Noise Level dB(A) (Leq - Day)	06:00 - 07:00	22.7	23.1	CNC, Protocol for Ambient Level Noise Monitoring - 2015
2		07:00 - 08:00	27.7	27.5	
3		08:00 - 09:00	28.6	28.3	
4		09:00 - 10:00	28.3	28.2	
5		10:00 - 11:00	28.3	28.3	
6		11:00 - 12:00	28.3	28.7	
7		12:00 - 13:00	28.8	29.2	
8		13:00 - 14:00	28.1	27.5	
9		14:00 - 15:00	28	22.2	
10		15:00 - 16:00	22.3	22.8	
11		16:00 - 17:00	22.8	22.1	
12		17:00 - 18:00	22.3	22.2	
13		18:00 - 19:00	22.1	22.1	
14		19:00 - 20:00	20.1	20.2	
15		20:00 - 21:00	20.2	20.2	
16	21:00 - 22:00	27.9	28.2	CNC, Protocol for Ambient Level Noise Monitoring - 2015	
17	22:00 - 23:00	21.1	21.1		
18	23:00 - 00:00	22.2	22.2		
19	00:00 - 01:00	22.2	22.2		
20	01:00 - 02:00	22.2	22.2		
21	02:00 - 03:00	22.2	22.2		
22	03:00 - 04:00	22.2	22.2		
23	04:00 - 05:00	20.1	20.1	CNC, Protocol for Ambient Level Noise Monitoring - 2015	
24	05:00 - 06:00	20.2	20.2		
25	06:00 - 07:00	22.2	22.2		
Sampling Stations: ENM/BCCL 2023 (Signature Name): SATHISH D (Signature): (Signature): Authorised Signatory					

Note: The results shall remain in the original format as received. This report can be reproduced in print & soft without the written permission of the CNDP/C, CMPDI, EN/II.

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 $\mu\text{g}/\text{m}^3$ 700 $\mu\text{g}/\text{m}^3$	High Volume Sampling (Average flow rate not less than 1.1)
	Respirable Particulate Matter (size less than 10 μm) (RPM)	Annual Average * 24 hours **	250 $\mu\text{g}/\text{m}^3$ 300 $\mu\text{g}/\text{m}^3$	Respirable Particulate Matter sampling and analysis
	Sulphur Dioxide (SO_2)	Annual Average * 24 hours **	80 $\mu\text{g}/\text{m}^3$ 120 $\mu\text{g}/\text{m}^3$	1 Improved wet and Gaeke method 2 Ultraviolet fluorescence
	Oxide of Nitrogen as NO_2	Annual Average * 24 hours **	80 $\mu\text{g}/\text{m}^3$ 120 $\mu\text{g}/\text{m}^3$	1 Jacob & Hochheiser Modified (Na -Arsenic) Method 2 Gas phase Chemiluminescence

Note:

- * Annual Arithmetic mean for the measurements taken in a year, following the guidelines for frequency of sampling laid down in clause 2.
- ** 24 hourly/8 hourly values shall be met 92% of the time in a year. However, 8% of the time it may exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (b) of section 18 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.354(E), dated 11th April 1994 and S.O.335(E), dated 14th NOVEMBER 1988, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

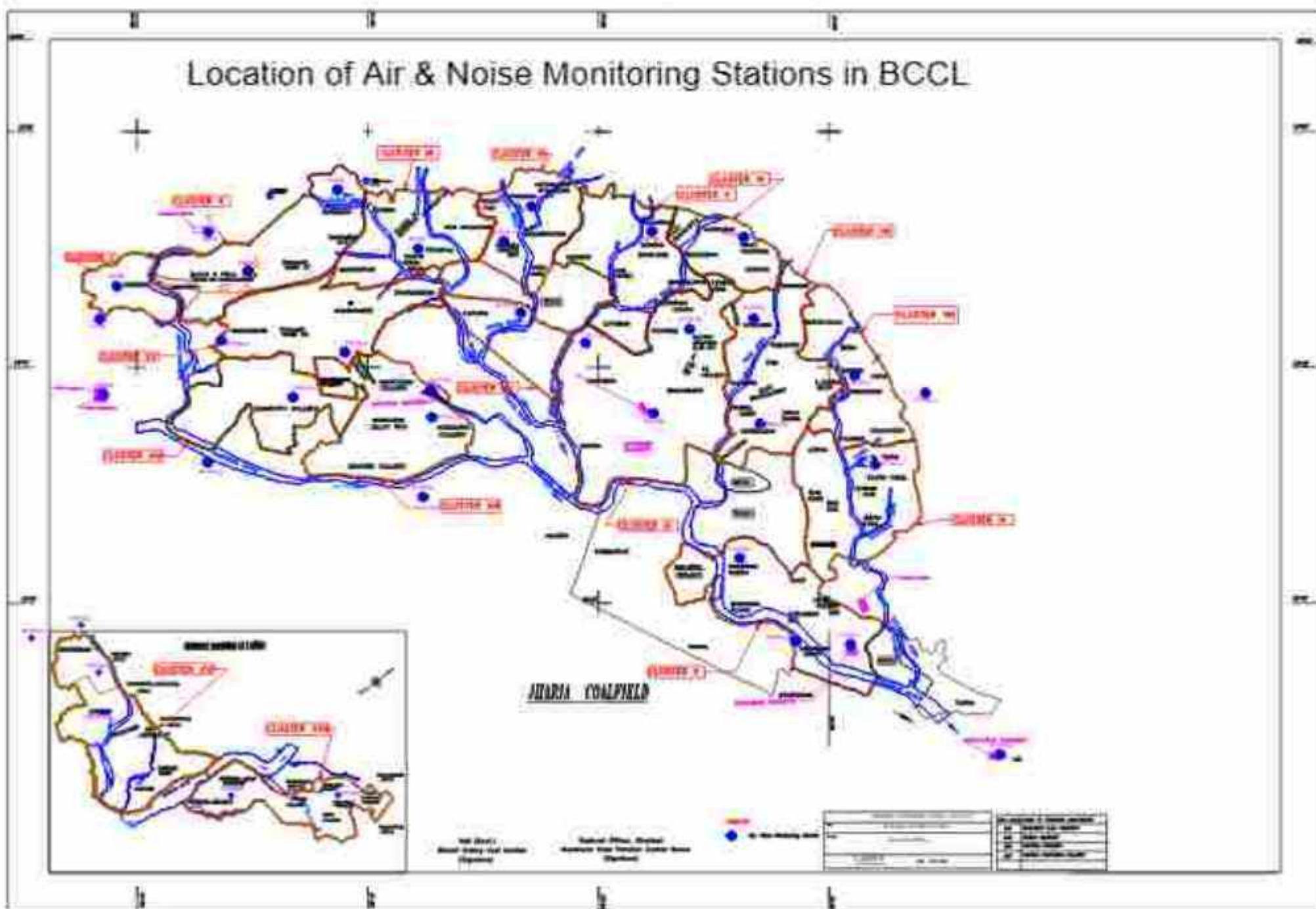
Pollutant	Time Weighted Average	Concentration in Ambient Air Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	Methods of Measurement
Sulphur Dioxide (SO ₂), $\mu\text{g}/\text{m}^3$	Annual * 24 Hours **	50 80	20 40	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogen dioxide (NO ₂), $\mu\text{g}/\text{m}^3$	Annual * 24 Hours **	40 80	30 60	-Salt and Griessner modified (NaOH NaAsO ₂) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10 μm) or PM ₁₀ , $\mu\text{g}/\text{m}^3$	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5 μm) or PM _{2.5} , $\mu\text{g}/\text{m}^3$	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O ₃), $\mu\text{g}/\text{m}^3$	8 Hours * 1 Hour **	100 160	100 160	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb), $\mu\text{g}/\text{m}^3$	Annual * 24 Hours **	0.50 1.0	0.50 1.0	-AAS/ICP Method after sampling on EPM 3000 or equivalent filter paper -ED XRF using Teflon filter
Carbon Monoxide (CO), mg/m^3	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH ₃), $\mu\text{g}/\text{m}^3$	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C ₆ H ₆), $\mu\text{g}/\text{m}^3$	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m^3	Annual *	01	01	-Solvent extraction followed by HPLC/GC analysis
Arsenic (As), ng/m^3	Annual *	08	08	-AAS/ICP Method after sampling on EPM 3000 or equivalent filter paper
Nickel (Ni), ng/m^3	Annual *	20	20	-AAS/ICP Method after sampling on EPM 3000 or equivalent filter paper

* Annual Arithmetic mean of minimum 116 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

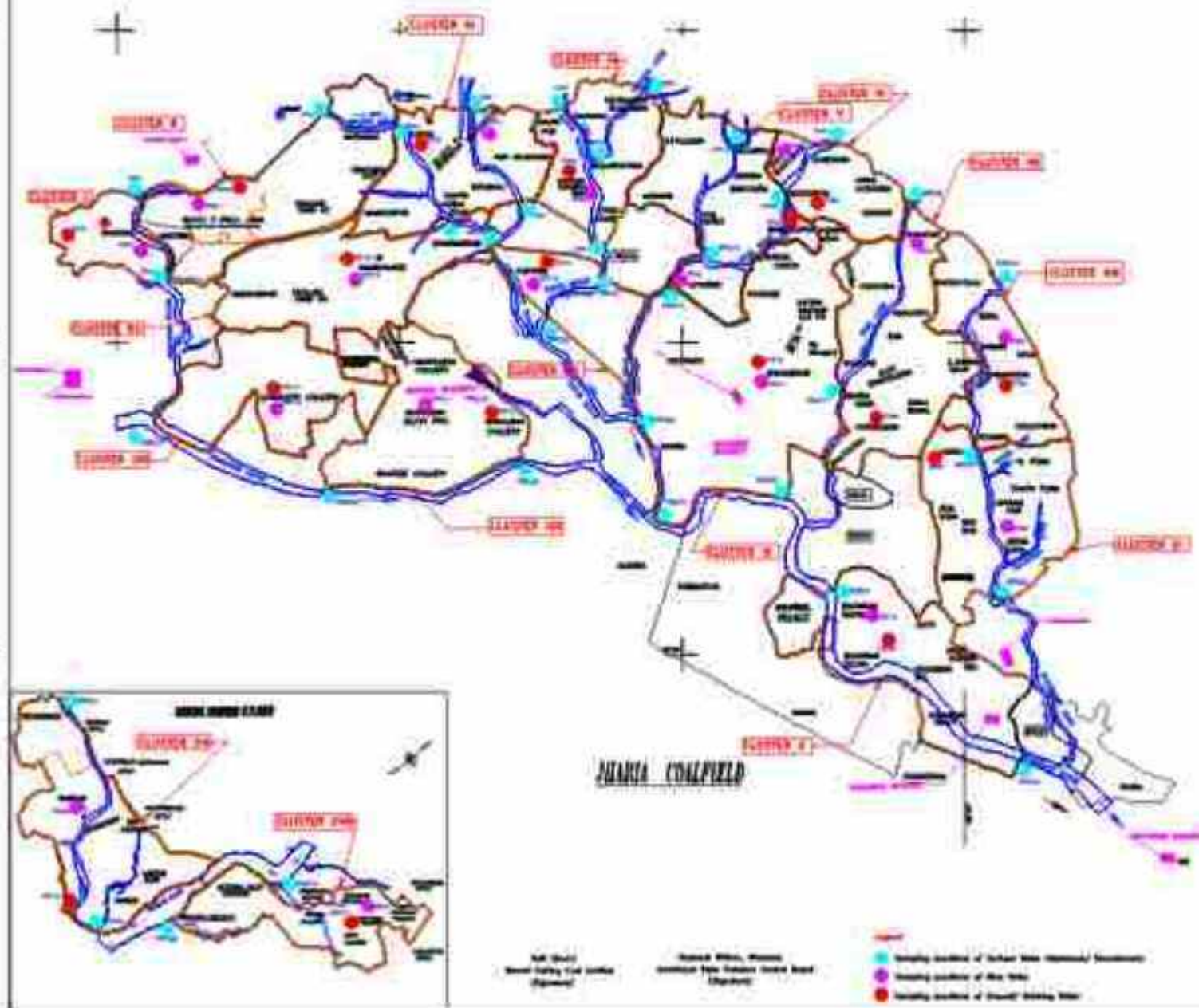
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 95% of the time in a year, 4% of the time may A/QAE exceed the limits but not on ten consecutive days of monitoring.

NOTE: Whenever and whenever 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



Sl. No.	Project Name	Project Type	Project Status	Project Manager	Project Start Date	Project End Date	Project Budget	Project Actual Cost	Project Variance
1	Project A	Construction	Completed	John Doe	2020-01-01	2020-03-31	\$100,000	\$95,000	\$5,000
2	Project B	Software Development	In Progress	Jane Smith	2020-02-01	2020-05-31	\$200,000	\$180,000	\$20,000
3	Project C	Marketing Campaign	Completed	Mike Johnson	2020-03-01	2020-04-30	\$50,000	\$52,000	-\$2,000
4	Project D	Research & Development	On Hold	Sarah Lee	2020-04-01	2020-06-30	\$150,000	\$100,000	\$50,000
5	Project E	Infrastructure Upgrade	Completed	David Brown	2020-05-01	2020-07-31	\$300,000	\$290,000	\$10,000
6	Project F	Product Launch	In Progress	Emily White	2020-06-01	2020-08-31	\$75,000	\$70,000	\$5,000
7	Project G	System Integration	Completed	Chris Green	2020-07-01	2020-09-30	\$120,000	\$115,000	\$5,000
8	Project H	Customer Service Initiative	On Hold	Alex Black	2020-08-01	2020-10-31	\$80,000	\$40,000	\$40,000
9	Project I	Website Redesign	Completed	Olivia Grey	2020-09-01	2020-11-30	\$60,000	\$58,000	\$2,000
10	Project J	Supply Chain Optimization	In Progress	Noah Blue	2020-10-01	2020-12-31	\$180,000	\$160,000	\$20,000

STRICTLY RESTRICTED
FOR COMPANY USE ONLY RESTRICTED

The information given in this report is not to be
 commercialized either directly or indirectly in the
 press or by any person not holding an official
 position in the CIL GOVERNMENT

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

(FOR THE MONTH MARCH, 2023)

E. C. no. J-11015/213/2010-IA.II (M) dated 06.02.2013.



CMPDI

ISO 9001 Company
 Regional Institute-II
 Dhanbad, Jharkhand

CONTENTS

SL. NO.	CHAPTER	PARTICULARS	PAGE NO.
1.	CHAPTER - I	EXECUTIVE SUMMARY	3-5
2.	CHAPTER-II	INTRODUCTION	6
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°37' N to 23°52' N latitudes and 86°09' E to 86°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 (PM₁₀), Fine Particulate Matter (PM_{2.5}), Sulphur Di-oxide (SO₂) 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 Koordih Mixed Mine. 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.

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 PM₁₀, PM_{2.5}, SO₂, NO_x 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) Govindpur Village (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



cmpdi
A Mine Rules Company

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

CMPDI, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD - 828005
Phone: 0326-225-890
email: info@cmpdi.coalindia.in

Test Report for Ambient Air Samples

Month & Year		05/2023	Cluster	Cluster III			Report No.	RI-II/AIR/2022-23/12	
Customer		Environment Department, Bharat Coling Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gmenvr.bcl@coalindia.in)						Date of Issue	29.04.2023
Project		Block-IV	Sample Ref. No.		REM/BCL/2023/12		Sampling Method		
Date of Sampling		13.03.23		23.03.23		Period of Analysis	13.03.2023	30.03.2023	Zone of Station: Core Zone
Sl. No.	Parameter	Method Analysis	of	Observed Values (in $\mu\text{g}/\text{m}^3$)		Range Of Testing	LDL	MoEF Standards Notification dated 25th September, 2000 (GSR 742 E)	NAAQS, 2009
				1st FN	2nd FN				
1	PM_{10}	IS -5182(Part-23) 2006, R-2017		90	116	$10 \mu\text{g}/\text{m}^3 - 1000 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	300	100
2	$\text{PM}_{2.5}$	IS -5182(Part-24) 2019		45	58	$10 \mu\text{g}/\text{m}^3 - 400 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	Not Specified	60
3	SO_2	IS-5182(Part-I), 2001, R-2017		<10	<10	$10 \mu\text{g}/\text{m}^3 - 1000 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	120	80
4	NO_2	IS-5182 (Part-6) 2006, R-2017		27	29	$05 \mu\text{g}/\text{m}^3 - 420 \mu\text{g}/\text{m}^3$	$06 \mu\text{g}/\text{m}^3$	120	80

* LDL indicates Lower Detection Limit,

** All units are in $\mu\text{g}/\text{m}^3$, 24 hourly Average,

[Signature]
ANALYSED BY

[Signature]
(Gaurav Kant)
REVIEWED BY

[Signature]
(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



cmpdi
A Mine Related Company

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

CMFDI, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD - 826005
Phone: 0326-223-890
email: rdi2@cmpdi.coalindia.in

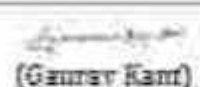
Test Report for Ambient Air Samples

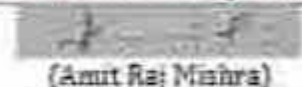
Month & Year		03/2023	Cluster		Cluster III	Report No.		RI-II/AIR/2022-23/12
Customer		Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bcl@coalindia.in)				Date of Issue		29.04.2023
Project		Nuraidih	Sample Ref. No.		REM/BCL/2023/12	Sampling Method		CMFDI/RI-II/LPM 12, (IS 5182)
Date of Sampling		11.03.23	17.03.23	Date of Sampling	11.03.2023	10.03.2023	Zone of Station:	Buffer Zone
Sl. No.	Parameter	Method Analysis of	Observed Values (in $\mu\text{g}/\text{m}^3$)		Range Of Testing	LDL	MoEF Standards Notification dated 25th September, 2000 (GSR 742-E)	NAAQS, 2009
			1st FN	2nd FN				
1	PM_{10}	IS-5182(Part-23) 2006, R-2017	96	93	$10 \mu\text{g}/\text{m}^3 - 1200 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	300	100
2	$\text{PM}_{2.5}$	IS-5182(Part-24) 2019	59	42	$10 \mu\text{g}/\text{m}^3 - 400 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	Not Specified	60
3	SO_2	IS-5182(Part-2) 2001, R-2017	<10	<10	$10 \mu\text{g}/\text{m}^3 - 1250 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	120	80
4	NO_2	IS-5182 (Part-6) 2006, R-2017	25	26	$06 \mu\text{g}/\text{m}^3 - 420 \mu\text{g}/\text{m}^3$	$06 \mu\text{g}/\text{m}^3$	120	80

* LDL indicates Lower Detection Limit.

** All units are in $\mu\text{g}/\text{m}^3$, 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), CMFDI RI-II.

--- End of Report ---
Page -1 of 1



cmpdi
A World Mined Company

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

CMPDIL RI-II
KOYLA SHAWAN COMPLEX
DHANBAD - 826005
Phone: 0226-223-850
email: rdi2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year		03/2023	Cluster III		Report No.		RI-II/AIR/2022-23/12		
Customer		Environment Department, Bharat Coking Coal Limited (BCL), Koyla Shawan, Dhanbad (E-mail: gmam.bcl@coalindia.in)				Date of Issue		29.04.2023	
Project		Govindpur	Sample Ref. No.		REM/BCL/2023/12	Sampling Method		CMPDI/RI-II/LPM 13, (IS 5182)	
Date of Sampling		14.03.23	24.03.23	Period of Analysis		14.03.2023	24.03.2023	Zone of Station:	Buffer Zone
Sl. No.	Parameter	Method of Analysis	Observed Values (in $\mu\text{g}/\text{m}^3$)		Range Of Testing	LDL	MoEF Standards Notification dated 25th September 2000 (CSR 742 E)	NAAQS, 2009	
			1st FN	2nd FN					
1	PM_{10}	IS-5182(Part-23):2006, R-2017	39	113	$10 \mu\text{g}/\text{m}^3 - 1000 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	300	100	
2	$\text{PM}_{2.5}$	IS-5182(Part-24):2019	45	51	$10 \mu\text{g}/\text{m}^3 - 400 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	Not Specified	60	
3	SO_2	IS-5182(Part-2):2001, R-2017	<10	<10	$10 \mu\text{g}/\text{m}^3 - 1090 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	120	80	
4	NO_2	IS-5182 (Part-6):2006, R-2017	23	27	$06 \mu\text{g}/\text{m}^3 - 420 \mu\text{g}/\text{m}^3$	$06 \mu\text{g}/\text{m}^3$	120	80	

* LDL indicates Lower Detection Limit.

** All units are in $\mu\text{g}/\text{m}^3$, 24 hourly Average.

[Signature]

ANALYSED BY

[Signature]
(Gaurav Kant)

REVIEWED BY

[Signature]
(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



cmpdi
A Mine Rules Company

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

CMPDI, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD - 826005
Phone: 0326-223-890
Email: rii@cmpdi.coalindia.in

Test Report for Ambient Air Samples

Month & Year		03/2023	Cluster		Cluster III		Report No.		RI-II/AIR/2022-23/12						
Customer		Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bcl@coalindia.in)					Date of Issue		29.04.2023						
Project		Kharkharae		Sample Ref. No.		REM/BCCL/2023/12		Sampling Method		CMPDI/RI-II/LPM 13, (IS 5102)					
Date of Sampling		11.03.23		12.03.23		Period of Analysis		11.03.2023		02.03.2023		Zone of Station		Buffer Zone	
Sl. No.	Parameter	Method Analysis	of	Observed Values (in $\mu\text{g}/\text{m}^3$)		Range Of Testing	LDL	MoEF Standards Notification dated 25th September 2000 (GSR 743 E)	NAAQS, 2009						
				1st FN	2nd FN										
1	PM_{10}	IS-5182(Part-23):2006, R-2017		97	116	$10 \mu\text{g}/\text{m}^3 - 1000 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	300	100						
2	$\text{PM}_{2.5}$	IS-5182(Part-24):2019		58	64	$10 \mu\text{g}/\text{m}^3 - 400 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	Not Specified	60						
3	SO_2	IS-5182(Part-3):2001, R-2017		10	<10	$10 \mu\text{g}/\text{m}^3 - 1000 \mu\text{g}/\text{m}^3$	$10 \mu\text{g}/\text{m}^3$	120	80						
4	NO_2	IS-5182 (Part-6):2006, R-2017		26	26	$06 \mu\text{g}/\text{m}^3 - 420 \mu\text{g}/\text{m}^3$	$06 \mu\text{g}/\text{m}^3$	120	80						

**All WTL/DLE in $\mu\text{g}/\text{m}^3$, 24 hourly Average. * LDL indicates Lower Detection Limit.

[Signature]

ANALYSED BY

[Signature]
(Gaurav Kant)
REVIEWED BY

[Signature]

(Amit Raj Mishra)
Authorised Signatory

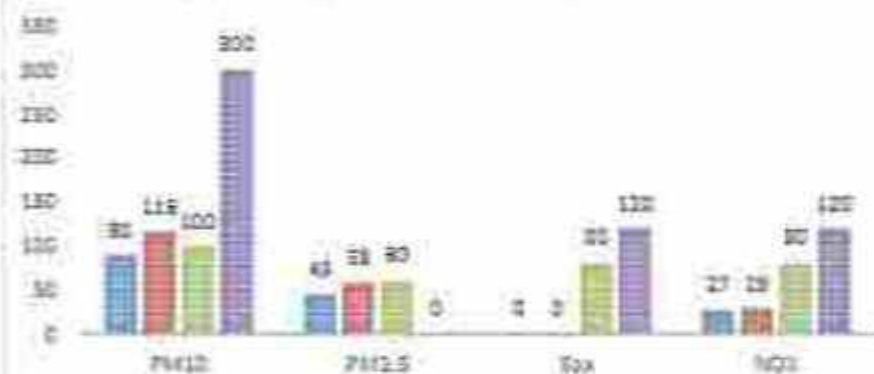
Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env), CMPDI RI-II.

— End of Report —

Page-1 of 1

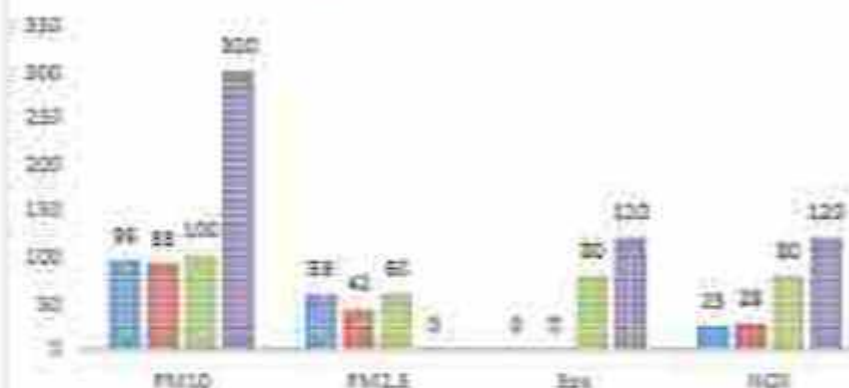
AMBIENT AIR QUALITY AT BLOCK IV KOORIDIH

■ 13.03.23 ■ 17.03.23 ■ NAAQS ■ OGP Standards



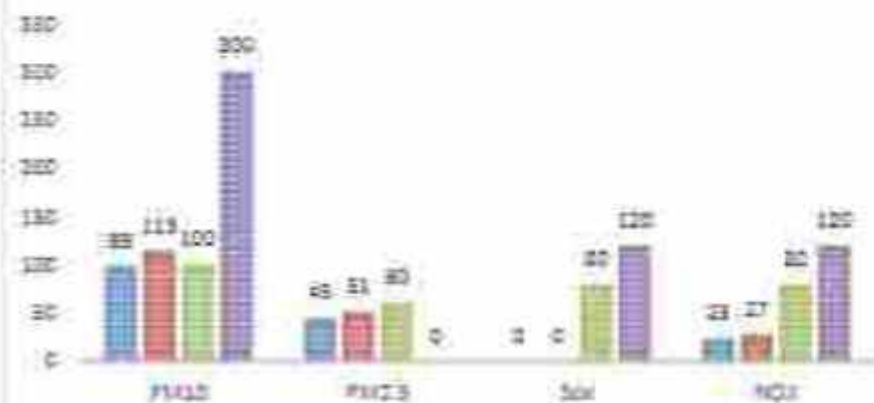
AMBIENT AIR QUALITY AT MURAIIDH OCP

■ 11.03.23 ■ 17.03.23 ■ NAAQS ■ OGP Standards



AMBIENT AIR QUALITY AT GOVINDPUR VILLAGE

■ 14.03.23 ■ 14.03.23 ■ NAAQS ■ OGP Standards



AMBIENT AIR QUALITY AT KHARKHAREE

■ 11.03.23 ■ 12.03.23 ■ NAAQS ■ OGP Standards



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 Khuttia 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

CMPDI, RI-II
 KIVRA BINAWAN COMPLEX
 CHANDABAD - 835003
 Phone: 0336-233-833
 email: cdi@cmpdi.coalindia.in

Test Report for Mine Effluent samples

Month & Year	03/2023	Cluster	Cluster III	Report No.	RI-II/WATER/2022-23/12
Customer	Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmanr.bcci@coalindia.in)				Date of Issue 29.04.2023
Project		Sampling Ref. No.	REM/BCCL/2023/12	Sampling Method	IS 3025 (Part-1) CMPDI/RI-II/LPH 13
Sampling Stations	(I)	Covindpur	Sample Collected in 2.5 ltr jerrycan. Color as observed is transparent		Period of Analysis 06.03.2023 to 17.04.2023
			Date of Sampling	06.03.23 20.03.23	
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: 29.09.2000)
			First Fortnight	Second Fortnight	LDL
1	Total Suspended Solids	IS 3025/17-1984, R: 2017, Gravimetric	33	42	100 (Max)
2	pH	IS 3025/11-1983, R: 2017, Electrometric	7.91	8	5.5 - 9.0
3	Oil & Grease	IS 3025/39-1991, R: 2019, Partition Gravimetric	<2.0	<2.0	10 (Max)
4	COD	APHA 23rd Edition 5320 C Titrimetric Method	20	28	250 (Max)

***All units in mg/L unless specified otherwise. LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

Double 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 —

NOISE LEVEL QUALITY MONITORING

4.1 Location of sampling sites

- i) Basseriya Managers Office (N9)
- ii) Nichitpur (N8)
- iii) Kusunda / Dhansar OCP (N10)
- iv) Pootki Bahari Office (N16)

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 integration 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.



cmpdi
Central Pollution Control Board
Ministry of Environment, Forest and Climate Change, Government of India

INDIA WASTE PLANNING AND DESIGN INSTITUTE LIMITED
Environmental Laboratory, Regional Institute II
Ambattur Noise Level Test Report

CMPDI, B-4
SOVIK SHAWAN COMPLEX
CHANNAYAN, CHENNAI-600005
Phone: 022-233-8333
Email: cmpdi@cmpdi.co.in

Month & Year	03/2023	Cluster	Cluster III	Report No.			SI/III/NOISE/2023-23/12		
Customer	Kieritormas Department, Bharat Coking Coal Limited (BCCL), Forte Bhawan, Chaboot (E-mail: gmanish.bcl@bharatcoal.co)			Date of Issue			29.04.2023		
Project	Sample Ref. No.			BCCL/BCCL/2023/12		Sampling Method		CMPDI, SI/III/LPM 12	
Sampling Stations	I	Warabith DCF	Date of Sampling		11.03.23	17.03.23	Time Category of Station		Buffer Zone
Sl. No.	Parameter	Hour / Time of day	Observed Values [In Lag dB(A)] First Fortnight	Observed Values [In Lag dB(A)] Second Fortnight	Method of Analysis	Range Of Testing	LQs	NOISE POLLUTION (REGULATION AND CONTROL) RELATED STANDARDS	
1	Noise Level [dB(A)] - Day	06:00 - 07:00	47.2	47.7	CPCB Protocol for Ambient Level Noise Monitoring - 2013	25 dB-125 dB	25 dB(A)	Industrial Commercial Residential Silence	75 45 35 50
2		07:00 - 08:00	48.2	50.4					
3		08:00 - 09:00	54.7	53					
4		09:00 - 10:00	55.8	55.5					
5		10:00 - 11:00	55.7	55.1					
6		11:00 - 12:00	58.3	58.1					
7		12:00 - 13:00	58	60.3					
8		13:00 - 14:00	55.3	55.1					
9		14:00 - 15:00	55.7	56.1					
10		15:00 - 16:00	56.3	55.2					
11		16:00 - 17:00	55.7	55.7					
12		17:00 - 18:00	58.8	58.2					
13		18:00 - 19:00	56.7	56.5					
14		19:00 - 20:00	47.3	49.3					
15		20:00 - 21:00	46.8	46.7					
16		21:00 - 22:00	46.5	45.8					
		Lag dB	55.1	55.2					
1	Noise Level [dB(A)] - Night	22:00-23:00	51	50.5	CPCB Protocol for Ambient Level Noise Monitoring - 2013	25 dB-125 dB	25 dB(A)	Industrial Commercial Residential Silence	75 45 35 50
2		23:00-00:00	50.7	50.8					
3		00:00-01:00	50.5	50.2					
4		01:00-02:00	49.2	48					
5		02:00-03:00	48.5	47.5					
6		03:00-04:00	47.8	47.1					
7		04:00-05:00	47.8	47.3					
8		05:00-06:00	47.8	47.3					
		Lag dB	55.1	55.2					

125, Industrial Level Category - LPM

*All noise measurements are reported for 2.5 hour period at 10m to 25m

Sampling Stations

03611282 ST

Signature

(Center Seal)

03611282 ST

By (Name)

Authorized Signatory

Note: The results above relate to the program tested as indicated. This report can not be reproduced in part or full without the written permission of the CMPDI, CHENNAI, INDIA.

— End of Report —

Page 4 of 5



cmpdi

Environment Laboratory, Registrar, Institute of
Advanced Study, Level 1, East Campus

CHENNAI, INDIA
KOTLA BHAYAN COMPLEX
CHENNAI - 600002
Phone: 044-225-8000
www.vadilam.com

Month & Year	03/2023	Cluster	Cluster III	Report No.			SC/II/2022/2023-23/12					
Customer	Electronics Department, Bharat Coking Coal Limited (BCL), Rourkela Division, Odisha (E-mail: gm@bcl.coilodisha.in)			Date of Issue			19.04.2023					
Project	Sample Ref. No.			BCL/BCL/2023/12			Sampling Method			CEPDC/BI/IL/1P/11		
Sampling Stations	i	Geographical Village		Date of Sampling		14.03.23	24.03.23	Zone Category of Station		Buffer Zone		
Sl. No.	Parameter	Hour / Time of Day	Observed Values (in $\mu\text{g}/\text{m}^3$) First Fortnight	Observed Values (in $\mu\text{g}/\text{m}^3$) Second Fortnight	Method of Analysis	Range of Testing	LDL	PM10 POLLUTION (REGULATION AND CONTROL) CEPDC, 2020 Standards		Zone		Limit in $\mu\text{g}/\text{m}^3$
1	Noise Level dB(A) Leq - Day	08:00 - 07:00	51.8	51.2	CEPDC, Protocol for Ambient Level Noise Monitoring - 2015	55 dB - 115 dB	55 dB(A)	Industrial Commercial Residential Traffic	70			
2		07:00 - 06:00	47.8	51.1								
3		06:00 - 05:00	40.2	50.8								
4		05:00 - 04:00	47	48.1								
5		04:00 - 03:00	58.6	47.2								
6		03:00 - 02:00	47	46.1								
7		02:00 - 01:00	70.8	71.8								
8		01:00 - 00:00	71.9	70.7								
9		00:00 - 23:00	61.2	61.2								
10		23:00 - 22:00	62.1	62.1								
11		22:00 - 21:00	62.8	62.2								
12		21:00 - 20:00	62.2	62.1								
13		20:00 - 19:00	62.1	62.1								
14		19:00 - 18:00	62.2	62.2								
15		18:00 - 17:00	61.1	59								
16		17:00 - 16:00	52.7	54.3								
1	Noise Level dB(A) Leq - Night	Leq Day	55.7	55.2	CEPDC, Protocol for Ambient Level Noise Monitoring - 2015	55 dB - 115 dB	55 dB(A)	Industrial Commercial Residential Traffic	70			
2		23:00-02:00	58.8	58.1								
3		22:00-01:00	55.7	58.2								
4		20:00-01:00	56.7	56.8								
5		21:00-02:00	51.8	51.8								
6		22:00-03:00	51.2	51.2								
7		24:00-02:00	58.1	52.8								
8		20:00-04:00	47.2	48.8								
9		Leq NIGHT	47.2	46.7								

Sampling Assistant
ANILYING BI

Signature of
(Cluster Sam)

REVIEWED BY



Authorised Signatory

NOTE: The laboratory results are the original tested at reference. This report can not be reproduced in part or full without the written permission of the HQ/CEPDC, CEPDC, BI/II.

— End of Report —

Page 6 of 8



compai

CENTRAL WIRE PLANNING AND DESIGN METHOD TO SUPPORT

Strömman Laboratory, National Institute of
Andrology, Johns Hopkins University

Month & Year	03/2023	Cluster	Cluster III	Report No.			BU/II/NO/II/2023-23/13				
Customer	Kerfommas Department, BRRI, Coling Coal			Lemah (BCCI), Kerya Ekatan, Channat (E-mail: green.bcci@gmail.com)			Date of Issue		19.04.2023		
Project				Sample Ref. No.		BSP/BCCI/2023/LT		Sampling Method		CHRD, SII/II/LPH II	
Sampling Station	I	Character	Global Sampling		11.03.23	22.03.23	Zone Category of Station	Buffer Zone			
Sl. No.	Parameter	Work / Time of day	Observed Value (1st Leg, 50/50) First Forthright	Observed Value (1st Leg, 50/50) Second Forthright	Method of analysis	Range of Testing	LOL	NOISE POLLUTION REGULATION AND CONTROL KUALA LUMPUR STANDARDS Zone		Uniform dB	
1	Noise Level dB(A) Leg - Day	06:00 - 07:00	61.4	61.7	CPCB Protocol for ambient level Noise Monitoring - 2015	74 dB-115 dB	74 dB(A)	Industrial Commercial Residential Green	73 63 53 50		
2		07:00 - 08:00	61.7	61.6							
3		08:00 - 09:00	71.1	71.2							
4		09:00 - 10:00	71.2	71.2							
5		10:00 - 11:00	69.0	69.2							
6		11:00 - 12:00	64.0	64							
7		12:00 - 13:00	60.0	60							
8		13:00 - 14:00	61.0	61.0							
9		14:00 - 15:00	68.9	69.0							
10		15:00 - 16:00	68.9	68.7							
11		16:00 - 17:00	68.7	68.3							
12		17:00 - 18:00	68.1	68							
13		18:00 - 19:00	65.7	65.7							
14		19:00 - 20:00	64.9	64							
15	Noise Level dB(A) Leg - Night	20:00 - 21:00	61.8	62	CPCB Protocol for ambient level Noise Monitoring - 2015	75 dB-110 dB	75 dB(A)	Industrial Commercial Residential Green	70 60 50 45		
16		21:00 - 22:00	61.1	61.6							
17		Leg DAY	66.1	66.1							
18		22:00-23:00	61.7	61.7							
19		23:00-00:00	61.0	61.6							
20		00:00-01:00	61.0	61.6							
21		01:00-02:00	60.9	60.7							
22		02:00-03:00	60.0	60.0							
23		03:00-04:00	60.7	60							
24		04:00-05:00	60.0	60.0							
25	Leg NIGHT	05:00-06:00	67.0	67.0							
26		Leg NIGHT	66.0	66.6							

^aU.S. National Oceanic and Atmospheric Administration 1999

^a All units have electron impact (N₂) and gas-phase (I) ionization (E_i)

Sanjiv Kumar
4841222.87

RECEIVED BY

Author's Disclosure of Potential Conflicts of Interest and Author Contributions

NOTE: The results were revised in the original tables as required. The report are not of reproductive quality. See without the written permission of the AGO/DA. (Page 10/11)

—End of Report—

Page 2 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 $\mu\text{g}/\text{m}^3$ 700 $\mu\text{g}/\text{m}^3$	High Volume Sampling (Average flow rate not less than 1.1)
	Respirable Particulate Matter (size less than 10 μm) (RPM)	Annual Average * 24 hours **	250 $\mu\text{g}/\text{m}^3$ 300 $\mu\text{g}/\text{m}^3$	Respirable Particulate Matter sampling and analysis
	Sulphur Dioxide (SO_2)	Annual Average * 24 hours **	80 $\mu\text{g}/\text{m}^3$ 120 $\mu\text{g}/\text{m}^3$	1 Improved wet and Gaeke method 2 Ultraviolet fluorescence
	Oxide of Nitrogen as NO_2	Annual Average * 24 hours **	80 $\mu\text{g}/\text{m}^3$ 120 $\mu\text{g}/\text{m}^3$	1 Jacob & Hochheiser Modified (Na -Arsenic) Method 2 Gas phase Chemiluminescence

Note:

- * Annual Arithmetic mean for the measurements taken in a year, following the guidelines for frequency of sampling laid down in clause 2.
- ** 24 hourly/8 hourly values shall be met 92% of the time in a year. However, 8% of the time it may exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (b) of section 18 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.354(E), dated 11th April 1994 and S.O.835(E), dated 14th NOVEMBER 1999, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

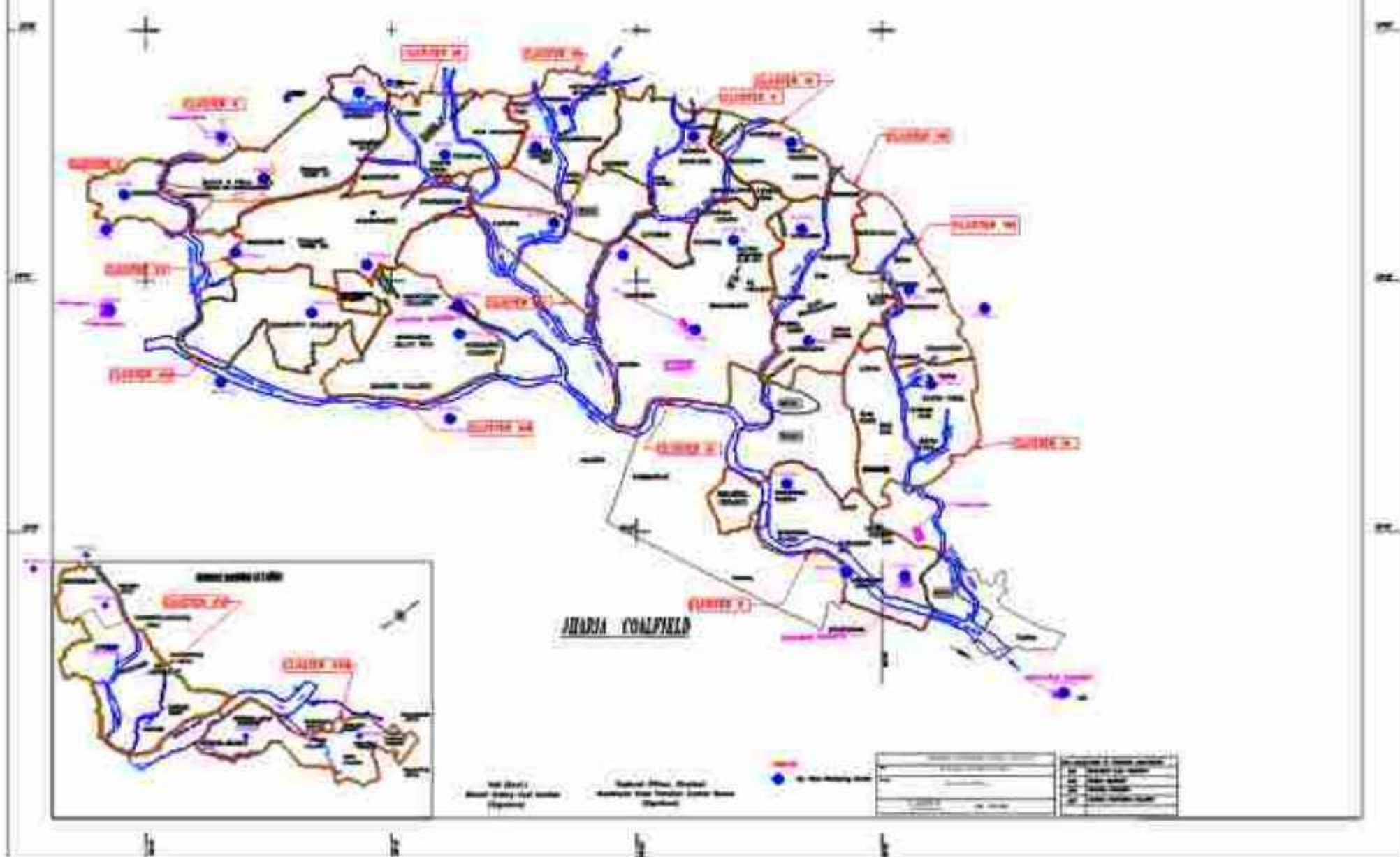
Pollutant	Time Weighted Average	Concentration in Ambient Air Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	Methods of Measurement
Sulphur Dioxide (SO ₂), $\mu\text{g}/\text{m}^3$	Annual * 24 Hours **	50 80	20 40	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogen dioxide (NO ₂), $\mu\text{g}/\text{m}^3$	Annual * 24 Hours **	40 80	30 60	-Jacob & Kricheldorf modified (NaOH-NaAsO ₂) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10 μm) or PM ₁₀ , $\mu\text{g}/\text{m}^3$	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5 μm) or PM _{2.5} , $\mu\text{g}/\text{m}^3$	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O ₃), $\mu\text{g}/\text{m}^3$	8 Hours * 1 Hour **	100 160	100 160	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb), $\mu\text{g}/\text{m}^3$	Annual * 24 Hours **	0.50 1.0	0.50 1.0	-AAS/ICP Method after sampling on EPM 3000 or equivalent filter paper -ED XRF using Teflon filter
Carbon Monoxide (CO), mg/m^3	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH ₃), $\mu\text{g}/\text{m}^3$	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C ₆ H ₆), $\mu\text{g}/\text{m}^3$	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m^3	Annual *	01	01	-Solvent extraction followed by HPLC/GC analysis
Arsenic (As), ng/m^3	Annual *	08	08	-AAS/ICP Method after sampling on EPM 3000 or equivalent filter paper
Nickel (Ni), ng/m^3	Annual *	20	20	-AAS/ICP Method after sampling on EPM 3000 or equivalent filter paper

* Annual Arithmetic mean of minimum 116 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

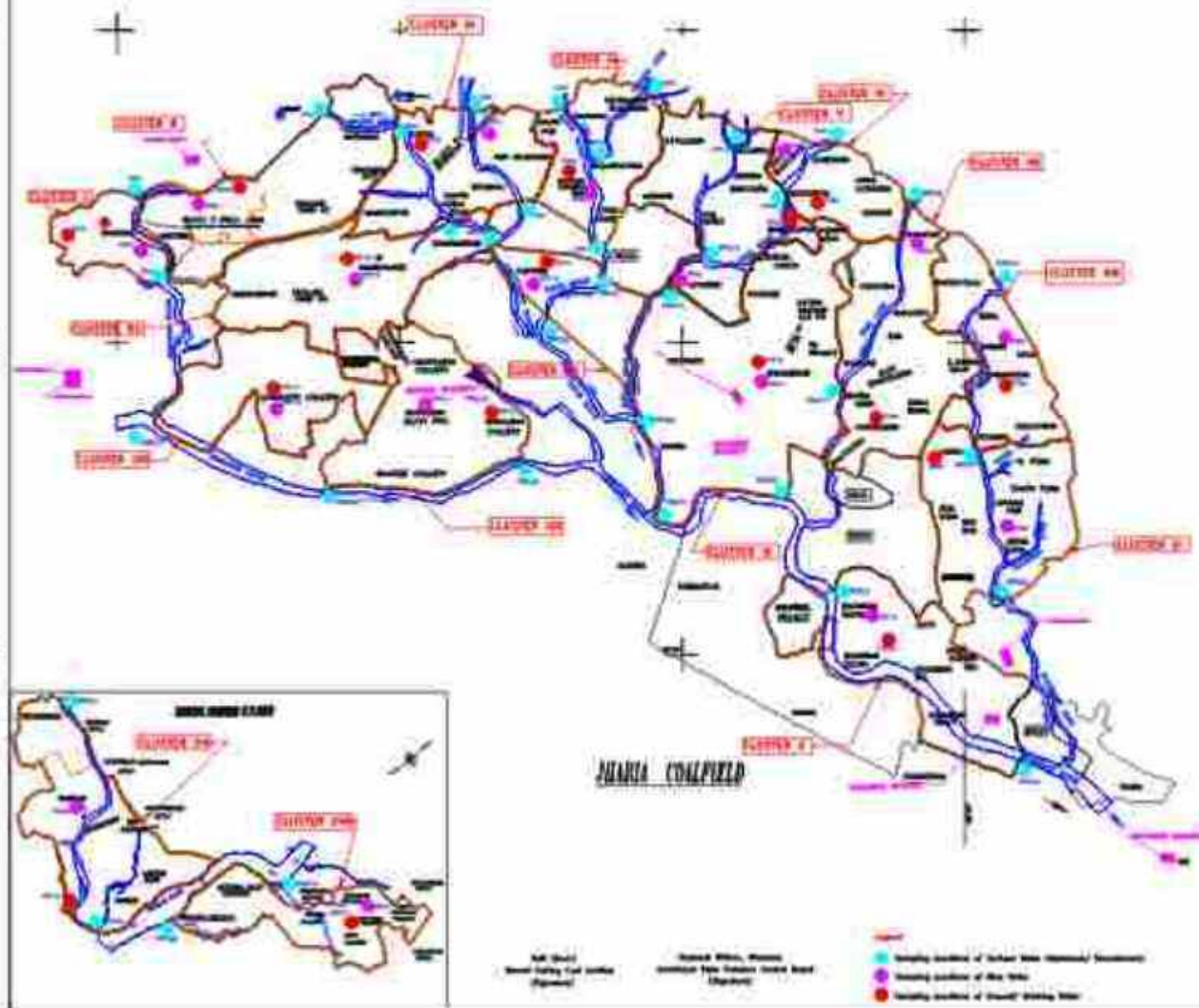
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 95% of the time in a year, 4% of the time may A/QAE exceed the limits but not on ten consecutive days of monitoring.

NOTE: Whenever and whenever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to initiate regular or continuous monitoring and further investigations.

Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



Sl. No.	Particulars	Amount	Amount	Amount	Amount	Amount
1	...	...	...	...	...	...
2	...	...	...	...	...	...
3	...	...	...	...	...	...
4	...	...	...	...	...	...
5	...	...	...	...	...	...
6	...	...	...	...	...	...
7	...	...	...	...	...	...
8	...	...	...	...	...	...
9	...	...	...	...	...	...
10	...	...	...	...	...	...
11	...	...	...	...	...	...
12	...	...	...	...	...	...
13	...	...	...	...	...	...
14	...	...	...	...	...	...
15	...	...	...	...	...	...
16	...	...	...	...	...	...
17	...	...	...	...	...	...
18	...	...	...	...	...	...
19	...	...	...	...	...	...
20	...	...	...	...	...	...
21	...	...	...	...	...	...
22	...	...	...	...	...	...
23	...	...	...	...	...	...
24	...	...	...	...	...	...
25	...	...	...	...	...	...
26	...	...	...	...	...	...
27	...	...	...	...	...	...
28	...	...	...	...	...	...
29	...	...	...	...	...	...
30	...	...	...	...	...	...
31	...	...	...	...	...	...
32	...	...	...	...	...	...
33	...	...	...	...	...	...
34	...	...	...	...	...	...
35	...	...	...	...	...	...
36	...	...	...	...	...	...
37	...	...	...	...	...	...
38	...	...	...	...	...	...
39	...	...	...	...	...	...
40	...	...	...	...	...	...
41	...	...	...	...	...	...
42	...	...	...	...	...	...
43	...	...	...	...	...	...
44	...	...	...	...	...	...
45	...	...	...	...	...	...
46	...	...	...	...	...	...
47	...	...	...	...	...	...
48	...	...	...	...	...	...
49	...	...	...	...	...	...
50	...	...	...	...	...	...
51	...	...	...	...	...	...
52	...	...	...	...	...	...
53	...	...	...	...	...	...
54	...	...	...	...	...	...
55	...	...	...	...	...	...
56	...	...	...	...	...	...
57	...	...	...	...	...	...
58	...	...	...	...	...	...
59	...	...	...	...	...	...
60	...	...	...	...	...	...
61	...	...	...	...	...	...
62	...	...	...	...	...	...
63	...	...	...	...	...	...
64	...	...	...	...	...	...
65	...	...	...	...	...	...
66	...	...	...	...	...	...
67	...	...	...	...	...	...
68	...	...	...	...	...	...
69	...	...	...	...	...	...
70	...	...	...	...	...	...
71	...	...	...	...	...	...
72	...	...	...	...	...	...
73	...	...	...	...	...	...
74	...	...	...	...	...	...
75	...	...	...	...	...	...
76	...	...	...	...	...	...
77	...	...	...	...	...	...
78	...	...	...	...	...	...
79	...	...	...	...	...	...

1	1000000	1000000
2	1000000	1000000
3	1000000	1000000
4	1000000	1000000
5	1000000	1000000
6	1000000	1000000
7	1000000	1000000
8	1000000	1000000
9	1000000	1000000
10	1000000	1000000
11	1000000	1000000
12	1000000	1000000
13	1000000	1000000
14	1000000	1000000
15	1000000	1000000
16	1000000	1000000
17	1000000	1000000
18	1000000	1000000
19	1000000	1000000
20	1000000	1000000
21	1000000	1000000
22	1000000	1000000
23	1000000	1000000
24	1000000	1000000
25	1000000	1000000
26	1000000	1000000
27	1000000	1000000
28	1000000	1000000
29	1000000	1000000
30	1000000	1000000
31	1000000	1000000
32	1000000	1000000
33	1000000	1000000
34	1000000	1000000
35	1000000	1000000
36	1000000	1000000
37	1000000	1000000
38	1000000	1000000
39	1000000	1000000
40	1000000	1000000
41	1000000	1000000
42	1000000	1000000
43	1000000	1000000
44	1000000	1000000
45	1000000	1000000
46	1000000	1000000
47	1000000	1000000
48	1000000	1000000
49	1000000	1000000
50	1000000	1000000
51	1000000	1000000
52	1000000	1000000
53	1000000	1000000
54	1000000	1000000
55	1000000	1000000
56	1000000	1000000
57	1000000	1000000
58	1000000	1000000
59	1000000	1000000
60	1000000	1000000
61	1000000	1000000
62	1000000	1000000
63	1000000	1000000
64	1000000	1000000
65	1000000	1000000
66	1000000	1000000
67	1000000	1000000
68	1000000	1000000
69	1000000	1000000
70	1000000	1000000
71	1000000	1000000
72	1000000	1000000
73	1000000	1000000
74	1000000	1000000
75	1000000	1000000
76	1000000	1000000
77	1000000	1000000
78	1000000	1000000
79	1000000	1000000
80	1000000	1000000
81	1000000	1000000
82	1000000	1000000
83	1000000	1000000
84	1000000	1000000
85	1000000	1000000
86	1000000	1000000
87	1000000	1000000
88	1000000	1000000
89	1000000	1000000
90	1000000	1000000
91	1000000	1000000
92	1000000	1000000
93	1000000	1000000
94	1000000	1000000
95	1000000	1000000
96	1000000	1000000
97	1000000	1000000
98	1000000	1000000
99	1000000	1000000
100	1000000	1000000

**STRICTLY RESTRICTED -
FOR COMPANY USE ONLY RESTRICTED**

The information given in this report is not to be
communicated either directly or indirectly to the
public or to any person not holding an official
position in the CIL. (27/5/2022/5/1)

**WATER QUALITY REPORT
OF
BHARAT COKING COAL LIMITED,
CLUSTER – III
(FOR THE Q.E. DECEMBER, 2022)**

E. C. no. J-11015/213/2010-IA.II (M) dated 06.02.2013



CMPDI

ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CLUSTER - III

(FOR THE Q.E. DECEMBER, 2022)

CONTENTS

SL. NO.	CHAPTER	PARTICULARS
1		EXECUTIVE SUMMARY
2	CHAPTER -I	INTRODUCTION
3	CHAPTER-II	WATER SAMPLING & ANALYSIS
4	Plates: Plate No. -I	SURFACE PLAN SHOWING WATER MONITORING LOCATIONS

STRICTLY RESTRICTED
FOR COMPANY USE ONLY RESTRICTED

The information given in this report is not to be communicated either directly or indirectly to the public or to any person not holding an official position in the CIL / GOVERNMENT.

WATER QUALITY REPORT
OF
BHARAT COKING COAL LIMITED
CLUSTER – II
(FOR THE Q.E. DECEMBER, 2022)
E. C. no. J-11015/213/2010-IA.II (M) dated 06.02.2013



CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the environment around us. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. One of these major attributes is water.

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°37' N to 23°52' N latitudes and 86°09' E to 86°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 Water sampling stations

The Water sampling stations were selected for mine sump water, drinking water supply, well/ Hand pump water also surface water samples.

3.0 Methodology of sampling and analysis

3.1 Water quality

Water samples were collected as per standard practice. Effluent samples were analyzed for 25 parameters on quarterly basis and for 27 parameters on half yearly basis. The drinking and Surface water samples were collected and analyzed for 25 and 17 parameters respectively, on quarterly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory at CMPDI, RI-II, Dhanbad.

4.0 Results and interpretations

4.1 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, IS:10500/2012 (Drinking water) and IS: 2296 (Surface water), are with in permissible limits.

CHAPTER - I

INTRODUCTION

1.0 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.

Bharat Coking Coal Limited (BCCL), a subsidiary company of Coal India Limited (CIL) is operating UG Mines and Opencast Mines in Jharia Coalfield (JCF). The Jharia Coalfield (JCF) having an area of 450 Sq.KM.

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.

1.1 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 Akashkinaree Mine and Block IV Kooridih Mixed Mine. 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 Khudis and Bagdighi Nala.

1.2 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.

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

CHAPTER – II

WATER QUALITY MONITORING

3.1 Location of sampling sites (Refer Plate No. - I)

- i) Drinking water quality at Jogidih Village (DW3)
- ii) Surface water quality at U/S of Khudia Nala (SW4)
- iii) Surface water quality at D/S of Khudia Nala (SW5)
- iv) Surface water quality at U/S of Bagdighi Nala (SW6)
- v) Surface water quality at D/S of Bagdighi Nala (SW7)
- vi) Mine water discharge of Govindpur Colliery(MW3)

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. Effluent samples were analyzed for 25 parameters on quarterly basis and for 27 parameters on half yearly basis. The drinking and Surface water samples were collected and analyzed for 25 and 17 parameters respectively, on quarterly basis. Thereafter the samples were preserved and analyzed at the Environmental Laboratory at 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.



cmpdi
Central Mine Planning and Design Institute Limited

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

CHPDI, RI-II
KOYLA SHAWAN COMPLEX
CHANDABAD - 526005
Phone: 0526-223-650
mail: rri2cmpdi@coalindia.in

Month & Year	QUARTER ENDING DEC 2022	Cluster	III			Report No.	RI-2/CH/22-23/24/23
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Singhbhum, Dhanbad (E-mail: ggram-bcl@coalindia.in)					Date of Issue	01.01.23
Project	Singbhum Village		Sample Ref. No.	BBCL/BCL/22-23/CH		Sampling Method	CHPDI RI-II LPM 12/25/2022 Para-01
Sampling Station	Singbhum Village	Date of Sampling	04.12.2022	Sample Collected in 2 Ltr Nertopane, Color as observed is transparent			
			Period of Analysis		Nov 22	Jan 23	
Sl. No.	Parameter	Method of Analysis	Observed Values		IS 15559:2015		
			Obs'd	Range Or Tasting	LDL	Acceptable Limit (ppm)*	Permissible Limit in the absence of (Parameter Name) (ppm)
1.	Codm. Water unit	APHA, 12th Edition, 2120-C Spectrophotometric, 510nm wavelength Method 2017	3	1-5000	1	3	15
2	Turbidity, mg/l	IS 3025, (Part 40) 1991 & 2014, AAS Flame Method & EDTA Method	24	10-4000	2	15	200
3	Chloride, mg/l	IS 3025 (Part 21) 1983 & 2017, Argentometric Method	46	1.5-12000	6	240	1000
4	Sulphate, mg/l	APHA, 12th Edition, 2142-H Method	0.11	0.1-200	0.2	3	1.5
5	Iron, mg/l	IS 3025 (Part 42) 2005 & 2019, AAS-Flame Method	<0.2	0.1-10	0.2	1	No relaxation
6	Magnesium	APHA, 12th Edition, 2106-B Titrimetric Method	87	10-700	6	30	100
7	Fluoride, mg/l	APHA, 12th Edition, 2143-H Spectrophotometric Method	18.20	0.2-400	0.3	4.0	No relaxation
8	Cadmium	APHA, 12th Edition, 2140-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 21 - 1983 & 2017 Electrode method, pH Meter Method	7.23	1-14	0.1	6.5-8.5	No relaxation
10	Ammonia, mg/l	APHA, 12th Edition, 4500-N Turbidity Method	128	100-4000	10	300	<100
11	Taste	APHA 12th Edition, 2140-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total alkalinity (as CaCO ₃), mg/l	IS 3025, Part 12 - 1996 & 2019 Titrimetric Method	132	4.0-50000	6	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 14 - 1996 & 2017 Gravimetric method	146	10.0-50000	24	500	1000
14	Total Hardness, mg/l	IS 3025 (Part 21) 2005 EDTA Method	433	4.0-50000	9	300	600
15	Turbidity, NTU	IS 3025, (Part 42) 1994 & 2017 Nephelometric Turbidity method	1.4	1-800	0.1	1	1
16	Iron, mg/l	IS 3025 (Part 42) 1994 & 2019, AAS-Flame Method	<0.1	0.1-10	0.1	1	1.5

*All units in mg/L unless specified otherwise.

**Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & EDL indicates Below Detection Limit.

(Signature)

(Kumar Vaibhav)
CHECKED BY

(Signature)

(Anuraj Mishra)
HOD's Signature

ANALYSED BY

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.



cmpdi
A Whil Ratan Company

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

CMPDIL RI-II
RDYLA BHAWAN COMPLEX
DHANBAD, -826005
Phone: 2226-223-258
email: rdi2cmpdi@coalindia.in

Block & Year	QUARTER EXHIBING 2022-23		Client	BCL		Report No.	RI-2-TH-T7-T9/2022	
Customer	Electronics Department, Bharat Ironing Co. Ltd. (BCL), Kalya Nagar, Chanda (Jharkhand) green.bcl@gmail.com					Date of Issue	14-02-2022	
Project	Jagdish Village			Sample Ref. No.	BCL/BCL/17-22/TH	Sampling Method	CMPDI/RI-II/LPH-12/12-2022/Part-42	
Sampling Station	Jagdish Village		Date of Sampling	14.01.2022	Sample Collected in 2 Lit Jar/containers. Color as observed is transparent			
			Period of Analysis		Jan-22		Jan-22	
			Observed Values				IS 10500: 2012	
Sr. No.	Parameter	Method of Analysis	Obs.	Range Of Testing	LDL	Acceptable Limit (mg/L)	Acceptable Limit in the form of (Maximum Allowable Concentration) (mg/L)	
1	Iron (as Fe, mg/L) Max	APHA, 12th Edition, Colorimetric	<0.1	0.1-0.2	0.1	0.1	1	
2	Copper (as Cu, mg/L) Max	IS 2002 Part 42: 1992 & 1018, AAS-Flame APHA, 12th Edition, AAS-ETA	<0.01	0.01-0.2	0.01	0.01	1.5	
3	Free Radical Chlorine (mg/L) Min	APHA, 12th Edition, 8000-C1 & (colorimetric method)	<0.04	0.04-4	0.04	0.1	1	
4	Lead (as Pb, mg/L) Max	IS 2002 Part 42: 1992 & 1018 (Spectrophotometric) APHA, 12th Edition, AAS-ETA	<0.005	0.005-0.5	0.005	0.01	No reduction	
5	Fluoride compound (as F, mg/L) Max	APHA, 12th Edition, 4-Amino Antipyrine	<0.001	0.001-0.2	0.001	0.002	0.002	
6	Selenium (mg/L) Max	APHA 12th Edition IS-2002, 8000-SE-2002, 8-3019, AAS-ETA	<0.007	0.007-0.2	0.007	0.01	No reduction	
7	Total Arsenic (as As, mg/L) Max	IS-2002 Part 42: 1992 & 1018, APHA 12th Edition AAS-ETA	<0.004	0.004-0.2	0.004	0.01	0.05	
8	Total Chromium (as Cr, mg/L) Max	IS-2002 Part 42: 1992 & 1018, AAS-Flame APHA, 12th Edition, AAS-ETA	<0.01	0.01-0.2	0.01	0.01	No reduction	
9	Manganese (Mn, mg/L) Max	IS 2002 Part 42: 1992 & 1018, AAS-Flame APHA, 12th Edition, AAS-ETA	<0.02	0.02-0.5	0.02	0.01	No reduction	
10	Hardness as Ca, mg/L) Max	IS 2002 Part 42: 1992 & 1018, AAS-Flame Method	0.04	0.02-0.2	0.02	0.1	0.3	

**All units in mg/L unless specified otherwise.

**Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BCL indicates Below Detection Limit.

(Signature)

(Kumar Vaibhav)
CHECKED BY

(Signature)

(Amit Raj Mishra)

ANALYSED BY

HOD's Signature

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.



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

CMPDI, R-II

CPFLA BHAWAN, COERPLEX

DHANBAD - 826003

Phone: 2223-223-853

Email: rrii2.cmpdi@coelindia.in

Month & Year	QUARTER ENDING DATE		Cluster	H All		Report No.	RI-2/SW/22-23/QE/03
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bcl@coelindia.in)					Date of Issue	16.03.2023
Project	Sample Ref. No.		REM/BCL/2022/SW/		Sampling Method	(IS 3025, Part-1) CMPDI/RI-II/LPM 13	
Sampling Stations	(i)	Downstream in Khudla Nala(SW4)	Date of Sampling		12.12.22	Period of Analysis	
	(ii)	Downstream of Khudla Nala (Downstream with cluster III) (SW5)	Date of Sampling		12.12.22	Nov/22 TO Jan 23	
Sl. No.	Parameter	Method of Analysis	Observed Values		IS 3025 (PART 1) SURFACE WATER (1992) Class 'C'	Range of Testing	LDL
			SW4	SW5			
1	BOD (3 days IT+C), mg/l	IS 3025 (Part 41) : 1993, B-2019, 3 day incubation at 27°C	<1.0	<1.0	3	1-100.0	1
2	Colour,Hazen Units	APHA 23rd Edition, 2120-B-2017	4	4	10	1-100.0	1
3	Chlorides, mg/l	IS-3025(Part 31): 1988, B-2019 Argentometric Method	44	39	600	10-1500.0	3
4	Copper, mg/l	IS 3025 (Part 47) : 1992 B-2019, AAS-Flame Method	<0.2	<0.2	1.5	0.2-10.0	0.2
5	Dissolved Oxygen, mg/L	IS 3025 (Part 38) : 1989, B-2003 Winkler Azide Method	6.3	6.3	4	0.1-10.0	0.0
6	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.4	0.43	1.5	0.1-2.00	0.2
7	Hexavalent Chromium, mg/l	APHA 23rd Edition, 18-Diphenylcarbohydrazide Method IS 3025 (Part 51) : 2000,B-2019	<0.01	<0.01	0.05	0.01-1.4	0.01
8	Iron, mg/l	IS 3025 (Part 53) : 2003,B-2019, AAS-Flame Method	<0.2	<0.2	30	0.2-10	0.2
9	Nitrate, mg/l	APHA, 23rd Edition, UV-Spectrophotometric Method	4.29	2.19	30	0.1-45.0	0.3
10	pH value	IS 3025, (Part 11) : 1985 B-2017 Electrode (pH Meter) method	8.01	7.81	8.5-8.5	7.0-12.0	1
11	Sulphate, mg/l	APHA -23rd Edmon 4500-S, Turbidity Method	43	36	400	10.0-400.0	10
12	Total Dissolved Solids, mg/l	IS 3025, (Part 16) : 1994 B-2017 Gravimetric method	310	617	1500	25.0-5000.0	25
13	Zinc, mg/l	IS 3025(Part 49) : 1994, B-2019, AAS-Flame Method	0.1	<0.1	1.5	0.1-1.0	0.1

*Oral sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit

**All units in mg/L unless specified otherwise. Sample Collected in 5 Ltr Jerrycan. Color as observed is transparent.

(Signature)

Analysed by

(Signature)
(Kumar Vaibhav)

CHECKED BY

(Signature)
(Amit Raj Mishra)

HOD's Signature

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, R-II.

--- End of Report ---

Page -1 of 2



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

CMPDI, B-4
 KOTA GUJARAT 386014
 DHANBAD, 826001
 Phone: 0325-225-403
 email: rtri2.cmpdi@coalindia.in

Month & Year	QUARTER ENDING DEC 2022	Cluster	II & III		Report No.	RI-2/SW/22-23/QE/03	
Customer	Environment Department, Bharat Coking Coal Limited (BCEL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bcel@coalindia.in)				Date of Issue	16.03.2023	
Project	Sample Ref. No.		223/BCEL/1021/SW /		Sampling Method	(IS 3025 Part-1) CMPDI/RI-II/LPM 13	
Sampling Stations	I	Downstream in Khudia Nala(SWA)	Date of Sampling		12.12.22	Period of Analysis	
	II	Downstream of Khudia Nala (Downstream with cluster II) (SWS)	Date of Sampling		12.12.22	Nov'22 to Jan'23	
Sl. No.	Parameter	Method of Analysis	Observed Values		IS-3025 (PART-1) SURFACE WATER (SWS) Class 'C'	Range of Testing	LDL
			SWA	SWS			
1	Arsenic (as As), mg/l Max	IS-3025,Part 37,1968, E-2019/ APHA 23rd Edition AAS-VGA	<0.006	<0.006	0.2	0.005-10	0.006
2	Lead (as Pb), mg/l Max	APHA, 23rd Edition, AAS-GTA	<0.005	<0.005	0.1	0.005-10	0.005
3	Phenolic compounds (as C6H5OH), mg/l Max	APHA, 22nd Edition 4-Amino Antipyrine	<0.002	<0.002	0.005	0.002-10	0.002
4	Selenium, mg/l Max	IS-3025,Part 56,2003, R-2019/ APHA 23rd Edition, AAS-VGA	<0.003	<0.003	0.05	0.007-10	0.007

***Crude sampling carried out for water sampling. LDL indicates Lower Detection Limit & EDL in Cases Below Detection Limit. All units in mg/l unless specified otherwise. Sample Collected in 5 Ltr ferricure, Color as observed is transparent.

[Signature]
 16.3.23

(Rumar Vaidhar)

(Amit Raj Nishra)

Analysed by

CHECKED BY

HOD's Initial/Signature

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.

**CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED****Environment Laboratory, Regional Institute-II****SURFACE WATER ANALYSIS TEST REPORT**

COPDIL, RI-II

KOLLA BHAWAN COMPLEX

CHENNAI - 600003

Phone: 044-2234493

Email: rrii2.cmpdi@coalindia.in

Month & Year	QUARTER ENDING DEC 2022	Cluster	III & XV			Report No.	RJ-3/SW/22-23/QE/03
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gmenv@bcl.coalindia.in)					Date of Issue	16.01.23
Project	Sample Ref. No.		REV/BECL/2022/017		Sampling Method	(IS 3025, Part-1) CMPDI/RI-II/LPM 15	
Sampling Stations	(i)	Upstream in Bagtigi Kales(SW1)	Date of Sampling		26.12.22	Period of Analysis	
	(ii)	Downstream in Bagtigi Kales(SW2)	Date of Sampling		26.12.22	Nov/22 to Jan 23	
Sl. No.	Parameter	Method of Analysis	Observed Values		AS PER IS 3025 (PART 1) 1993 R: 2019 SURFACE WATER (1993) Class- C	Range of Testing	LDL
			(i)	(ii)			
1	BOD (3 days 20°C), mg/l	IS 3025 (Part 44) : 1993 R: 2019, 3 day incubation at 20°C	<1.0	<2.0	3	2.00-10.00	1
2	Colour, Hazen Units	APHA 23rd Edition, 2120-B-2017	1	1	10	1-1000	1
3	Chlorides, mg/l	IS 3025 (Part 31) : 1988 R: 2019 Argentometric Method	78	50	500	50-1500.0	5
4	Copper, mg/l	IS 3025 (Part 42) : 1993 R: 2019, AAS-Flame Method	<0.1	<0.1	1.0	0.1-10.0	0.1
5	Dissolved Oxygen, mg/L	IS 3025 (Part 35) : 1989 R: 2002 Winkler Azide Method	8.6	8.8	6	0.1-10.0	0.1
6	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.48	0.53	1.5	0.1-2.00	0.1
7	Hexavalent Chromium, mg/l	APHA 23rd Edition, 1,5-Diphenylcarbohydrazide Method	<0.01	<0.01	0.05	0.01-1.4	0.01
8	Iron, mg/l	IS 3025 (Part 53) : 2003 R: 2019, AAS-Flame Method	<0.1	<0.2	50	0.2-10	0.1
9	Nitrate, mg/l	APHA, 23rd Edition, UV-Spectrophotometric Method	1.06	4.16	50	0.5-45.0	0.5
10	pH value	IS 3025 (Part 11) : 1983 R: 2017 Electronic (pH Meter) method	8.09	8.07	6.5-8.5	7.0-12.0	1
11	Sulphate, mg/l	APHA - 23rd Edition, 4300-S, Turbidity Method	36	24	400	100-400.0	10
12	Total Dissolved Solids, mg/l	IS 3025 (Part 16) : 1984 R: 2017 Gravimetric method	383	429	1500	250-5000.0	25
13	Zinc, mg/l	IS 3025 (Part 49) : 1994 R: 2019, AAS-Flame Method	<0.1	0.12	15	0.1-30	0.1

***Good sampling protocol not for water samples. LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit

***All units in mg/L unless specified otherwise Sample Collected in 5 Ltr ferricune. Color as observed is transparent

(Kumar Vaibhav)

Analysed by**CHECKED BY**

(Amit Raj Mishra)

HOD's Initial/Signature

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 2



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

CMPDI, R-II
 KINRA BANGALUA COMPLEX,
 DHANBAD - 826005
 Phone: 0326-222-800
 Email: ror2.cmpdi@coalindia.in

Month & Year	QUARTER ENDING DATE 2023		Cluster	III & IV		Report No.	RI-2/SW/23- 23/QE/03
Customer	Environment Department, Biharat Colliery Coal Limited (BCL), Koya Bhawan, Dhanbad (E-mail: gmenv.bcl@coalindia.in)					Date of Issue	16.01.23
Project	Sample Ref. No.			REN/BCL/2022/SW/	Sampling Method	(IS 3025, Part-1) CMPDI/RI-II/LPM 13	
Sampling Stations	(i)	Upstream in Bagdigi Nala(SW6)		Date of Sampling	26.12.22	Period of Analysis	
	(ii)	Downstream in Bagdigi Nala(SW7)		Date of Sampling	26.12.22	Nov/22 to Jan 23	
Sl. No.	Parameter	Method of Analysis	Observed Values		IS 3025, Part-1 SURFACE WATER (1992) Class 'C'	Range of Testing	LDL
			(i)	(ii)			
1	Arsenic (as As), mg/l Max	IS-3025, Part 37-1988, R-2019/ APHA 23rd Edition AAS-VGA	<0.006	<0.006	0.3	0.006-10	0.006
2	Lead (as Pb), mg/l Max	APHA 23rd Edition, AAS-GTA	<0.005	<0.005	0.1	0.005-10	0.005
3	Phenolic compounds (as C6H5OH), mg/l Max	APHA 23rd Edition 4-Amino Antipyrine	<0.002	<0.002	0.005	0.002-10	0.002
4	Selenium, mg/l Max	IS-3025, Part 56-2003, R-2019/ APHA 23rd Edition, AAS-VGA	<0.007	<0.007	0.05	0.007-10	0.007

**Grid sampling carried out for water samples. *LDL indicates Lower Detection Limit & PCL indicates Below Detection Limit.

***All units in mg/l unless specified otherwise. Sample Collected in 5 Lit. ferricane. Color as observed is transparent.

[Signature]

(Kumar Vaibhav)

[Signature]
 (Amit Raj Mishra)

Analysed by

CHECKED BY

HOD's Initial/Signature

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, R-II.

— End of Report —
 Page-2 of 2



cmpdi
CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II
MINE EFFLUENT ANALYSIS TEST REPORT

CMPDI, RI-II
KOYLA BHAIWAN COMPLEX
DHANBAD - 826005
Phone: 0326-223-850
Email: info@cmpdi.co.in

Month & Year	QUARTER ENDING Dec 2022	Cluster	CCEP/RI-II	Report No.	M-2, NW/2022-23/CE/24
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: geninfo@bcl.co.in)			Date of Issue	
Project	Candigarh Colliery	Sample Ref. No.	R216/WCL/CO2/189/	Sampling & Method	CMPDI, RI-II, LFW 11, (D 2022, Part-I)
Sampling Station	W1C2	Date of Sampling	24.12.2022	Sample Collected in 2 Litre bottles, Color as observed is transparent	

Sl. No.	Parameter	Method of Analysis	Period of Analysis			IS 3025-SCM-VI STANDARD Class V
			WHO	Range of Testing	LOD	
1	pH (25°C, mg/l, Min)	IS 3025 (Part 22): 2002, A.2002 and Hachette at 17°C	<12	3-14.000	2	10
2	Colour	APHA 21° Colorimetric 2015-6-2017	5	10-2000	5	-
3	DOO, mg/l, Min	APHA 12th Edition 2005 (Thomson Method)	11	40-2000	4	110
4	Copper (as Cu), mg/l, Max	IS 3025 (Part 12): 2002, B. 2012, AAS-Perma	<0.1	0.1-100	0.1	4
5	Dissolved Phosphate (as P), mg/l, Max	IS 3025/ 21.1200 & 2012	<0.1	0.1-4	0.1	4
6	Fluoride (as F), mg/l, Max	IS 3025 1202 - 2002, Page 5-6 (2012 - A-2) SPADAM Method	<0.1	0.1-2	0.1	2
7	Manganese Chromium, mg/l, Max	IS 3025 (Part 12): 2002, AAS-Perma 2012	<0.05	0.01-1.0	0.01	0.1
8	Iron (as Fe), mg/l, Max	IS 3025 (Part 12): 2002, A / 2012, AAS-Perma	<0.2	0.1-10	0.1	4
9	Manganese (as Mn), mg/l, Max	APHA 21° Colorimetric 2015-6-2017	<0.1	0.1-10	0.005	0.1
10	Nickel (as Ni), mg/l, Max	IS 3025 (Part 12): 2002, A.2012 AAS-Perma	<0.1	0.1-100	0.1	4
11	Nitrate Nitrogen, mg/l, Max	APHA 21° Colorimetric 2015-6-2017, Spectrophotometric	0.12	0.1-45	0.1	10
12	Oil & Grease, mg/l, Max	IS 3025 (Part 12): 2002, A. 2012, Factor Chromatic	<0.1	0.1-1000	1	10
13	pH Value	IS 3025 (Part 12): 2002, A.2017, Potentiometric	7.0	1-14	0.1	0.2 to 9.0
14	Temperature (°C)	IS 3025 (Part 12): 2002, Thermometric	11.5	1-100		Shall not exceed 1°C above the surrounding temp.
15	Total Chromium (as Cr), mg/l, Max	IS 3025 (Part 12): 2002, A.2012 AAS-Perma	<0.1	0.1-4	0.1	2
16	Total Suspended Solids, mg/l, Max	IS 3025 (Part 12): 2002, A.2017 Gravimetric	17	10-2000	10	100
17	Zinc (as Zn), mg/l, Max	IS 3025 (Part 12): 2002, A. 2012, AAS-Perma	<0.1	0.1-10	0.1	4
18	Odour	APHA 21° Colorimetric 2015-6-2017	Agreeable	Qualitative	Qualitative	Qualitative

***All units in mg/l unless specified otherwise

***This sampling carried out for water samples. LOD is based on Lower Detection Limit & LOD is based on Lower Detection Limit

[Signature]
ANALYSED BY

[Signature]
(Kumar Vaidhyan)
CHECKED BY

[Signature]
(Amit Raj Mishra)

HOD's Signature

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 2



cmpdi
A Bharat Heavy Engineering Company

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

CMFDI, RI-II
KOPLA BRAHMAN COMPLEX
DHANEAD, -515005
Phone: 0326-223-050
Email: rri2@cmpdi.coalindia.in

Work & Task	QUARTER ENDING Dec 2023	Sluiter	CLAYTON		Report No.	RI-2/WW/2023- 22/QC-04	
Customer	Sinterment Department, Bharat Coking Coal Limited (BCL), Vajra Bhawan, Chanda (M.H.) green.bcl@coalindia.in				Date of Issue		
Project	Sintering Outfall		Sample Ref. No.	RII/2023/100/1	Sampling Method	CMFDI/RI-2, IPR 4.2, IS 2012 Part-01	
Sampling Station	IPMS	Date of Sampling	16.11.2023	Sample Collected in 2 Lit (bottles). Color as observed is transparent			
Period of Analysis					From	TO	16.11.2023
Sl. No.	Parameter	Method of Analysis		UNIT	Range Of Testing	LOL	ISIRI/ISIRI-11 STANDARDS Limit (mg/l)
1	Ammoniacal Nitrogen, mg/l, liter	IS 2012/IS 13328.1: 2005, Nessler's		mg/l	0.01-100	0.01	10
2	Arsenic (As), mg/l, liter	IS 2012, part 01-1328, IS 2012/ APHA 22 nd Edition AAS-VGA		mg/l	0.005-3	0.005	0.2
3	Free Ammonia, mg/l, liter	IS 2012/IS 13328, Nessler's		mg/l	0.01-10	0.01	3
4	Cadmium (Cd), mg/l, liter	IS 2012/Part 01-1328, IS 2012 AAS-Flame /APHA, 22 nd Edition, IIIR, AAS-Flame		mg/l	0.01-10	0.005	1
5	Chloride compounds	APHA, 22 nd Edition-Mercuric Nitrate		mg/l	0.01-4	0.005	1
6	Cobaltum, mg/l, liter	IS 2012, part 01-1328, IS 2012/ APHA 22 nd Edition, AAS-VGA		mg/l	0.01-4	0.005	0.05
7	Sulphate (as SO ₄) mg/l, liter	APHA 22 nd Edition Barium Chloride Barium Method		mg/l	0.01-4	0.005	1
8	Total Dissolved Nitrogen, mg/l, liter	IS 2012/IS 13328, Nessler's		mg/l	0-100	1	100
9	Total Dissolved Chloride, mg/l, liter	APHA, 22 nd Edition, 4300-Cl ₂ (mercuric method)		mg/l	0.01	0.01	1

*All units in mg/L unless specified otherwise

*If sampling carried out for water samples, *LEL refers to Lower Detection Limit & EDL refers to End of Detection Limit

(Kumar Vaidhyan)
CHECKED BY

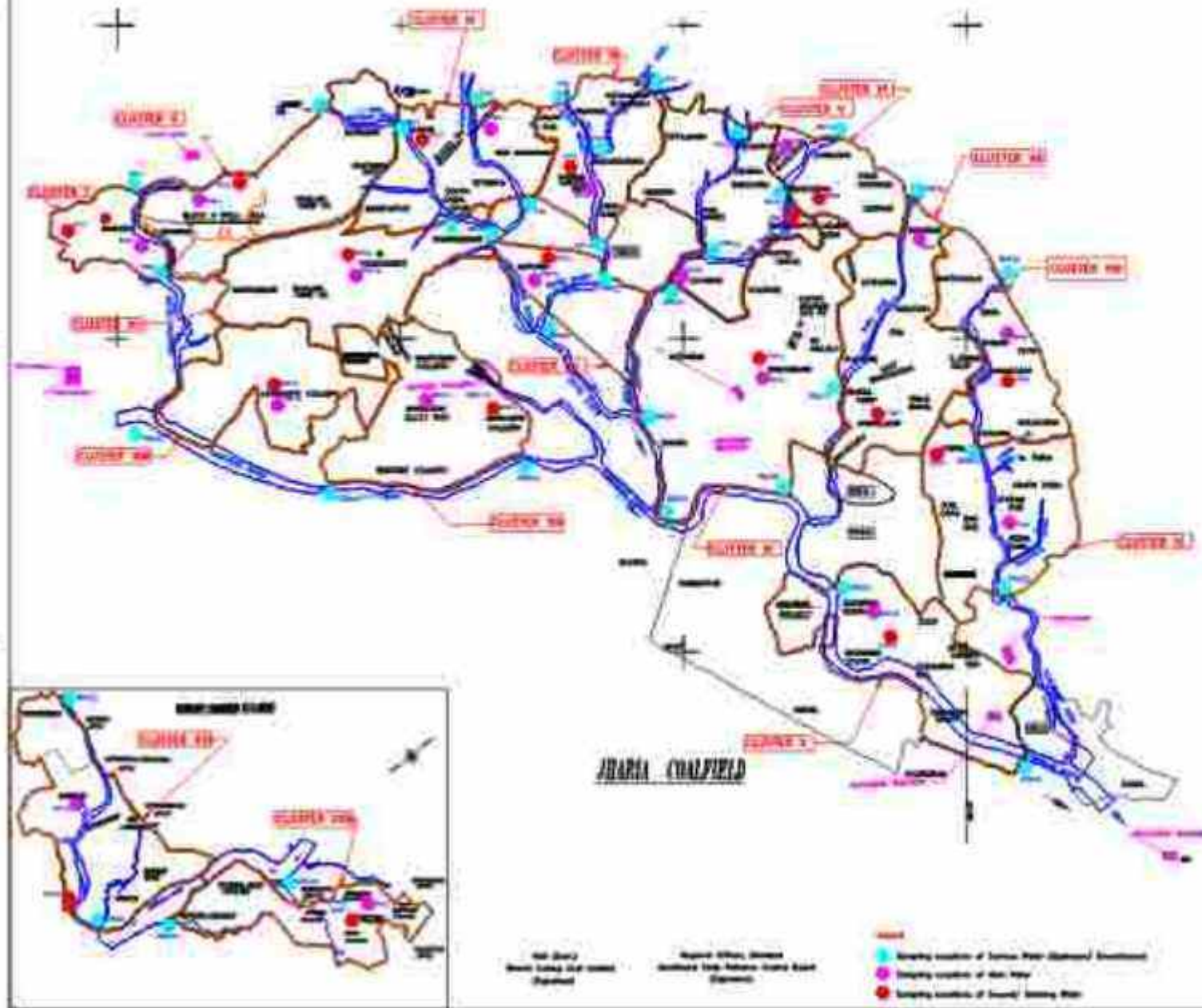
(Amit Raj Mishra)
HOD's Signature

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(Ev), CMFDI RI-II.

--- End of Report ---

Page-2 of 2

Water Sampling Locations in BCCL



Cluster	Location	Latitude	Longitude	Altitude	Area	Population	Water Body	Sampling Location	Sampling Date	Sampling Time	Sampling Method	Sampling Result
Cluster I	...	...	...	...	...	...	...	...	...	...	...	...
Cluster II	...	...	...	...	...	...	...	...	...	...	...	...
Cluster III	...	...	...	...	...	...	...	...	...	...	...	...
Cluster IV	...	...	...	...	...	...	...	...	...	...	...	...
Cluster V	...	...	...	...	...	...	...	...	...	...	...	...
Cluster VI	...	...	...	...	...	...	...	...	...	...	...	...
Cluster VII	...	...	...	...	...	...	...	...	...	...	...	...
Cluster VIII	...	...	...	...	...	...	...	...	...	...	...	...
Cluster IX	...	...	...	...	...	...	...	...	...	...	...	...
Cluster X	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XI	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XII	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XIII	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XIV	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XV	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XVI	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XVII	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XVIII	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XIX	...	...	...	...	...	...	...	...	...	...	...	...
Cluster XX	...	...	...	...	...	...	...	...	...	...	...	...

Prepared by	...
Checked by	...
Approved by	...
Date	...

**STRICTLY RESTRICTED -
FOR COMPANY USE ONLY RESTRICTED**

The information given in this report is not to be
communicated either directly or indirectly to the
public or to any person not holding an official
position in the CIL. (2019/08/06/01)

**WATER QUALITY REPORT
OF
BHARAT COKING COAL LIMITED,
CLUSTER – III
(FOR THE Q.E. DECEMBER, 2022)**

E. C. no. J-11015/213/2010-IA.II (M) dated 06.02.2013



CMPDI

ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CLUSTER - III

(FOR THE Q.E. DECEMBER, 2022)

CONTENTS

SL. NO.	CHAPTER	PARTICULARS
1		EXECUTIVE SUMMARY
2	CHAPTER -I	INTRODUCTION
3	CHAPTER-II	WATER SAMPLING & ANALYSIS
4	Plates: Plate No. -I	SURFACE PLAN SHOWING WATER MONITORING LOCATIONS

STRICTLY RESTRICTED
FOR COMPANY USE ONLY RESTRICTED

The information given in this report is not to be communicated either directly or indirectly to the public or to any person not holding an official position in the CIL / GOVERNMENT.

WATER QUALITY REPORT
OF
BHARAT COKING COAL LIMITED
CLUSTER – II
(FOR THE Q.E. DECEMBER, 2022)
E. C. no. J-11015/213/2010-IA.II (M) dated 06.02.2013



CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the environment around us. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. One of these major attributes is water.

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°37' N to 23°52' N latitudes and 86°09' E to 86°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 Water sampling stations

The Water sampling stations were selected for mine sump water, drinking water supply, well/ Hand pump water also surface water samples.

3.0 Methodology of sampling and analysis

3.1 Water quality

Water samples were collected as per standard practice. Effluent samples were analyzed for 25 parameters on quarterly basis and for 27 parameters on half yearly basis. The drinking and Surface water samples were collected and analyzed for 25 and 17 parameters respectively, on quarterly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory at CMPDI, RI-II, Dhanbad.

4.0 Results and interpretations

4.1 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, IS:10500/2012 (Drinking water) and IS: 2296 (Surface water), are with in permissible limits.

CHAPTER - I

INTRODUCTION

1.0 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.

Bharat Coking Coal Limited (BCCL), a subsidiary company of Coal India Limited (CIL) is operating UG Mines and Opencast Mines in Jharia Coalfield (JCF). The Jharia Coalfield (JCF) having an area of 450 Sq.KM.

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.

1.1 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 Akashkinaree Mine and Block IV Kooridih Mixed Mine. 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 Khudis and Bagdighi Nala.

1.2 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.

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

CHAPTER – II

WATER QUALITY MONITORING

3.1 Location of sampling sites (Refer Plate No. - I)

- i) Drinking water quality at Jogidih Village (DW3)
- ii) Surface water quality at U/S of Khudia Nala (SW4)
- iii) Surface water quality at D/S of Khudia Nala (SW5)
- iv) Surface water quality at U/S of Bagdighi Nala (SW6)
- v) Surface water quality at D/S of Bagdighi Nala (SW7)
- vi) Mine water discharge of Govindpur Colliery(MW3)

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. Effluent samples were analyzed for 25 parameters on quarterly basis and for 27 parameters on half yearly basis. The drinking and Surface water samples were collected and analyzed for 25 and 17 parameters respectively, on quarterly basis. Thereafter the samples were preserved and analyzed at the Environmental Laboratory at 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.



cmpdi
Central Mine Planning and Design Institute Limited

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

CHMPDI, RI-II
KOYLA SHAWAN COMPLEX
CHANDABAD - 506005
Phone-0524-223-650
mail: rri2cmpdi@coalindia.in

Month & Year	QUARTER ENDING DEC 2022	Cluster	III			Report No.	RI-2/WH/23-15/24/23
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Singh Bhawan, Chandabad (E-mail: genam-bcl@coalindia.in)					Date of Issue	01.01.23
Project	Jagdish Village		Sample Ref. No.	BBCL/BCLL/II-23/WH		Sampling Method	CHMPDI RI-II LPM 12/05/2021 Para-01
Sampling Station	Jagdish Village	Date of Sampling	04.12.2022	Sample Collected in 2 Ltr Nertopane, Color as observed is transparent			
		Period of Analysis		Nov 22		Jan 23	
Sl. No.	Parameter	Method of Analysis	Observed Values		IS 15559:2015		
			Obs'd	Range Or Tasting	LDL	Acceptable Limit (ppm)*	Permissible limit as the maximum of (Permissible limit)
1.	Codm. Water unit	APHA, 12th Edition, 2120-C Spectrophotometric, 2120-C (Wavelength Method 2121)	3	1-5000	1	3	3
2	Turbid. mg/l	IS 3025, (Part 4C) 1991 & 2014, AAS Flame Method & EDTA Method	24	10-4000	2	15	200
3	Chloride, mg/l	IS 3025 (Part II) 1984 & 2017, Argentometric Method	46	1.5-12000	6	240	1000
4	Fluoride, mg/l	APHA, 12th Edition, 2142-B Method	0.21	0.2-200	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 4C) 2005 & 2019, AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 12th Edition, 2106-B & Titrimetric Method	87	40-700	6	30	100
7	Sulfate, mg/l	APHA, 12th Edition, 2101-B Spectrophotometric Method	1820	0.2-400	0.2	40	No relaxation
8	Cadmium	APHA, 12th Edition, 2110-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part II - 1985 & 2017 Electrode method, pH Meter Method	7.23	1-14	0.1	6.5-8.5	No relaxation
10	Ammonia, mg/l	APHA - 12th Edition, 4500-N, Turbidity Method	128	100-4000	10	300	<100
11	Taste	APHA 12th Edition, 2110-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total alkalinity (as CaCO ₃) mg/l	IS 3025, Part II - 1985 & 2017 Titrimetric Method	132	40-50000	6	300	600
13	Total Dissolved Solids, mg/l	IS 3025, Part II - 1985 & 2017 Gravimetric method	546	10.0-50000	24	500	1000
14	Total Hardness, mg/l	IS 3025 (Part II) 2005 EDTA Method	433	40-50000	9	300	600
15	Turbidity, NTU	IS 3025, (Part 4C) 1994 & 2017 Nephelometric Turbidity method	1.4	1-500	0.1	1	1
16	Iron, mg/l	IS 3025 (Part 4C) 1994 & 2019, AAS-Flame Method	<0.1	0.1-10	0.1	1	1.5

*All units in mg/L unless specified otherwise.

**Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.

(Signature)

(Kumar Vaibhav)
CHECKED BY

(Signature)

(Anuraj Mishra)
HOD's Signature

ANALYSED BY

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.

Page - 1 of 2

— End of Report —



cmpdi
A Whil. Ratan Company

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

CMPDIL RI-II
KIDLA BHAWAN COMPLEX
DHANBAD, -838005
Phone: 3326-223-858
email: rdi2cmpdi@coalindia.in

Block & Year	QUARTER EXHIB 2002002	Client	II	Report No.	RI-2-TH-T7-T8-T9-10-11		
Customer	Electronics Department, Bharat Ironing Co. Ltd. (BCL), Kalya Nagar, Chanda (J. M.) gprati@bharatironing.co.in			Date of Issue	14.02.2013		
Project	Jagdish Village	Sample Ref. No.	BCL/2012/10-11/TH	Sampling Method	CMPDI/RI-II/LPH-11/12/2012/Part-42		
Sampling Station	Jagdish Village	Date of Sampling	14.01.2013	Sample Collected in 2 Lit. Jerrycan. Color as observed is transparent			
		Period of Analysis	Jan-12	Jan-13			
Sr. No.	Parameter	Method of Analysis	Observed Values			IS 10500: 2012	
			Obs.	Range of Testing	LDL	Acceptable Limit (mg/L)	Acceptable Limit in the Form of (Maximum Allowable Concentration)
1	Iron (as Fe, mg/L) Max	APHA, 19th Edition, Colorimetric	0.2	0.1-0.2	0.2	0.2	1
2	Copper (as Cu, mg/L) Max	IS 2002 Part 42: 1992 & 1018, AAS-Flame APHA, 19th Edition, AAS-ETA	<0.01	0.01-0.2	0.01	0.01	1.5
3	Free Radical Chlorine (mg/L) Min	APHA, 19th Edition, 8000-C1 & (colorimetric HACH DR)	<0.10	0.04-0.5	0.04	0.2	1
4	Lead (as Pb, mg/L) Max	IS 2012 Part 47: 1992 & 1018 (Spectrophotometric) APHA, 19th Edition, AAS-ETA	<0.015	0.005-0.5	0.005	0.01	No reduction
5	Fluoride compound (as F, mg/L) Max	APHA, 19th Edition, 4-Amino Antipyrine	<0.001	0.001-0.2	0.001	0.002	0.002
6	Selenium (mg/L) Max	APHA 19th Edition 13-3012, 10-2002, 8-3012, AAS-ETA	<0.007	0.001-0.2	0.001	0.01	No reduction
7	Total Arsenic (as As, mg/L) Max	IS 2012 Part 57: 1992 & 1018, AAS-Flame APHA 19th Edition AAS-ETA	<0.004	0.004-0.2	0.004	0.01	0.05
8	Total Chromium (as Cr, mg/L) Max	IS 2012 Part 52: 1992, 8-3012, AAS-Flame APHA, 19th Edition AAS-ETA	<0.01	0.01-0.2	0.01	0.01	No reduction
9	Manganese (as Mn, mg/L) Max	IS 2012 Part 54: 1992, 8-3012, AAS-Flame APHA, 19th Edition AAS-ETA	<0.01	0.001-0.5	0.001	0.01	No reduction
10	Hardness as Ca, mg/L) Max	IS 2012 Part 50: 1992, 8-3012, AAS-Flame Method	0.04	0.01-0.5	0.01	0.1	0.3

**All units in mg/L unless specified otherwise.

**Only sampling carried out for water samples. *LDL indicates Lower Detection Limit & BCL indicates Below Detection Limit.

(Signature)

(Kumar Vaibhav)
CHECKED BY

(Signature)

(Amit Raj Mishra)

ANALYSED BY

HOD's Signature

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.



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

CMPDI, R-II

CPFLA BHAWAN, COERPLEX

DHANBAD - 826003

Phone: 0353-223-453

Email: rrii2.cmpdi@coelindia.in

Month & Year	QUARTER ENDING DATE		Cluster	H All		Report No.	RI-2/SW/22-23/QE/03
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bcl@coelindia.in)					Date of Issue	16.03.2023
Project	Sample Ref. No.		REM/BCL/2022/SW/		Sampling Method	(IS 3025, Part-1) CMPDI/RI-II/LPM 13	
Sampling Stations	(i)	Downstream in Khudla Nala(SW4)	Date of Sampling		12.12.22	Period of Analysis	
	(ii)	Downstream of Khudla Nala (Downstream with cluster III) (SW5)	Date of Sampling		12.12.22	Nov/22 TO Jan 23	
Sl. No.	Parameter	Method of Analysis	Observed Values		IS 3025 (PART-1) SURFACE WATER (1992) Class 'C'	Range of Testing	LDL
			SW4	SW5			
1	BOD (3 days IT+C), mg/l	IS 3025 (Part 44) : 1993, B-2019, 3 day incubation at 27°C	<1.0	<1.0	3	1-100.0	1
2	Colour,Hazen Units	APHA 23rd Edition, 2120-B-2017	4	4	10	1-100.0	1
3	Chlorides, mg/l	IS-3025(Part 31): 1988, B-2019 Argentometric Method	44	39	600	10-1500.0	3
4	Copper, mg/l	IS 3025 (Part 47) : 1992 B-2019, AAS-Flame Method	<0.2	<0.2	1.5	0.2-10.0	0.2
5	Dissolved Oxygen, mg/L	IS 3025 (Part 38) : 1989, B-2003 Winkler Azide Method	6.3	6.3	4	0.1-12.0	0.0
6	Fluoride, mg/l	APHA, 23rd Edition, EPA823 Method	0.4	0.43	1.5	0.1-2.00	0.2
7	Hexavalent Chromium, mg/l	APHA 23rd Edition, 1,5-Diphenylcarbohydrazide Method	<0.01	<0.01	0.05	0.01-1.4	0.01
8	Iron, mg/l	IS 3025 (Part 53) : 2003,B-2019, AAS-Flame Method	<0.2	<0.2	30	0.2-10	0.2
9	Nitrate, mg/l	APHA, 23rd Edition, UV-Spectrophotometric Method	4.29	2.39	30	0.1-45.0	0.3
10	pH value	IS 3025, (Part 11) : 1985 B-2017 Electrode (pH Meter) method	8.01	7.81	8.5-8.5	1.0-12.0	1
11	Sulphate, mg/l	APHA -23rd Edition, 4500-S, Turbidity Method	43	36	400	10.0-400.0	10
12	Total Dissolved Solids, mg/l	IS 3025, (Part 16) : 1994 B-2017 Gravimetric method	310	617	1500	25.0-5000.0	25
13	Zinc, mg/l	IS 3025(Part 49) : 1994, B-2019, AAS-Flame Method	0.1	<0.1	1.5	0.1-1.0	0.1

*Oral sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit

**All units in mg/L unless specified otherwise. Sample Collected in 5 Ltr Jerrycan. Color as observed is transparent.

(Signature)

Analysed by

(Signature)
(Kumar Vaibhav)

CHECKED BY

(Signature)
(Amit Raj Mishra)

HOD's Signature

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, R-II.

--- End of Report ---

Page -1 of 2



CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

SURFACE WATER ANALYSIS TEST REPORT

CMPDI, B-4
KOTVA SUKHAN COMPLEX
DHANBAD, JHARKH
Phone: 2225-222-402
Email: rtri2.cmpdi@coalindia.in

Month & Year	QUARTER ENDING DEC 2022	Cluster	II & III		Report No.	RI-2/SW/22-23/QE/03	
Customer	Environment Department, Bharat Coking Coal Limited (BCEL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bcel@coalindia.in)				Date of Issue	16.03.2023	
Project	Sample Ref. No.		2224/BCEL/1022/SW/		Sampling Method	(IS 3025, Part-1) CMPDI/RI-II/LPM 13	
Sampling Stations	I	Downstream in Khodia Nala (SWA)	Date of Sampling		12.12.22	Period of Analysis	
	II	Downstream of Khodia Nala (Downstream with cluster II) (SWS)	Date of Sampling		12.12.22	Nov'22 to Jan'23	
Sl. No.	Parameter	Method of Analysis	Observed Values		IS-3025 (2003) STANDARD (WATER QUALITY) CLASS 'C'	Range of Testing	LDL
			SWA	SWS			
1	Arsenic (as As), mg/l Max	IS-3025, Part 37, 1968, E-2019/ APHA 23rd Edition AAS-VGA	<0.006	<0.006	0.2	0.005-10	0.006
2	Lead (as Pb), mg/l Max	APHA, 23rd Edition, AAS-GTA	<0.005	<0.005	0.1	0.005-10	0.005
3	Phenolic compounds (as C6H5OH), mg/l Max	APHA, 22nd Edition 4-Amino Antipyrine	<0.002	<0.002	0.005	0.002-10	0.002
4	Selenium, mg/l Max	IS-3025, Part 56, 2003, R-2019/ APHA 23rd Edition, AAS-VGA	<0.003	<0.003	0.05	0.007-10	0.007

**Only sampling carried out for water sampling. LDL indicates Lower Detection Limit & SDL in Cases Below Detection Limit.

***All units in mg/l unless specified otherwise Sample Collected in 5 Ltr ferricure, Color as observed is transparent

[Signature]
24

(Rumar Vaidhar)

(Amit Raj Nishra)

Analysed by

CHECKED BY

HOD's Initial/Signature

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 2 of 2

**CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED****Environment Laboratory, Regional Institute-II****SURFACE WATER ANALYSIS TEST REPORT**

COPDIL, RI-II

KOLLA BHAWAN COMPLEX

CHENNAI - 600003

Phone: 044-2234493

Email: rrii2.cmpdi@coalindia.in

Month & Year	QUARTER ENDING DEC 2022	Cluster	III & XV			Report No.	RJ-3/SW/22-23/QE/03
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gmenv@bcl.coalindia.in)					Date of Issue	16.01.23
Project	Sample Ref. No.		REV/BECL/2022/017		Sampling Method	(IS 3025, Part-1) CMPDI/RI-II/LPM 15	
Sampling Stations	(i)	Upstream in Bagtigi Kales(SW1)	Date of Sampling		26.12.22	Period of Analysis	
	(ii)	Downstream in Bagtigi Kales(SW2)	Date of Sampling		26.12.22	Nov/22 to Jan 23	
Sl. No.	Parameter	Method of Analysis	Observed Values		R-1226 RELEASE SURFACE WATER (1993) Class-C	Range of Testing	LDL
			(i)	(ii)			
1	BOD (3 days 20°C), mg/l	IS 3025 (Part 44) : 1993, R: 2019, 3 day incubation at 20°C	<1.0	<2.0	3	2.00-10.00	1
2	Colour, Hazen Units	APHA 23rd Edition, 2120-B-2017	1	1	10	1-1000	1
3	Chlorides, mg/l	IS-3025 (Part 31) : 1988, R: 2019 Argentometric Method	78	50	500	50-1500.0	5
4	Copper, mg/l	IS 3025 (Part 42) : 1993 R: 2019, AAS-Flame Method	<0.1	<0.1	1.0	0.1-10.0	0.1
5	Dissolved Oxygen, mg/L	IS 3025 (Part 35) : 1989, R: 2002 Winkler Azide Method	8.6	8.8	6	0.1-10.0	0.1
6	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method	0.48	0.53	1.5	0.1-2.00	0.1
7	Hexavalent Chromium, mg/l	APHA 23rd Edition, 1,5-Diphenylcarbohydrazide Method	<0.01	<0.01	0.05	0.01-1.4	0.01
8	Iron, mg/l	IS 3025 (Part 53) : 2003 R: 2019, AAS-Flame Method	<0.1	<0.2	50	0.2-10	0.1
9	Nitrate, mg/l	APHA, 23rd Edition, UV-Spectrophotometric Method	1.06	4.16	50	0.5-45.0	0.5
10	pH value	IS 3025 (Part 11) : 1983 R: 2017 Electronic (pH Meter) method	8.09	8.07	6.5-8.5	7.0-12.0	1
11	Sulphate, mg/l	APHA - 23rd Edition, 4300-1, Turbidity Method	36	41	400	100-400.0	10
12	Total Dissolved Solids, mg/l	IS 3025 (Part 16) : 1984 R: 2017 Gravimetric method	383	429	1500	150-5000.0	25
13	Zinc, mg/l	IS 3025 (Part 49) : 1994, R: 2019, AAS-Flame Method	<0.1	0.12	15	0.1-30	0.1

***Good sampling protocol apt for water samples. LDL indicates Lower Detection Limit & BCL indicates Below Detection Limit

***All units in mg/L unless specified otherwise. Sample Collected in 5 Ltr ferricune. Color as observed is transparent

(Kumar Vaibhav)

Analysed by**CHECKED BY**

(Amit Raj Mishra)

HOD's Initial/Signature

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 2



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

CMPDI, R-II
 KANHA BHAVAN COMPLEX,
 DHANBAD - 826005
 Phone: 0328-222-800
 E-mail: ror2.cmpdi@coalindia.in

Month & Year	QUARTER ENDING DEC 2022		Cluster	III & XV		Report No.	RI-2/SW/23-23/QE/03	
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bcl@coalindia.in)					Date of Issue	16.01.23	
Project	Sample Ref. No.			REN/BCL/2022/SW/	Sampling Method	(IS 3025, Part-1) CMPDI/RI-II/LPM 13		
Sampling Stations	(i)	Upstream in Bagdi Nala(SW6)		Date of Sampling	26.12.22	Period of Analysis		
	(ii)	Downstream in Bagdi Nala(SW7)		Date of Sampling	26.12.22	Nov/22 to Jan 23		
Sl. No.	Parameter	Method of Analysis		Observed Values		IS 3025, Part-1 SURFACE WATER (1991) Class C	Range of Testing	LDL
				(i)	(ii)			
1	Arsenic (as As), mg/l Max	IS-3025, Part 37-1988, R-2019/ APHA 23rd Edition AAS-VGA		<0.006	<0.006	0.3	0.006-10	0.006
2	Lead (as Pb), mg/l Max	APHA 23rd Edition, AAS-GTA		<0.005	<0.005	0.1	0.005-10	0.005
3	Phenolic compounds (as C6H5OH), mg/l Max	APHA 23rd Edition 4-Amino Antipyrine		<0.002	<0.002	0.005	0.002-10	0.002
4	Selenium, mg/l Max	IS-3025, Part 56-2003, R-2019/ APHA 23rd Edition, AAS-VGA		<0.007	<0.007	0.05	0.007-10	0.007

**Gross sampling carried out for water samples. *LDL indicates Lower Detection Limit & PQL indicates Below Detection Limit.

***All units in mg/l unless specified otherwise. Sample Collected in 5 Lit. ferricane. Color as observed is transparent.

[Signature]

(Kumar Vaibhav)

[Signature]
 (Amit Raj Mishra)

Analysed by

CHECKED BY

HOD's Initial/Signature

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, R-II.



cmpdi
CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II
MINE EFFLUENT ANALYSIS TEST REPORT

CMPDI, RI-II
KOYLA BHAIWAN COMPLEX
DHANBAD - 826005
Phone 0326-223-850
Email: info@cmpdi.coimindia.in

Month & Year	QUARTER ENDING Dec 2022	Cluster	CCEP/RI-II	Report No.	M-2, NW/2022-23/GE/04
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gyanendra.bcl@bcl.coimindia.in)			Date of Issue	
Project	Candigarh Colliery	Sample Ref. No.	R216/WCL/CO22/189/1	Sampling & Method	CMPDI, RI-II, LFW 11, (10 2022, Part-I)
Sampling Station	W1C2	Date of Sampling	24.12.2022	Sample Collected in 2 Litre bottles, Color as observed is transparent	

Sl. No.	Parameter	Method of Analysis	Period of Analysis			IS 3025-SCM-VI STANDARD Class V
			WHO	Range of Testing	LOD	
1	pH (25°C, mg/l, Min)	IS 3025 (10-2022), 9-2022 and Hachette at 17°C	<12	3-14.000	2	10
2	Colour	APHA 21 st Edition 2012-6-2017	5	10-2000	5	—
3	DOO, mg/l, Min	APHA 21 st Edition 2012-6-2017 and Hachette	11	40-2000	4	110
4	Copper (as Cu), mg/l, Max	IS 3025 (Part 1): 2012-9-2012, 10-2012	<0.1	0.1-100	0.1	5
5	Dissolved Phosphate (as P), mg/l, Max	IS 3025/ 11-2022 & 2022	<0.1	0.1-5	0.1	5
6	Fluoride (as F), mg/l, Max	IS 3025 11-2022 & 2022, Page 5-6-2012, 10-2012 & 9-2012/11-2022	<0.1	0.1-2	0.1	2
7	Manganese Chromium, mg/l, Max	IS 3025 (Part 1): 2012-9-2012, 10-2012	<0.05	0.05-1.0	0.05	0.1
8	Iron (as Fe), mg/l, Max	IS 3025 (Part 1): 2012-9-2012, 10-2012, 10-2012	<0.2	0.2-10	0.2	5
9	Manganese (as Mn), mg/l, Max	APHA 21 st Edition 2012-6-2017	<0.1	0.1-10	0.05	0.1
10	Nickel (as Ni), mg/l, Max	IS 3025 (Part 1): 2012-9-2012, 10-2012	<0.1	0.1-100	0.1	5
11	Nitrate Nitrogen, mg/l, Max	APHA 21 st Edition 2012-6-2017 and Hachette	0.1	0.1-45	0.1	10
12	Oil & Grease, mg/l, Max	IS 3025 (10-2022), 9-2012, 10-2012, 10-2012	<0.1	0.1-1000	1	10
13	pH value	IS 3025 (10-2022), 9-2017, 10-2017	7-14	3-14	0.1	0.2 to 0.3
14	Temperature (°C)	IS 3025 (10-2022), 10-2017	11.5	1-100		Shall not exceed 1°C above the surrounding temp.
15	Total Chromium (as Cr), mg/l, Max	IS 3025 (Part 1): 2012-9-2012, 10-2012	<0.1	0.1-5	0.1	2
16	Total Suspended Solids, mg/l, Max	IS 3025 (10-2022), 9-2017, 10-2017	17	10-2000	10	100
17	Zinc (as Zn), mg/l, Max	IS 3025 (10-2022), 9-2012, 10-2012	<0.1	0.1-10	0.1	5
18	Odour	APHA 21 st Edition 2012-6-2017	Agreeable	Qualitative	Qualitative	Qualitative

***All units in mg/l unless specified otherwise

***This sampling carried out for water samples. LOD is based on lower Detection Limit & LOD is based on lower Detection Limit

[Signature]
ANALYSED BY

[Signature]
(Kumar Vaidhyan)
CHECKED BY

[Signature]
(Amit Raj Mishra)

HOD's Signature

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 (Engr), CMPDI, RI-II.

— End of Report —

Page-1 of 2



cmpdi
A Bharat Heavy Engineering Company

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

CMFDI, RI-II
KOPLA BRAHMAN COMPLEX
DHANEAD, -515005
Phone: 0326-223-050
Email: rri2@cmpdi.coalindia.in

Work & Task	QUARTER ENDING Dec 2021	Sluiter	CLAYTON			Report No.	RI-2/WW/2021-22/QC-04
Customer	Sinterment Department, Bharat Coking Coal Limited (BCL), Vajra Bhawan, Chanda (M.H.) green.boil@coalindia.in					Date of Issue	
Project	Sintering Outfall		Sample Ref. No.	RII/2021/1221/WW/		Sampling Method	CMFDI/RI-II/1PM 12/15/2021 Part-01
Sampling Station	WWS	Date of Sampling	16.12.2021	Sample Collected in 2 Lit Jar (bottle). Color as observed is transparent			
				Period of Analysis	From	TO	16/12/2021
Sl. No.	Parameter	Method of Analysis		UNIT	Range Of Testing	LOL	ISIRI-ISO-11 STANDARD Limit (V)
1	Ammoniacal Nitrogen, mg/l, liter	IS 6023/34:1988, B: 2005, Nessler's		<0.03	0.01-100	0.01	10
2	Arsenic (As), mg/l, liter	IS-2021, part 27:1988, B:2018/ APHA 22 nd Edition AAS-VGA		<0.008	0.001-3	0.001	0.2
3	Free Ammonia, mg/l, liter	IS 6023/34:1988, Nessler's		<0.01	0.01-10	0.01	1
4	Cadmium (Cd), mg/l, liter	IS-2021, Part 58: 2000, B:2017 AAS-Flame /APHA 22 nd Edition 11118 AAS-Flame		<0.005	0.0-10	0.005	1
5	Chloride compounds	APHA 22 nd Edition 4400 Chloride Spectrophotometry		<0.002	0.001-4	0.001	1
6	Cobaltum, mg/l, liter	IS-2021, part 56:2000, B:2018/ APHA 22 nd Edition, AAS-VGA		<0.007	0.001-4	0.001	0.05
7	Sulphate (as S ²⁻) mg/l, liter	APHA 22 nd Edition Spectrophotometric Barium Method		<0.008	0.001-3	0.001	1
8	Total Dissolved Nitrogen, mg/l, liter	IS 6023/34:1988, Nessler's		<1.2	0-100	1	100
9	Total Dissolved Chlorine, mg/l, liter	APHA 22 nd Edition, 4500-Cl ₂ (mercuric method)		0.04		0.04	1

*All units in mg/L unless specified otherwise

> 10 sampling carried out for water samples. *LEL reflects Lower Detection Limit & EDL reflects End of Detection Limit

(Kumar Vaidhyan)
CHECKED BY

(Amit Raj Mishra)

HOD's Signature

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), CMFDI RI-II.

End of Report

Page-2 of 2

Water Sampling Locations in BCCL

The map illustrates the water sampling locations within the BCCL (Bharatpur Canal Control Limit) area. The map shows the canal network and various water bodies. Sampling locations are marked with colored dots: blue for surface water (discharge), pink for surface water (inlet), and red for surface water (outlet). A table on the right lists the sampling locations and their corresponding coordinates. An inset map shows the location of BCCL within the larger context of the region.

Sl. No.	Location	Latitude	Longitude
1	...	...	...
2	...	...	...
3	...	...	...
4	...	...	...
5	...	...	...
6	...	...	...
7	...	...	...
8	...	...	...
9	...	...	...
10	...	...	...
11	...	...	...
12	...	...	...
13	...	...	...
14	...	...	...
15	...	...	...
16	...	...	...
17	...	...	...
18	...	...	...
19	...	...	...
20	...	...	...
21	...	...	...
22	...	...	...
23	...	...	...
24	...	...	...
25	...	...	...
26	...	...	...
27	...	...	...
28	...	...	...
29	...	...	...
30	...	...	...
31	...	...	...
32	...	...	...
33	...	...	...
34	...	...	...
35	...	...	...
36	...	...	...
37	...	...	...
38	...	...	...
39	...	...	...
40	...	...	...
41	...	...	...
42	...	...	...
43	...	...	...
44	...	...	...
45	...	...	...
46	...	...	...
47	...	...	...
48	...	...	...
49	...	...	...
50	...	...	...

Map Scale: 1:50,000

North Arrow

Legend:

- Blue dot: Sampling location of Surface Water (Discharge)
- Pink dot: Sampling location of Surface Water (Inlet)
- Red dot: Sampling location of Surface Water (Outlet)

Inset Map: Shows the location of BCCL within the larger context of the region.

1	...	...	...	...	...
2	...	...	...	...	...
3	...	...	...	...	...
4	...	...	...	...	...
5	...	...	...	...	...
6	...	...	...	...	...
7	...	...	...	...	...
8	...	...	...	...	...
9	...	...	...	...	...
10	...	...	...	...	...
11	...	...	...	...	...
12	...	...	...	...	...
13	...	...	...	...	...
14	...	...	...	...	...
15	...	...	...	...	...
16	...	...	...	...	...
17	...	...	...	...	...
18	...	...	...	...	...
19	...	...	...	...	...
20	...	...	...	...	...
21	...	...	...	...	...
22	...	...	...	...	...
23	...	...	...	...	...
24	...	...	...	...	...
25	...	...	...	...	...
26	...	...	...	...	...
27	...	...	...	...	...
28	...	...	...	...	...
29	...	...	...	...	...
30	...	...	...	...	...
31	...	...	...	...	...
32	...	...	...	...	...
33	...	...	...	...	...
34	...	...	...	...	...
35	...	...	...	...	...
36	...	...	...	...	...
37	...	...	...	...	...
38	...	...	...	...	...
39	...	...	...	...	...
40	...	...	...	...	...
41	...	...	...	...	...
42	...	...	...	...	...
43	...	...	...	...	...
44	...	...	...	...	...
45	...	...	...	...	...
46	...	...	...	...	...
47	...	...	...	...	...
48	...	...	...	...	...
49	...	...	...	...	...
50	...	...	...	...	...
51	...	...	...	...	...
52	...	...	...	...	...
53	...	...	...	...	...
54	...	...	...	...	...
55	...	...	...	...	...
56	...	...	...	...	...
57	...	...	...	...	...
58	...	...	...	...	...
59	...	...	...	...	...
60	...	...	...	...	...
61	...	...	...	...	...
62	...	...	...	...	...
63	...	...	...	...	...
64	...	...	...	...	...
65	...	...	...	...	...
66	...	...	...	...	...
67	...	...	...	...	...
68	...	...	...	...	...
69	...	...	...	...	...
70	...	...	...	...	...
71	...	...	...	...	...
72	...	...	...	...	...
73	...	...	...	...	...
74	...	...	...	...	...
75	...	...	...	...	...
76	...	...	...	...	...
77	...	...	...	...	...
78	...	...	...	...	...
79	...	...	...	...	...
80	...	...	...	...	...
81	...	...	...	...	...
82	...	...	...	...	...
83	...	...	...	...	...
84	...	...	...	...	...
85	...	...	...	...	...
86	...	...	...	...	...
87	...	...	...	...	...
88	...	...	...	...	...
89	...	...	...	...	...
90	...	...	...	...	...

NAME	DATE
GRADE	SCORE
1. The first step in the scientific method is to ask a question.	
2. A hypothesis is a statement that can be tested.	
3. The results of an experiment are called data.	
4. A conclusion is a statement that summarizes the results of an experiment.	
5. The scientific method is a way of finding out about the world.	

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. CIL/COA/IND/01

WATER QUALITY REPORT
OF
BHARAT COKING COAL LIMITED,
CLUSTER – III
(FOR THE Q.E. MARCH, 2023)

E. C. no. J-11015/213/2010-IA.II (M) dated 06.02.2013



CMPDI

ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CLUSTER - III

(FOR THE Q.E. MARCH,2023)

CONTENTS

SL. NO.	CHAPTER	PARTICULARS
1.		EXECUTIVE SUMMARY
2.	CHAPTER - I	INTRODUCTION
3.	CHAPTER-II	WATER SAMPLING & ANALYSIS
4.	Plates: Plate No. - I	SURFACE PLAN SHOWING WATER MONITORING LOCATIONS

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 - DEPARTMENT

WATER QUALITY REPORT
OF
BHARAT COKING COAL LIMITED
CLUSTER – II
(FOR THE Q.E. MARCH, 2023)
E. C. no. J-11015/213/2010-IA.II (M) dated 06.02.2013



CMPDI

ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the environment around us. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. One of these major attributes is water.

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°37' N to 23°52' N latitudes and 86°09' E to 86°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 Water sampling stations

The Water sampling stations were selected for mine sump water, Ground water supply, well/ Hand pump water also surface water samples.

3.0 Methodology of sampling and analysis

3.1 Water quality

Water samples were collected as per standard practice. Effluent samples were analyzed for 25 parameters on quarterly basis and for 27 parameters on half yearly basis. The Ground and Surface water samples were collected and analyzed for 25 and 17 parameters respectively, on quarterly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory at CMPDI, RI-II, Dhanbad.

4.0 Results and interpretations

4.1 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, IS 10500/2012 (Ground water) and IS 2296 (Surface water), are with in permissible limits.

CHAPTER - I

INTRODUCTION

- 1.0 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.

Bharat Coking Coal Limited (BCCL), a subsidiary company of Coal India Limited (CIL) is operating UG Mines and Opencast Mines in Jharia Coalfield (JCF). The Jharia Coalfield (JCF) having an area of 450 Sq.KM.

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.

- 1.1 The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogdih Colliery, Maheshpur Colliery, South Govindpur Colliery, Tetunya Colliery, Govindpur Colliery, New Akashinaraa Mine and Block IV Kooridih Mixed Mine. 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.
- 1.2 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.

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

CHAPTER – II

WATER QUALITY MONITORING

3.1 Location of sampling sites (Refer Plate No. - I)

- i) Ground water quality at Jogidih Village (GW3)
- ii) Surface water quality at U/S of Khudia Nala (SW4)
- iii) Surface water quality at D/S of Khudia Nala (SW5)
- iv) Surface water quality at U/S of Bagdighi Nala (SW6)
- v) Surface water quality at D/S of Bagdighi Nala (SW7)

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. Effluent samples were analyzed for 25 parameters on quarterly basis and for 27 parameters on half yearly basis. The Ground and Surface water samples were collected and analyzed for 25 and 17 parameters respectively, on quarterly basis. Thereafter the samples were preserved and analyzed at the Environmental Laboratory at 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
GROUND WATER ANALYSIS TEST REPORT

CMPDI, RI-II
 KOTLA BHAWAN COMPLEX
 BHANSGAR - 814008
 Phone: 0325-225-828
 email: rri@cmpdi.in

Month & Year	QUARTER CHOICE MARCH 2023	Client	CLUSTER II			Report No.	RI-I/Env/II/ 13/Q4/24
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Korta Bhanan, Bhankar (S.M.) ghant.bcl@coalindia.in					Date of Issue	18.03.2023
Project	Jagdish Village		Sample Ref. No.	BBH/BCL/2022/BW/	Sampling Method	CMPDI/RI-II/LTH 13.10.2022 Part-01	
Sampling Station	ENV	Date of Sampling	12.02.2023	Sample Collected in 5 Litre (various). Color as observed is transparent			
			Period of Analysis		13.02.23	to	14.04.23
Sl. No.	Parameter	Method of Analysis	Observed Values			IS:10500:2012	
			Env	Range OC Testing	LFL	Acceptable (mm) (Max)	Permissible Limit in the absence of observed source (mm)
1	Colour, Kemer unit	APHA, 12+ 600nm, J130-C Spectrophotometer Single Wavelength Method 2017	0	1-5000	1	5	12
2	Calcium, mg/l	IS:2021 (Part 40) (1991) 0.22% AAS-Flame Method & EDTA Method	22	10-4000	5	75	200
3	Magnesium, mg/l	IS:2021 (Part 21) (1991) 0.22% AAS-Flame Method	22	10-12000	1	225	1000
4	Fluoride, mg/l	APHA, 12th Edition, SPAD10 Method	0.81	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS:2021 (Part 40) (1991) 0.22% AAS-Flame Method	0.1	0.2-10	0.2	1	No restriction
6	Nitrate	APHA, 12th Edition, 4400-NO ₃ -W Colorimetric Method	99	0.0-100	4	30	100
7	Nitrate, mg/l	APHA, 12th Edition, UV-Spectrophotometric Method	7.82	0.2-40.0	0.2	40	No restriction
8	Copper	APHA, 12th Edition, 3110-C	Agreement	Quantitative	Qualitative	Agreement	Agreement
9	pH value	IS:2021, Part 11 (1991) 0.22% Electrode/pH Meter Method	7.62	0-14	0.1	6.5-8.5	No restriction
10	Barium, mg/l	APHA, 12th Edition, 4320-B Turbidity Method	97	10.0-400.0	10	300	400
11	Yarn	APHA, 12th Edition, 3110-C	Agreement	Quantitative	Qualitative	Agreement	Agreement
12	Total Solids (Secchi) mg/l	IS:2021, Part 10 (1991) 0.22% Turbidity Method	300	0-10000	4	300	500
13	Total Dissolved Solids, mg/l	IS:2021, Part 10 (1991) 0.22% Turbidity Method	712	11.0-5000.0	11	500	2000
14	Total Hardness, mg/l	IS:2021 (Part 21) (1991) EDTA Method	215	0-10000	4	300	1000
15	Turbidity, NTU	IS:2021 (Part 10) (1991) 0.22% Nephelometric/Turbidimetric Method	1.2	0-400	0.1	1	5
16	Zinc, mg/l	IS:2021 (Part 40) (1991) 0.22% AAS-Flame Method	0.1	0.2-1.0	0.1	1	1.5

***All units in mg/L unless specified otherwise

***Data sampling carried out for water samples. LFL, indicates Lower Detection Limit & BCL indicates Below Detection Limit.

ANALYSED BY

(Kumar Vaibhav)
CHECKED BY

(Amit Raj Mishra)

HOD's Signature

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.



cmpdi
A Water India Company

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

CMPDI, RI-II
MOLA SHAKHAI COMPLEX
BHANAGAR - 426002
Phone 0226-225-230
email: rir@cmpdi.coa.in

Month & Year	QUARTER DHOHC March 2023	Cluster	CLUSTER III			Report No.	RI-2-TH-23-23-19-04
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Koria Bheem, Bhokard (G-mad) green.eco@coai.coa.in					Date of Issue	18.03.2023
Project	Jagdish Village		Sample Ref. No.	BCL/BCL-1023-TH	Sampling Method	CMPDI/RI-II/LPH-12 (IS 2023 Part-V)	
Sampling Station	SW-2	Date of Sampling	18.03.2023	Sample Collected in 5-Ltr bottles. Color as observed is transparent			
Sl. No.	Parameter	Method of Analysis	Period of Analysis		IS	IS 2023-2012	
			Observed Values				
			SW-2	Range of Testing	LDL	Acceptable Limit (Max)	Permissible Limit in the Absence of Alternative Source (Max)
1	Barium (as Ba), mg/L Max	APHA, 13th Edition, Colorimetric	<0.2	0.2-10	0.2	0.2	1
2	Copper (as Cu), mg/L Max	IS 2023 Part 42: 2002 R: 2018, AAS-Flame APTA, 12th Edition, AAS-GTA	<0.05	0.05-10	0.05	0.05	10
3	Free Amino Nitrogen, mg/L Max	APHA, 13th Edition, AAO-CH-2 (Microscopic Method-1)	<0.04	0.04-5	0.04	0.04	1
4	Lead (as Pb), mg/L Max	IS 2023 Part 47: 1994 (Revised 2019) APTA, 12th Edition, AAS-GTA	<0.05	0.05-10	0.05	0.05	No restriction
5	Fluoride (as F), mg/L Max	APHA, 13th Edition, AAO-CH-2 (Microscopic Method-1)	<0.001	0.001-10	0.001	0.001	0.001
6	Selenium, mg/L Max	APHA 13th Edition IS-2023 part 54: 2023, S-2018, AAS-PTA	<0.007	0.007-10	0.007	0.007	No restriction
7	Total Ammonia Nitrogen (as N), mg/L Max	IS 2023 part 27: 1982, S-2009, APTA 13th Edition AAS-PTA	<0.004	0.004-10	0.004	0.004	0.05
8	Total Dissolved Solids (as SO ₄), mg/L Max	IS 2023 Part 42: 2002 R: 2018, AAS-Flame APTA, 12th Edition, AAS-GTA	<0.01	0.01-10	0.01	0.01	No restriction
9	Thiocyanate (as S), mg/L Max	IS 2023 Part 24: 2002 R: 2018, AAS-Flame APTA, 12th Edition, AAS-GTA	<0.002	0.002-10	0.002	0.002	No restriction
10	Mercuric ion, mg/L Max	IS 2023 Part 47: 1994, S-2019, AAS-Flame Method	0.02	0.04-10	0.04	0.1	0.1

***All units in mg/L, unless specified otherwise.

***Grab sampling carried out for water samples. ***LDL indicates Lower Detection Limit & EDC indicates Below Detection Limit.

(Signature)

(Kumar Veishav)
CHECKED BY

(Signature)

(Amit Raj Mishra)

ANALYSED BY

HOD's Signature

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.



cmpdi
Central Mine Planning and Design Institute Limited

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

SURFACE WATER ANALYSIS TEST REPORT

CEPDIL, R-II
PO-14, BHAKHAR COMPLEX
SHARDA - 422000
Phone: 0225-229-002
www: rrcil.cmpdi@coalindia.in

Month & Year	QUARTER ENDING March 2023		Cluster	H&M		Report No.	R1-2/SW/22- 22/OE/04
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Kanya Bazaar, Dhanbad (E-mail: amr@bcl.coalindia.in)					Date of Issue	18.05.2023
Project	Sample Ref. No.			REN/BCL/2001/	Sampling Method	(IS 3025, Part-1) CMPDI/R1-0/LPM 12	
Sampling Stations	(i)	Downstream in Khudia Haldia (ii)		Date of Sampling	27.03.2023	Period of Analysis 27.03.23 to 05.03.23	
Sl. No.	Parameter	Method of Analysis		Observed Values	IS 3025 (PART-1) SURFACE WATER (2002) Class 'C'	Range of Testing	LDL
1	BOD (3 days 20°C), mg/l	IS 3025 (Part 44) : 1992, R-2019, 3 day incubation at 20°C		<2.0	3	1.00-18.00	3
2	Colour, Hazen Units	APHA 23rd Edition, 2120-B-2017		1	10	1-100.0	1
3	Chlorides, mg/l	IS 3025 (Part 37) : 1988, R-2019 Argentometric Method		49	600	10-1300.0	9
4	Copper, mg/l	IS 3025 (Part 42) : 1992 R-2019, AAS-Flame Method		<0.2	1.5	0.2-10.0	0.2
5	Dissolved Oxygen, mg/L	IS 3025 (Part 38) : 1989, R-2002 Winkler's Indirect Method		5.7	4	0.1-18.0	0.1
6	Fluoride, mg/l	APHA, 23rd Edition, SPADNS Method		0.38	1.5	0.2-2.00	0.2
7	Hexavalent Chromium, mg/l	APHA 23rd Edition, 1,5-Diphenylcarbohydrazide Method IS 3025 (Part 52) : 2002, R-2019		<0.01	0.05	0.01-1.4	0.01
8	Iron, mg/l	IS 3025 (Part 55) : 2002, R-2019, AAS-Flame Method		<0.2	50	0.2-10	0.2
9	Nitrate, mg/l	APHA, 23rd Edition, UV-Spectrophotometric Method		1.09	30	0.3-45.0	0.3
10	pH value	IS 3025 (Part 11) : 1985 R-2017 Electrometric (Ft Meter) method		7.64	6.5-8.5	2.0-12.0	2
11	Sulphate, mg/l	APHA -23rd Edition, 4100-1 Turbidity Method		45	400	100-400.0	10
12	Total Dissolved Solids, mg/l	IS 3025 (Part 16) : 1984 R-2017 Gravimetric method		223	1500	250-5000.0	23
13	Zinc, mg/l	IS 3025 (Part 49) : 1994, R-2019, AAS-Flame Method		<0.1	1.5	0.1-3.0	0.1

**Crude sampling carried out for water samples. *LDL indicates Lower Detection Limit & BCL indicates Below Detection Limit

***All units in mg/l unless specified otherwise Sample Collected in 5 Ltr ferrisane. Color as observed is transparent

[Signature]
Analysed by

(Kumar Vaibhav)

(Amit Raj Mishra)

Analysed by

CHECKED BY

HOD's Signature

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, R-II.

— End of Report —

Page -1 of 2



CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

SURFACE WATER ANALYSIS TEST REPORT

CHDPA, 80-4
BTLA KANKARJH COMPLEX
DHANBAD - 826005
Phone: 2610-219-800
Email: rdti@cmpdi.coalindia.in

Month & Year	March 2023	Cluster	II & III		Report No.	RI-2/SW/22-23/QE/04	
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bcl@coalindia.in)				Date of Issue	18.05.2023	
Project	Sample Ref. No.			REP/BCL/2023	Sampling Method	(IS 3025, Part-1) CMPDI/RI-II/SPN 13	
Sampling Stations						Period of Analysis	
	(I)	Downstream in Khudia Nala(SW4)	Date of Sampling	17.03.2023		17.03.23 to 05.05.23	
Sl. No.	Parameter	Method of Analysis	Observed Values	IF 2796 ISLAND SURFACE WATER (IS-3025) Class 'C'	Range of Testing	LDL	
1	Arsenic (as As), mg/l, Max	IS-3025, Part 37:1988, R-2019/ APHA 23rd Edition AAS-VGA	0.0006	0.2	0.006-10	0.006	
2	Lead (as Pb), mg/l, Max	APHA, 23rd Edition, AAS-GTA	0.0005	0.1	0.005-10	0.005	
3	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 23rd Edition 4-Amino Antipyrine	0.002	0.005	0.002-10	0.002	
4	Selenium, mg/l, Max	IS-3025, Part 56:2003, R-2019/ APHA 23rd Edition, AAS-VGA	0.0007	0.05	0.007-10	0.007	

***Only sampling carried out for water samples. *LDL indicates Lower Detection Limit & EDL indicates Below Detection Limit.

***[all units in mg/L unless specified otherwise] Sample Collected in 5 Ltr ferric jar. Color as observed is transparent.

(Kumar Vaidhar)

(Amit Raj Mishra)

Analysed by

CHECKED BY

HOD's Initial/Signature

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-2 of 2



cmpdi
A Bharat Heavy Electricals Limited Company

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

Month & Year		March 2023		Cluster		III & XV			Report No.		RI-2/SW/22-23/QE/01		
Customer		Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bcl@coalindia.in)								Date of Issue		18.05.2023	
Project		Sample Ref. No.				REF/BCL/2021/		Sampling Method		(IS 3025 : Part-1) CMPDI/RI-II/LPM 13			
Sampling Stations		(i)		Downstream of Khudle Nala (Downstream with cluster III, Upstream with cluster IV)(SWS)		Date of Sampling		27.03.2023		Period of Analysis			
		(ii)		Upstream of Bagdi Nala(SWS)		Date of Sampling		27.03.2023		27.03.23 to 05.05.23			
Sl. No.	Parameter	Method of Analysis		Observed Values		IS 3025 (PART 1) SURFACE WATER (SWS) Class 'C'		Range of Testing	LOL				
				(i)	(ii)								
1	BOD (5 days 27°C),mg/l	IS 3025 (Part 44) : 1993, B-2019, 5 day incubation at 27°C		42.8	42.0	3		2.00-18.00	3				
2	Colour,Hazen Units	APHA 23rd Edition, 2120-B-2017		4	2	10		1-1000	1				
3	Chlorides,mg/l	IS 3025(Part 37):1988, B-2019 Argentometric Method		33	48	400		50-33000	3				
4	Copper,mg/l	IS 3025 (Part 47) : 1992 B-2019, AAS-Flame Method		<0.2	<0.2	1.5		0.1-180	0.2				
5	Dissolved Oxygen,mg/l	IS 3025 (Part 38) : 1988, B-2003 Winkler Ande Method		6.2	6.4	4		0.1-10.0	0.1				
6	Fluoride,mg/l	APHA, 23rd Edition, SPADNS Method		0.38	0.47	1.5		0.2-100	0.2				
7	Hexavalent Chromium,mg/l	APHA 23rd Edition, 1,5-Diphenylcarbohydrazide Method IS 3025 (Part 52) : 2003 B-2019		<0.01	<0.01	0.05		0.01-1.4	0.01				
8	Iron,mg/l	IS 3025 (Part 53) :2003,B-2019, AAS-Flame Method		<0.2	<0.2	30		0.2-10	0.2				
9	Nitrate ,mg/l	APHA, 23rd Edition, UV-Spectrophotometric Method		2.48	2.15	30		0.5-450	0.5				
10	pH value	IS 3025, (Part 15) : 1982 B-2017 Electrometric (Fb Meter) method		7.91	7.61	6.5-8.5		2.0-12.0	2				
11	Sulphate,mg/l	APHA -23rd Edition,4500-S, Turbidity Method		69	36	400		10.0-4000	10				
12	Total Dissolved Solids,mg/l	IS 3025, (Part 16) : 1984 B-2017 Gravimetric method		701	402	1500		25.0-3000.0	25				
13	Zinc,mg/l	IS 3025 (Part 49) : 1994, B-2019, AAS-Flame Method		<0.1	<0.1	15		0.1-3.0	0.1				

***Data sampling carried out for water samples. **LOL indicates Lower Detection Limit & BDL indicates Below Detection Limit

***All units in mg/L unless specified otherwise Sample Collected in 5 Ltr Jerrycan, Color as observed is transparent

[Signature]
Analysed by

(Kumar Vaibhav)

CHECKED BY

[Signature]
(Amit Raj Mishra)

HOD's Initial/Signature

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 2

Month & Year	March 2023		Cluster	III & XV		Report No.	RI-2/SW/22-23/QE/04	
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gman@bcl.coalindia.in)					Date of Issue	18.05.2023	
Project	Sample Ref. No.			REF/BCL/2023/	Sampling Method	(IS 3025, Part-1) CMPDI/RI-II/LFW 13		
Sampling Stations	(i)	Upstream in Begdigi Nala(SW5)		Date of Sampling	27.03.2023	Period of Analysis		
	(ii)	Downstream in Begdigi Nala(SW5)		Date of Sampling	27.03.2023	27.03.23 to 05.05.23		
Sl. No.	Parameter	Method of Analysis		Observed Values		pH, 25°C (INLAND SURFACE WATER (Fresh) Class 'C'	Range of Testing	LDL
				(i)	(ii)			
1	Arsenic (as As), mg/l Max	IS-3025, Part 37:1988, R-2019/ APHA 23rd Edition AAS-VGA		<0.006	<0.006	0.2	0.006-10	0.006
2	Lead (as Pb), mg/l Max	APHA, 23rd Edition, AAS-GTA		<0.005	<0.005	0.1	0.005-10	0.005
3	Phenolic compounds (as C6H5OH), mg/l Max	APHA, 22nd Edition 4-Amino Antipyrine		<0.002	<0.002	0.005	0.002-10	0.002
4	Selenium, mg/l, Max	IS-3025, Part 56:2003, R-2019/ APHA 23rd Edition, AAS-VGA		<0.007	<0.007	0.05	0.007-10	0.007

**Drill sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit

**All units in mg/l unless specified otherwise Sample Collected in 5 Ltr ferric cans. Color as observed is transparent



(Kumar Vaibhav)



(Anuraj Mishra)

Analysed by
CHECKED BY
HOD's Initial/Signature

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 2 of 2



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

CMPCIL Bldg
 P.O. Box No. 100, Dhanbad - 826001
 Phone: 2224-224-888
 Email: cmprdi@coalindia.in

Month & Year	March 2023		Cluster	III&IV		Report No.	RI-2/SW/22-23/QE/04
Customer	Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gmen@bcl@coalindia.in)					Date of Issue	18.05.2023
Project	Sample Ref. No.			REN/BCL/1011/	Sampling Method	(IS 3025, Part-1) CMPDI/RI-II/LPM 13	
Sampling Station:	(1)	Downstream in Begdigi (Nals(SWT))		Date of Sampling	27.03.2023	Period of Analysis	
						27.03.23 to 05.05.23	
Sl. No.	Parameter	Method of Analysis		Observed Values	IS 3025 (Part-1) SURFACE WATER (1985) Class 'C'	Range of Testing	LOL
1	BOD (3 days 27°C), mg/l	IS 3025 (Part 44) : 1993, B-2019, 3 day incubation at 27°C		<2.0	2	100-1000	2
2	Colour/Hazen Units	APHA 23rd Edition, 2120-B-2017		2	10	1-1000	1
3	Chlorides, mg/l	IS 3025 (Part 37) : 1985, B-2019 Argentometric Method		34	600	10-1500	3
4	Copper, mg/l	IS 3025 (Part 47) : 1992 B-2019, AAS-Flame Method		<0.2	1.5	0.2-100	0.2
5	Dissolved Oxygen, mg/L	IS 3025 (Part 38) : 1985, B-2003 Winkler Azide Method		6.3	4	0.1-100	0.1
6	Fluoride, mg/l	APHA 23rd Edition, SPADNS Method		0.33	1.5	0.2-200	0.2
7	Hexavalent Chromium, mg/l	APHA 23rd Edition, 1.5-Diphenylcarbohydrazide Method IS 3025 (Part 50) : 2002, B-2019		<0.01	0.05	0.01-1.4	0.01
8	Iron, mg/l	IS 3025 (Part 53) : 2003, B-2019, AAS-Flame Method		<0.2	50	0.2-10	0.2
9	Nitrate, mg/l	APHA 23rd Edition, UV-Spectrophotometric Method		2.84	50	0.3-450	0.3
10	pH value	IS 3025 (Part 11) : 1983 B-2017 Electrometric (pH Meter) method		7.86	6.5-8.3	1.0-12.0	2
11	Sulphate, mg/l	APHA 23rd Edition, 4500-S, Turbidity Method		35	400	100-4000	10
12	Total Dissolved Solids, mg/l	IS 3025 (Part 16) : 1984 B-2017 Gravimetric method		427	1000	250-5000	25
13	Zinc, mg/l	IS 3025 (Part 49) : 1994, B-2019, AAS-Flame Method		<0.1	15	0.1-30	0.1

**Grab sampling carried out for water samples. *LOL indicates Lower Detection Limit & SDL indicates Below Detection Limit

**all units in mg/L unless specified otherwise. Sample Collected in 5 Ltr ferricone. Color as observed is transparent

(Kumar Vaibhav)

(Amit Raj Mishra)

Analysed by

CHECKED BY

HOD's Initial/Signature

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 2



CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

SURFACE WATER ANALYSIS TEST REPORT

CHITRAL, J&K
COAL MINING COMPLEX
DHANBAD - 826001
Phone: 0655-223-433
Email: rth@cmpdi.coalindia.in

Month & Year		March 2023		Cluster		III&IV		Report No.		RI-2/SW/22-23/QE/04	
Customer		Environment Department, Bharat Coking Coal Limited (BCL), Koyla Bhawan, Dhanbad (E-mail: gman@bcl.coalindia.in)						Date of Issue		18.05.2023	
Project		Sample Ref. No.				REM/BCL/2022/		Sampling Method		(IS 3025, Part-1) CMPDI/RI-II/LPM 13	
Sampling Stations		(1)		Downstream in Bagdi Hail (SW7)		Date of Sampling		27.03.2023		Period of Analysis	
										27.03.23 to 05.05.23	
Sl. No.	Parameter	Method of Analysis		Observed Values		IS-3025 (CLASS) SURFACE WATER (2012) Class 'C'		Range of Testing		LOL	
1	Arsenic (as As), mg/l Max	IS-3025,Part 37-1988, R-2019/ APHA 23rd Edition AAS-VGA		<0.001		0.2		0.005-10		0.005	
2	Lead (as Pb), mg/l Max	APHA, 23rd Edition, AAS-GTA		<0.005		0.1		0.005-10		0.005	
3	Phenolic compounds (as C6H5OH), mg/l Max	APHA, 22nd Edition 4-Amino Antipyrine		<0.002		0.005		0.002-10		0.002	
4	Selenium, mg/l Max	IS-3025, Part 56-2003, R-2019/ APHA 23rd Edition, AAS-VGA		<0.001		0.05		0.007-10		0.007	

**On-site sampling carried out for water samples. *LOL indicates Lower Detection Limit & EDL indicates Below Detection Limit.

---All units in mg/l unless specified otherwise. Sample Collected in 5 Ltr Jerrycan, Color as observed is transparent.

Analyzed by

(Kumar Vaibhav)

HOD's Initial/Signature

Analyzed by

CHECKED BY

HOD's Initial/Signature

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-2 of 2

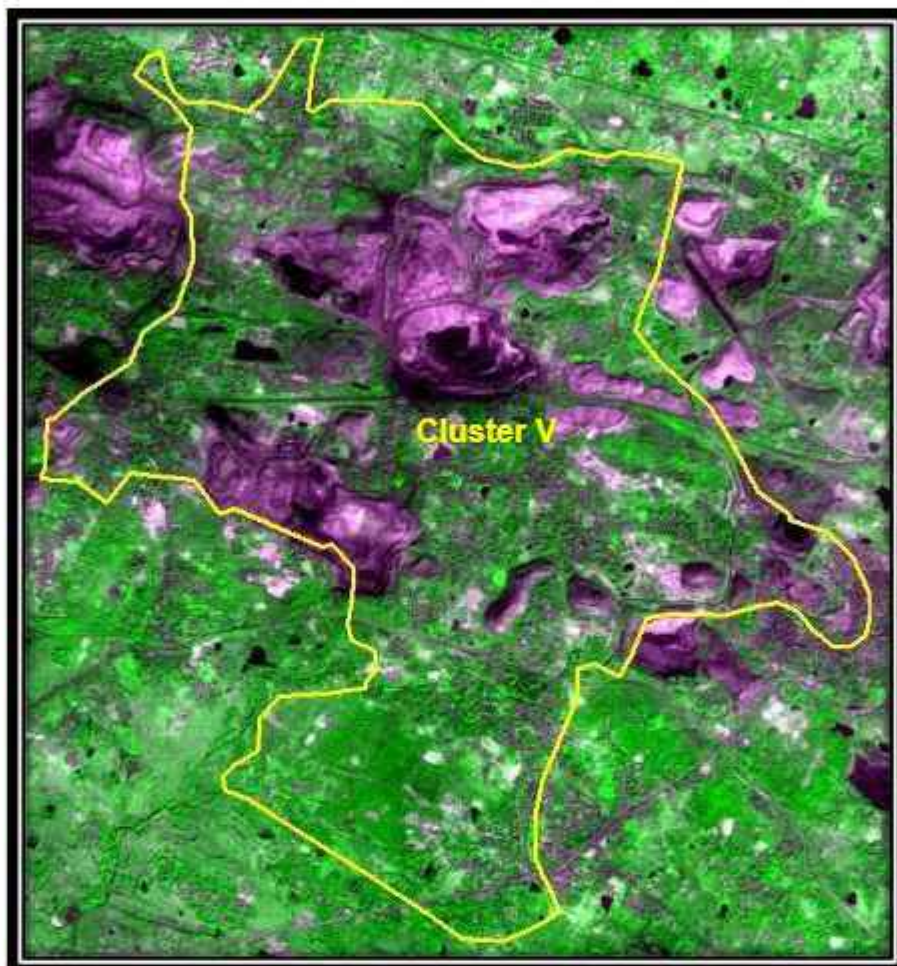
[illegible]

Sl. No.	Ref. No.	Author	Title	Year	Country	Language	Page No.	Price	Availability
1	1001	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
2	1002	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
3	1003	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
4	1004	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
5	1005	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
6	1006	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
7	1007	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
8	1008	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
9	1009	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
10	1010	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
11	1011	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
12	1012	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
13	1013	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
14	1014	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
15	1015	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
16	1016	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
17	1017	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
18	1018	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
19	1019	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available
20	1020	Dr. A. K. Singh	History of the State of Bihar	1980	India	Hindi	100	Rs. 100	Available

NAME	DATE
CLASS	PERIOD
TEACHER	

Annexure-XIV

Land Reclamation/ Restoration Monitoring of five Clusters of (Opencast + Underground) Coal Mines of Bharat Coking Coal Limited based on Satellite Data of the Year 2020



Submitted to
Bharat Coking Coal Limited



cmpdi
A Mini-Ratna Company

**Land Reclamation/ Restoration Monitoring of five Clusters
of (Opencast + Underground) Coal Mines of Bharat Coking
Coal Limited based on Satellite Data of the Year 2020**

March-2021



**Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi**

CONTENTS

Executive Summary	iii
1 Background	1
2 Objective	2
3 Methodology	2
4 Land Reclamation Status in Bharat Coking Coal Ltd.	6

List of Tables

Table -1	Cluster wise Land Reclamation Status	iv
Table -2	Area Statistics of Land Use Classes in Clusters	8

List of Figures

Figure-1	Cluster wise Land Reclamation Status-2020 (BCCL)	v
Figure-2	Methodology of Land Reclamation Monitoring	3
Figure-3	Bar-chart of Land Reclamation Status of Cluster III	14
Figure-4	Bar-chart of Land Reclamation Status of Cluster V	14
Figure-5	Bar-chart of Land Reclamation Status of Cluster VIII	15
Figure-6	Bar-chart of Land Reclamation Status of Cluster IX	15
Figure-7	Bar-chart of Land Reclamation Status of Cluster XVII	16

List of Plates

Plate -1	Land Use Map of Cluster III	9
Plate -2	Land Use Map of Cluster V	10
Plate -3	Land Use Map of Cluster VIII	11
Plate -4	Land Use Map of Cluster IX	12
Plate -5	Land Use Map of Cluster XVII	13

List of Photographs

Photo-1	Plantation on OB Dump, Cluster III	17
Photo-2	Eco Restoration Site, Cluster V	17
Photo-3	Plantation on OB Dump, Cluster V	18
Photo-4	Plantation on OB Dump, Cluster VIII	18
Photo-5	Gokul Eco Cultural Park, Cluster IX	19
Photo-6	Plantation in Cluster XVII	19

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, and 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 5 Clusters of mines viz. III, V, VIII, IX and XVII considered for land reclamation monitoring during the year 2020-21; XVII cluster of mines is added during the year 2020-21. These clusters consist of mainly opencast mines.
 - Out of the total mine leasehold area of 7988.22 Ha. of the 05 clusters producing less than 5mcm (Coal+OB) annually considered for monitoring during the year 2020-21; total excavated area is 1300.74 Ha. out of which 27.81 Ha. area (2.14%) has been planted on backfill (Biological Reclamation) and 657.49 Ha. area (50.55%) is under backfilling (Technical Reclamation) and 615.44 Ha. area (47.31%) under active mining. Cluster wise details of land reclamation of the above Clusters is given in Table-1.
 - Total area under plantation (green cover) covers an area of 645.75 Ha. which is 8.08% of total leasehold area.
 - 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 2020

Table - 1 Status of Land Reclamation in 5 clusters of BCCL based on Satellite Data of the Year 2020																			
(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	
				Area under Backfilling	Biological		Other Plantations												
					Plantation on Excavated / Backfilled Area		Plantation on External OB Dumps		Social Forestry, Avannee Plantation Etc.										
1	2	3		4		5		6		7		8		9 (=4+5+8)		10 (=5+6+7)		11(=4+5)	
		2017	2020	2017	2020	2017	2020	2017	2020	2017	2020	2017	2020	2017	2020	2017	2020	2017	2020
1	Cluster III	1552.53	1552.53	55.87	60.37	3.89	3.89	21.11	21.11	128.07	162.33	101.50	104.79	161.26	169.05	153.07	187.33	59.76	64.26
				94.65%	35.71%	2.41%	2.30%					62.94%	61.99%			9.86%	12.07%	37.06%	38.01%
2	Cluster V	1724.52	1724.52	162.09	187.59	7.19	7.19	23.85	23.85	105.29	105.29	112.24	103.52	281.52	298.30	136.33	136.33	169.28	194.78
				57.58%	62.89%	2.55%	2.41%					39.87%	34.70%			7.91%	7.91%	60.13%	65.30%
3	Cluster VIII	1331.95	1331.95	161.86	206.91	13.72	9.93	21.97	21.97	24.70	24.70	111.06	124.49	286.64	341.33	60.39	56.60	175.58	216.84
				56.47%	60.62%	4.79%	2.91%					38.75%	36.47%			4.53%	4.25%	61.25%	63.53%
4	Cluster IX	1967.22	1967.22	77.53	77.53	6.80	6.80	41.79	41.79	168.58	168.58	181.85	217.24	266.18	301.57	217.17	217.17	84.33	84.33
				29.13%	25.71%	2.55%	2.25%					68.32%	72.04%			11.04%	11.04%	31.68%	27.96%
5	Cluster XVII	-	1412.00	-	125.09	-	0.00	-	5.00	-	43.33	-	65.40	-	190.49	-	48.32	-	125.09
					65.67%		0.00%						34.33%				3.42%		65.67%
	TOTAL	6576.22	7988.22	457.35	657.49	31.60	27.81	108.72	113.72	426.64	504.23	506.65	615.44	995.60	1300.74	566.96	645.75	488.95	685.30
				45.94%	50.55%	3.17%	2.14%					50.89%	47.31%			8.62%	8.08%	49.11%	52.69%
(%) is calculated with respect to Excavated Area as applicable)																			

Note: In reference of the above Table, different parameters are classified as follows: (Cluster XVII started from current year)

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".

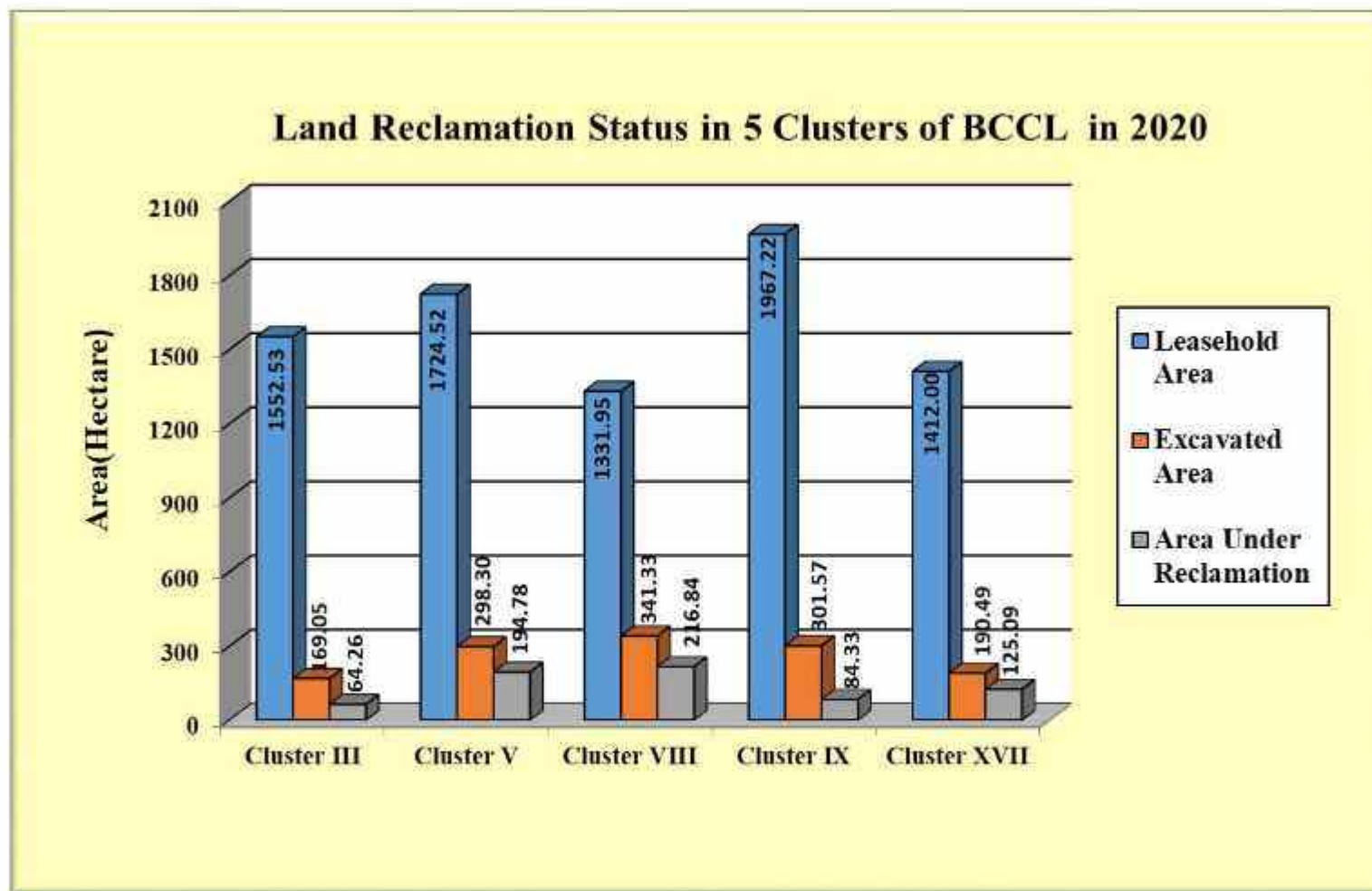


Fig. 1: Cluster wise Land Reclamation Status in five Clusters - 2020 (BCCL)

1. 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 m³ 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 capacity, 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. 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 cluster 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 2020 carried out for five clusters of mines comprising both underground and OC projects for Bharat Coking Coal Ltd.

2. Objective

Objective of the land reclamation/restoration monitoring is to assess the area of backfilled, plantation, OB dumps, social forestry, active mining area, settlements and 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. 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:

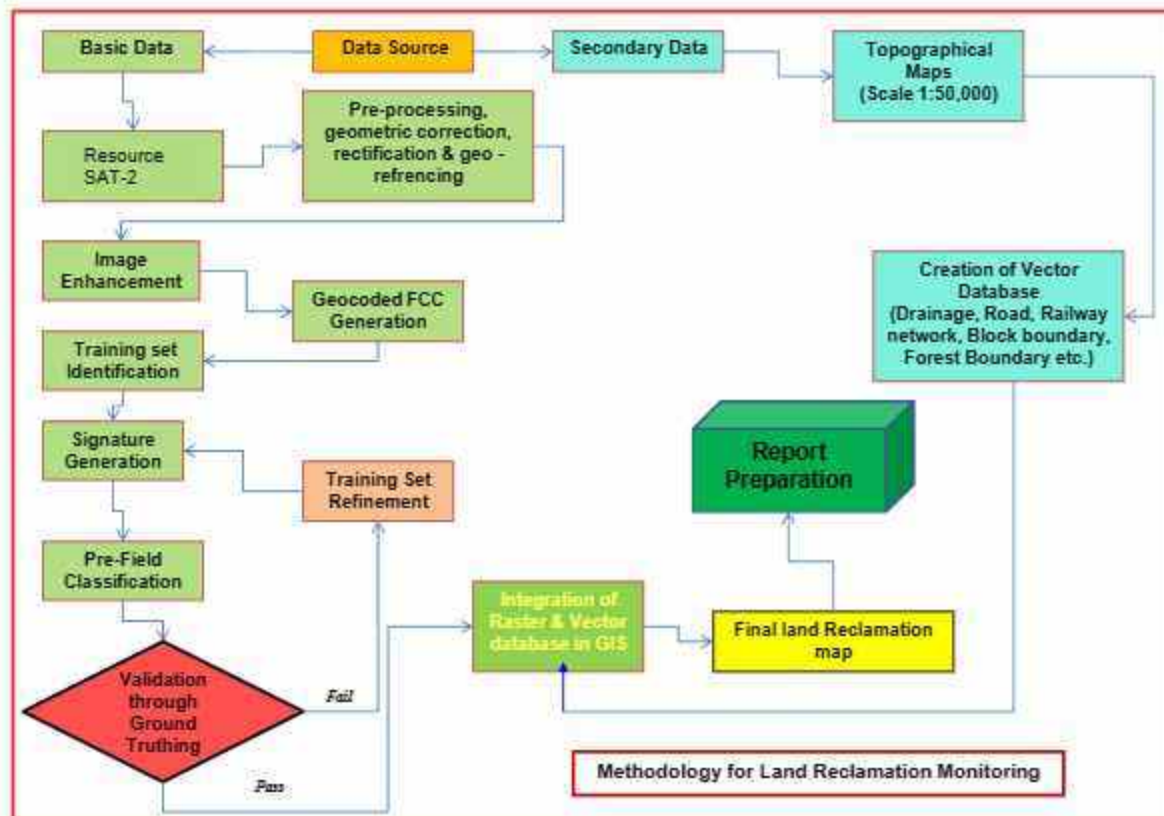


Fig. 2: Methodology of Land Reclamation Monitoring

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 Sol 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 14.0 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. 14.0 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 are 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. Land Reclamation Status in Bharat Coking Coal Ltd.

4.1 Following 5 clusters of mines comprising both underground and opencast projects of Bharat Coking Coal Ltd. have been taken up for land reclamation monitoring during the year 2020-21:

- Cluster III
- Cluster V
- Cluster VIII
- Cluster IX
- Cluster XVII

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 projects for the year 2020 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 7988.22 ha. of the 5 clusters of mines (Underground + Opencast) of BCCL mentioned above taken for this study in 2020-21, total excavated area is 1300.74 ha. out of which 27.81 ha. (2.14%) has been planted (*Biologically Reclaimed*), 657.49 ha. (50.55%) is under backfilling (*Technically Reclaimed*) and balance 615.44 ha. (47.31%) is under active mining.

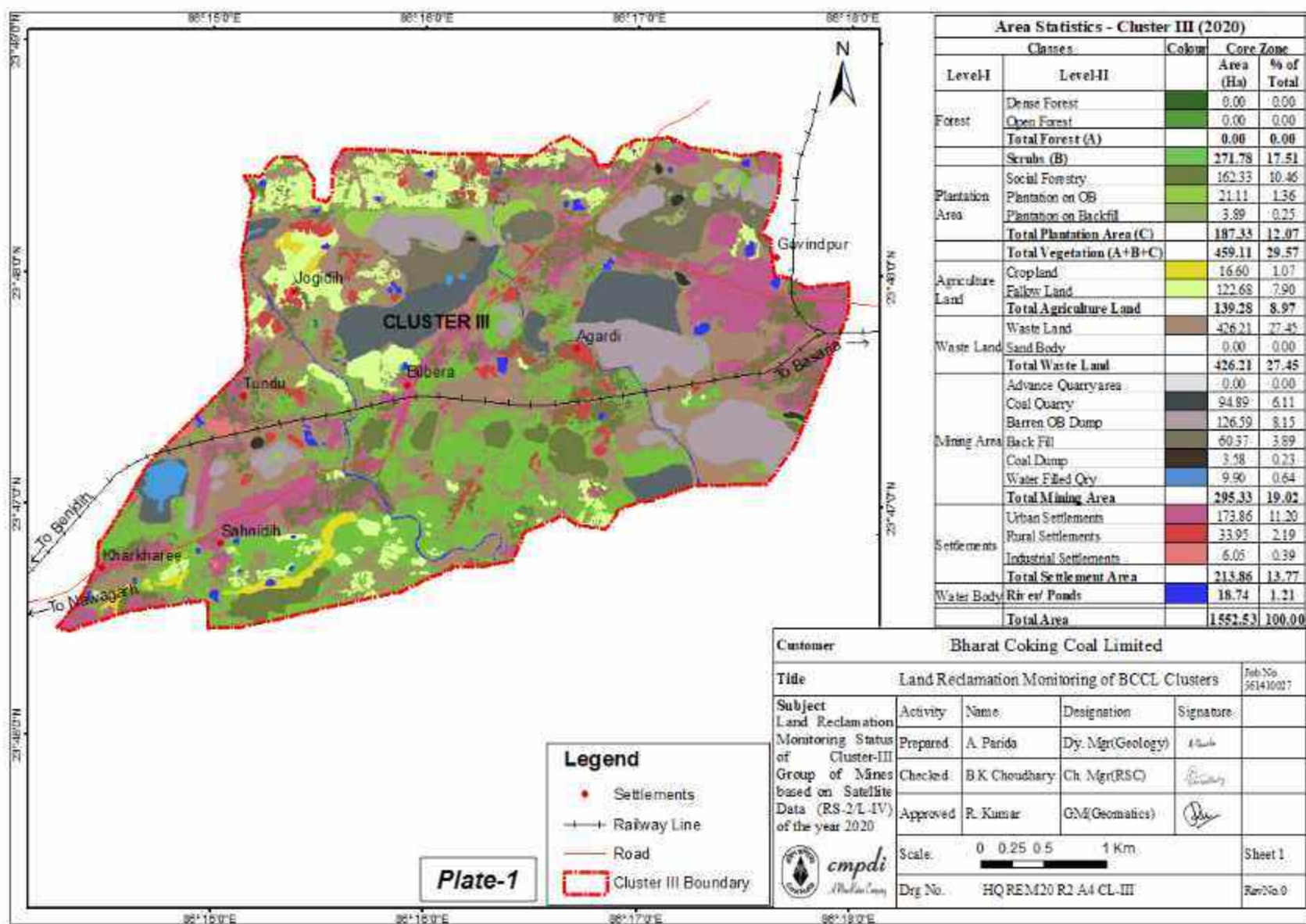
4.4 Land reclamation monitoring for cluster XVII of BCCL is taken up for the first time in the year 2020-21. Hence comparison of this cluster in year 2020 has not been made with respect to year 2017. The data thus generated in the year 2020 will be considered as base data for comparison of land reclamation of this cluster of mines at the interval of every three year.

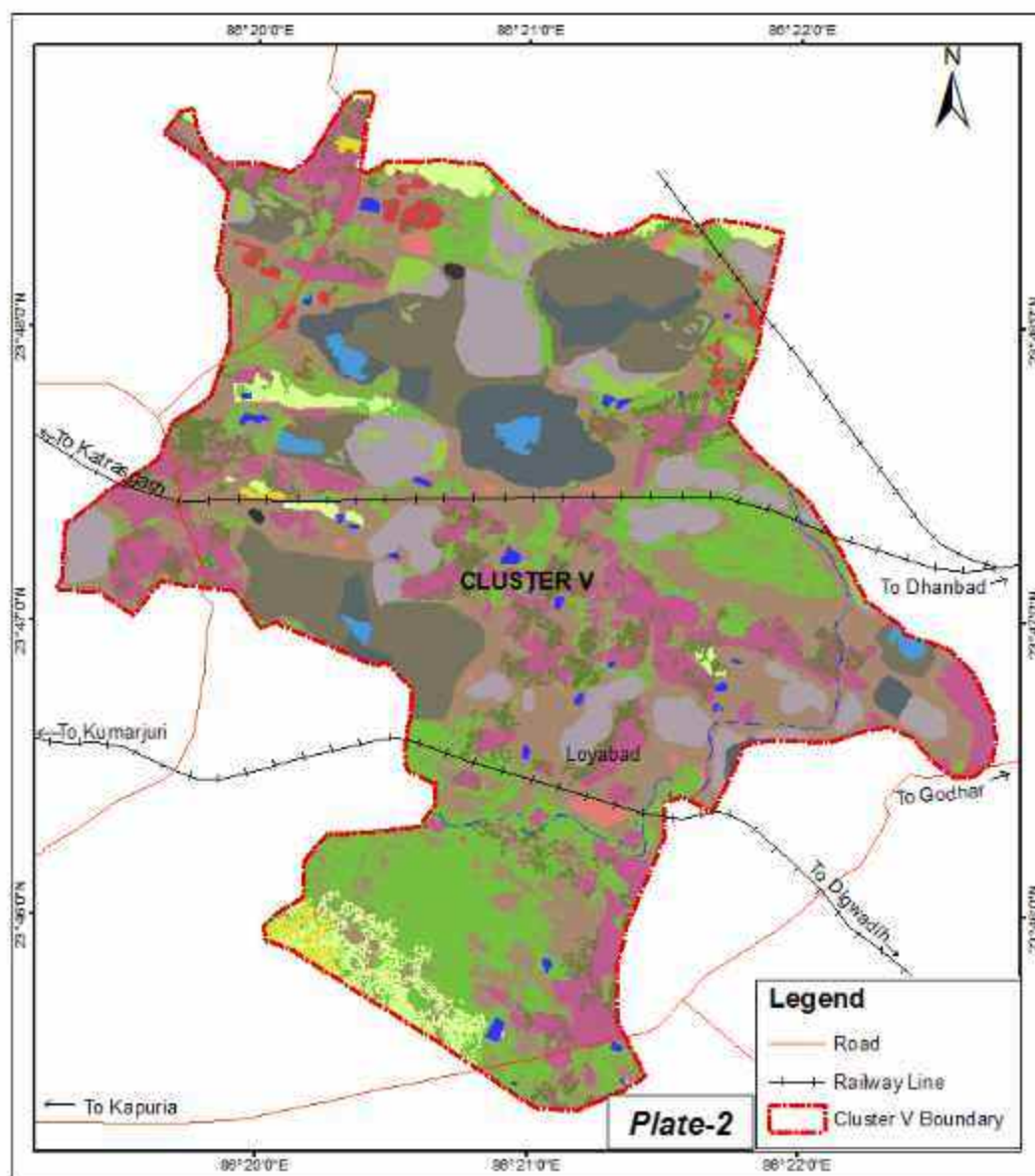
- 4.5** Study reveals that out of five clusters of mines of BCCL considered for reclamation monitoring in 2020, the area under total plantation (Green Cover) is maximum in Cluster IX i.e 217.17 ha., followed by Cluster III with 187.33 ha., Cluster V with 136.33 ha., Cluster VIII with 56.60 ha. and Cluster XVII with 48.32 ha.
- 4.6** Out of the 5 Clusters in BCCL considered for satellite data based land reclamation monitoring in 2020, Cluster XVII tops with 65.67% reclamation followed by Cluster V with 65.30%, Cluster VIII with 63.53%, Cluster III with 38.01% and Cluster IX with 27.96%.
- 4.7** In Cluster VIII, it is revealed that area under plantation on backfill (Biological Reclamation) has decreased from 13.72 ha. in the year 2017 to 9.93 ha. in the year 2020. This decrease of 3.79 ha. area in Biological reclamation is due to rehandling of backfill. Hence total area under plantation on backfill has decreased from 31.60 ha. (Yr 2017) to 27.81 ha. (Yr 2020).
- 4.8** On comparing the status of land reclamation for the year 2020 with respect to the year 2017 it is evident from the analysis that area under land reclamation has increased from 488.95 ha. (Yr 2017) to 685.30 ha. (Yr 2020). This increase of 196.35 ha. area under land reclamation is due to increase in reclamation activities in Cluster III, V & VIII as well as addition of Cluster XVII.
- 4.9** This study will again be carried out after an interval of three years to assess the progress and changes in land reclamation in the above clusters.

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 2020

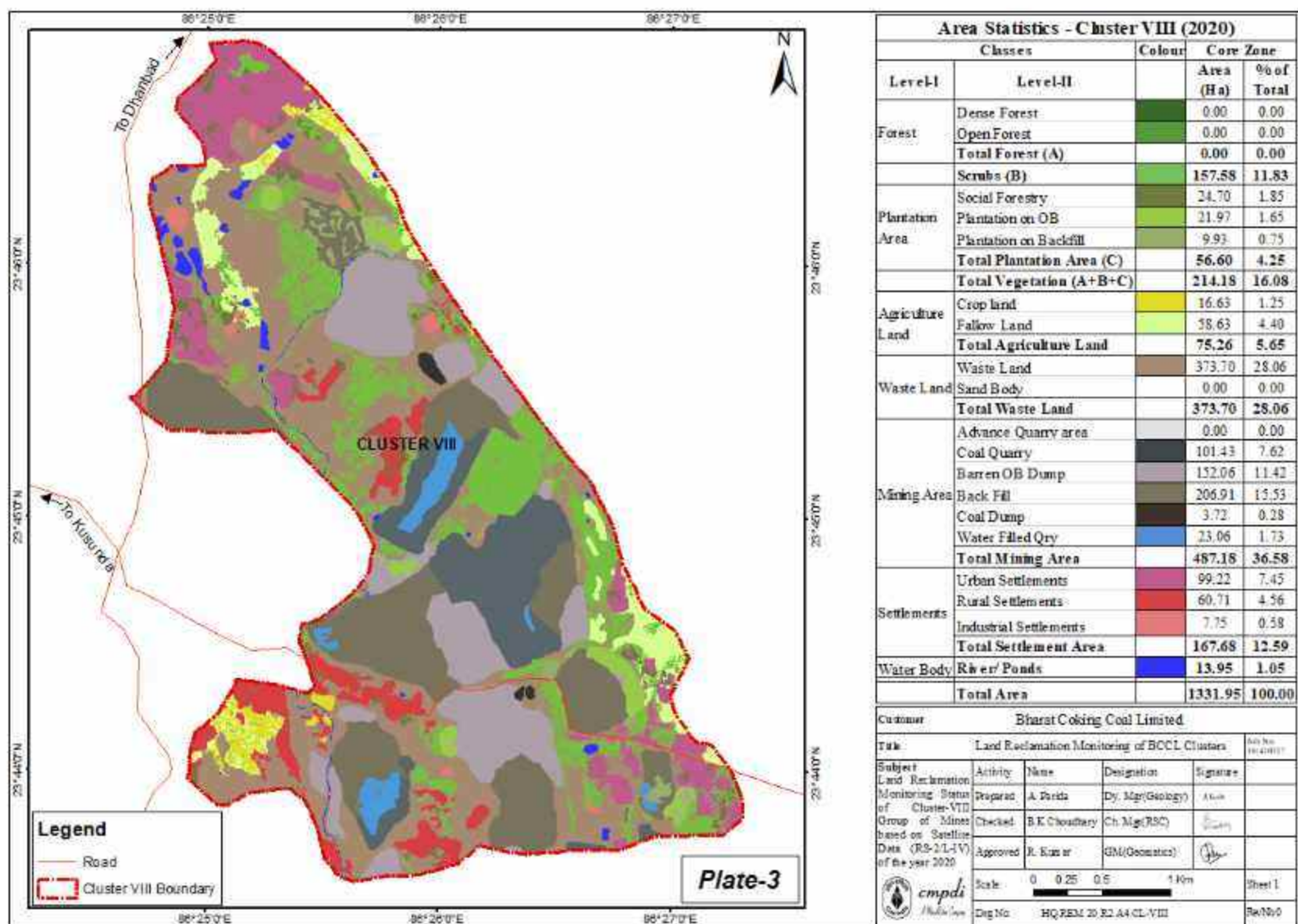
Status of Land Reclamation in 5 Clusters of (UG+OC) mines of Bharat Coking Coal Ltd. based on Satellite data of the Year 2020													
(Area in Hectare)													
		CLUSTER III		CLUSTER V		CLUSTER VIII		CLUSTER IX		CLUSTER XVII		TOTAL	
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
FOREST	Dense Forest	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)	271.78	17.51	320.90	18.61	157.58	11.83	346.67	17.62	178.99	12.68	1275.92	15.97
	Social Forestry/Avenue Plantation	162.33	10.46	105.29	6.11	24.70	1.85	168.58	8.57	43.33	3.07	504.23	6.31
	Plantation on OB Dump	21.11	1.36	23.85	1.38	21.97	1.65	41.79	2.12	5.00	0.35	113.72	1.42
PLANTATION	Plantation on Backfill (Biological Reclamation)	3.89	0.25	7.19	0.42	9.93	0.75	6.80	0.35	0.00	0.00	27.81	0.35
	Total Plantation (C)	187.33	12.07	136.33	7.91	56.60	4.25	217.17	11.04	48.32	3.42	645.75	8.08
	Total Vegetation (A+B+C)	459.11	29.57	457.23	26.51	214.18	16.08	563.84	28.66	227.31	16.10	1921.67	24.06
ACTIVE MINING	Coal Dump	3.58	0.23	1.70	0.10	3.72	0.28	4.89	0.25	0.00	0.00	13.89	0.17
	Coal Quarry	94.89	6.11	87.72	5.09	101.43	7.62	191.65	9.74	56.82	4.02	532.51	6.67
	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	9.90	0.64	15.80	0.92	23.06	1.73	25.59	1.30	8.58	0.61	82.93	1.04
	Total Area under Active Mining	104.79	6.75	103.52	6.00	124.49	9.35	217.24	11.04	65.40	4.63	615.44	7.70
	Barren OB Dump	126.59	8.15	174.62	10.13	152.06	11.42	166.03	8.44	44.48	3.15	663.78	8.31
UNDER MINE OPERATION	Area Under Backfilling (Technical Reclamation)	60.37	3.89	187.59	10.88	206.91	15.53	77.53	3.94	125.09	8.86	657.49	8.23
	Total Area under Mine Operation	295.33	19.02	467.43	27.10	487.18	36.58	466.69	23.67	234.97	16.64	1950.60	24.42
WASTE LANDS	Waste Lands	426.21	27.45	472.92	27.42	373.70	28.06	581.57	29.56	112.68	7.98	1967.08	24.62
	Fly Ash Pond / Sand Body	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.76	0.48	6.76	0.08
	Total Wasteland	426.21	27.45	472.92	27.42	373.70	28.06	581.57	29.56	119.44	8.46	1973.84	24.71
WATERBODIES	Reservoir, Nallah, Ponds	18.74	1.21	13.66	0.79	13.95	1.05	23.33	1.19	31.81	2.25	101.49	1.27
	Total Waterbodies	18.74	1.21	13.66	0.79	13.95	1.05	23.33	1.19	31.81	2.25	101.49	1.27
AGRICULTURE	Crop Lands	16.80	1.07	8.41	0.49	16.63	1.25	0.00	0.00	69.45	4.92	111.09	1.39
	Fallow Lands	122.68	7.90	58.64	3.40	58.63	4.40	43.56	2.21	472.71	33.48	756.22	9.47
	Total Agriculture	139.28	8.97	67.05	3.89	75.26	5.65	43.56	2.21	542.16	38.40	867.31	10.86
SETTLEMENTS	Urban Settlement	173.86	11.20	220.71	12.80	99.22	7.45	232.31	11.81	214.25	15.17	940.35	11.77
	Rural Settlement	33.95	2.19	13.97	0.81	60.71	4.56	47.79	2.43	31.36	2.22	187.78	2.35
	Industrial Settlement	6.05	0.39	11.55	0.67	7.75	0.58	9.13	0.46	10.69	0.76	45.17	0.57
	Total Settlements	213.86	13.77	246.23	14.28	167.68	12.59	289.23	14.70	256.31	18.15	1173.31	14.69
Grand Total		1552.53	100.00	1724.52	100.00	1331.95	100.00	1967.22	100.00	1412.00	100.00	7988.22	100.00

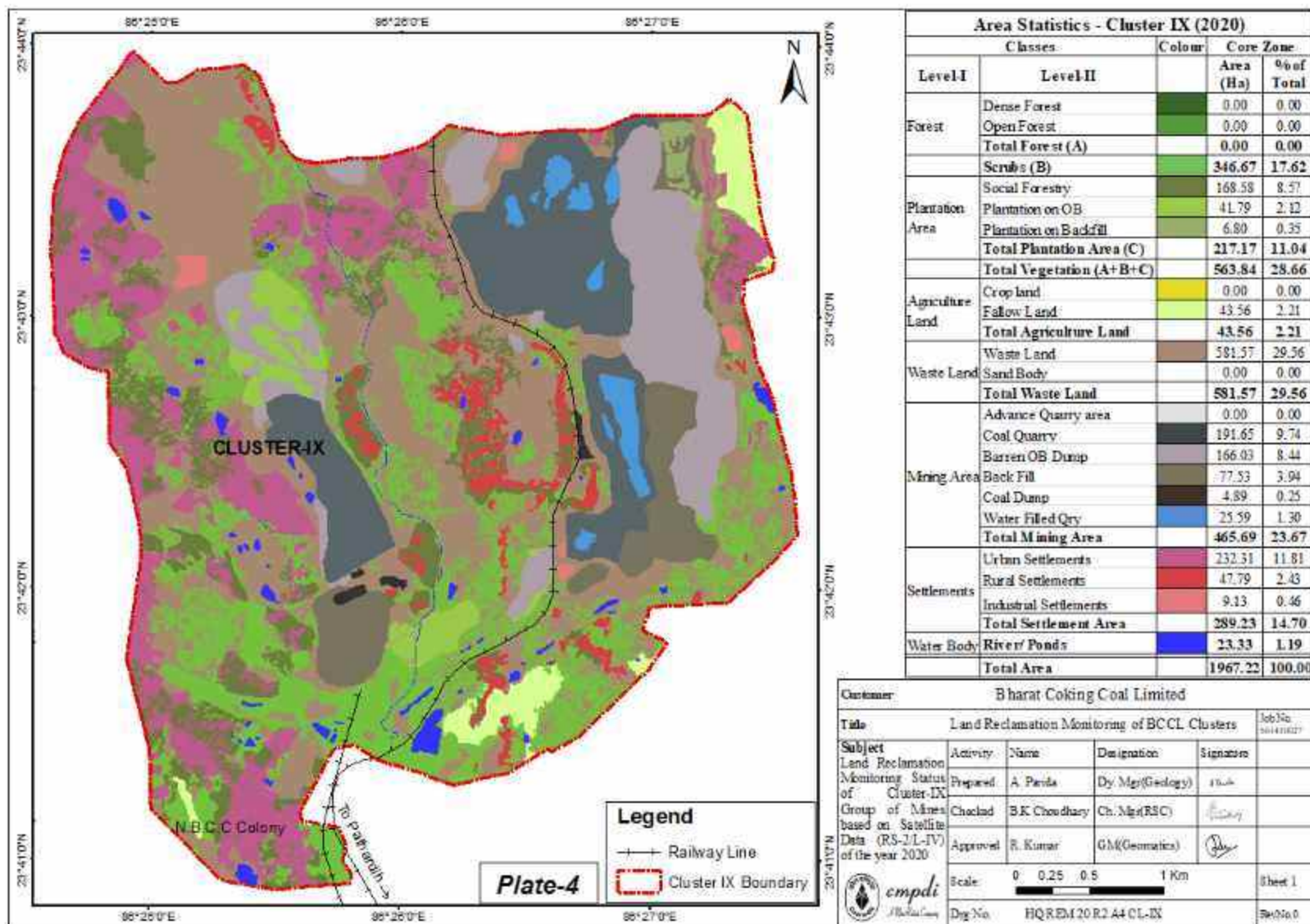


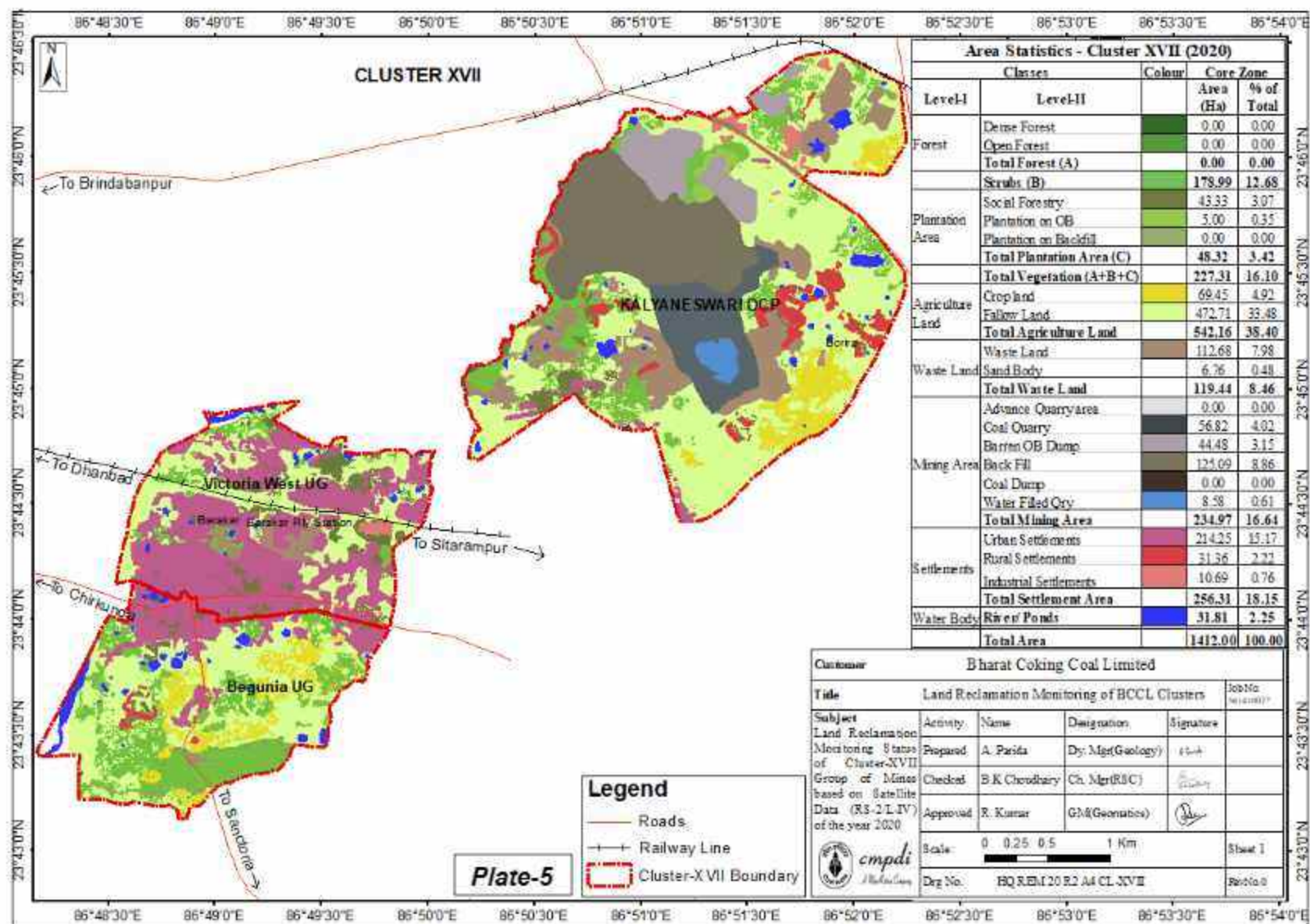


Area Statistics - Cluster V (2020)				
Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		0.00	0.00
	Scrubs (B)		320.90	18.61
Plantation Area	Social Forestry		105.29	6.11
	Plantation on OB		23.85	1.38
	Plantation on Backfill		7.19	0.42
	Total Plantation Area (C)		136.33	7.91
	Total Vegetation (A+B+C)		457.23	26.51
Agriculture Land	Crop land		8.41	0.49
	Fallow Land		58.64	3.40
	Total Agriculture Land		67.05	3.89
Waste Land	Waste Land		472.92	27.42
	Sand Body		0.00	0.00
	Total Waste Land		472.92	27.42
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		87.72	5.09
	Barren OB Dump		174.62	10.13
	Back Fill		187.59	10.88
	Coal Dump		1.70	0.10
	Water Filled Qry		15.80	0.92
	Total Mining Area		467.43	27.10
Settlements	Urban Settlements		220.71	12.80
	Rural Settlements		13.97	0.81
	Industrial Settlements		11.55	0.67
	Total Settlement Area		246.23	14.28
Water Body	River/Ponds		13.66	0.79
	Total Area		1724.52	100.00

Customer: Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters			Job No: 561410027
Subject	Activity	Name	Designation	Signature
Land Reclamation Monitoring Status of Cluster-V Group of Mines based on Satellite Data (RS-2L-IV) of the year 2020	Prepared	A. Parida	Dy. Mgr(Geology)	
	Checked	B.K. Choudhary	Ch. Mgr(RSC)	
	Approved	K. Kumar	GM(Geomatics)	
Scale:		0 0.25 0.5 1 Km		Sheet 1
Dwg No:		HQ REM 20 R.2 A4 CL-V		Rev No 0







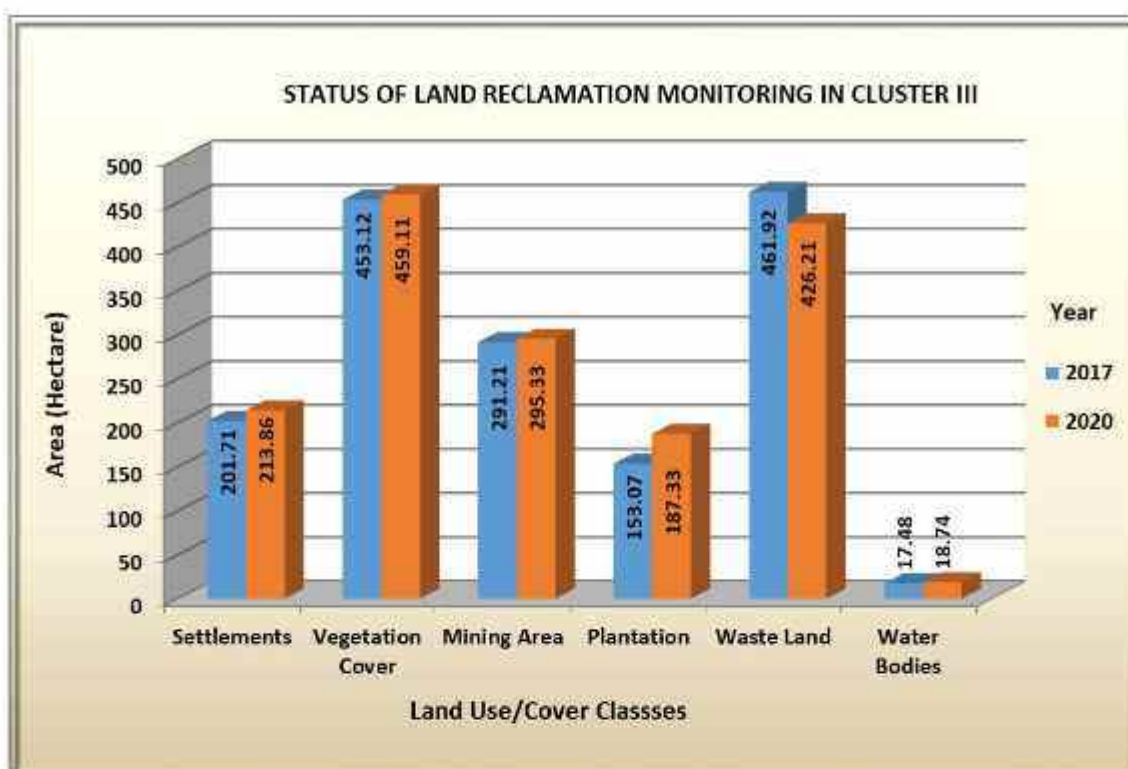


Fig. 3: Land Reclamation Status of Cluster III

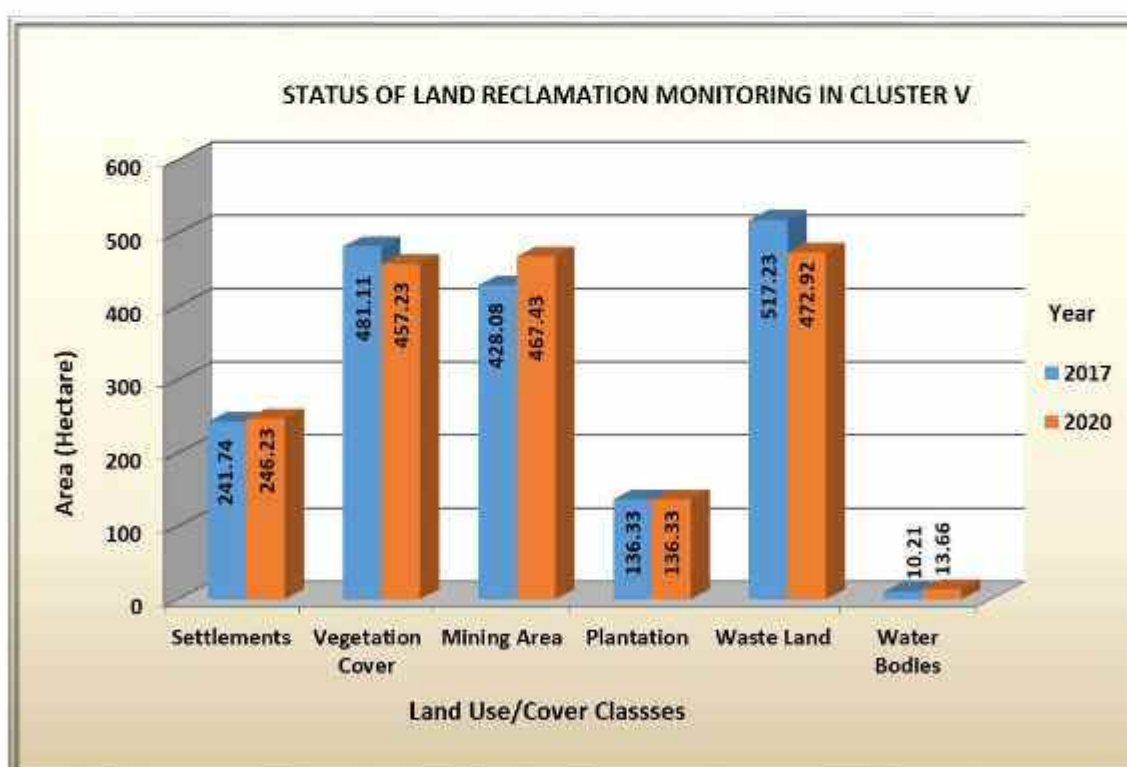


Fig. 4: Land Reclamation Status of Cluster V

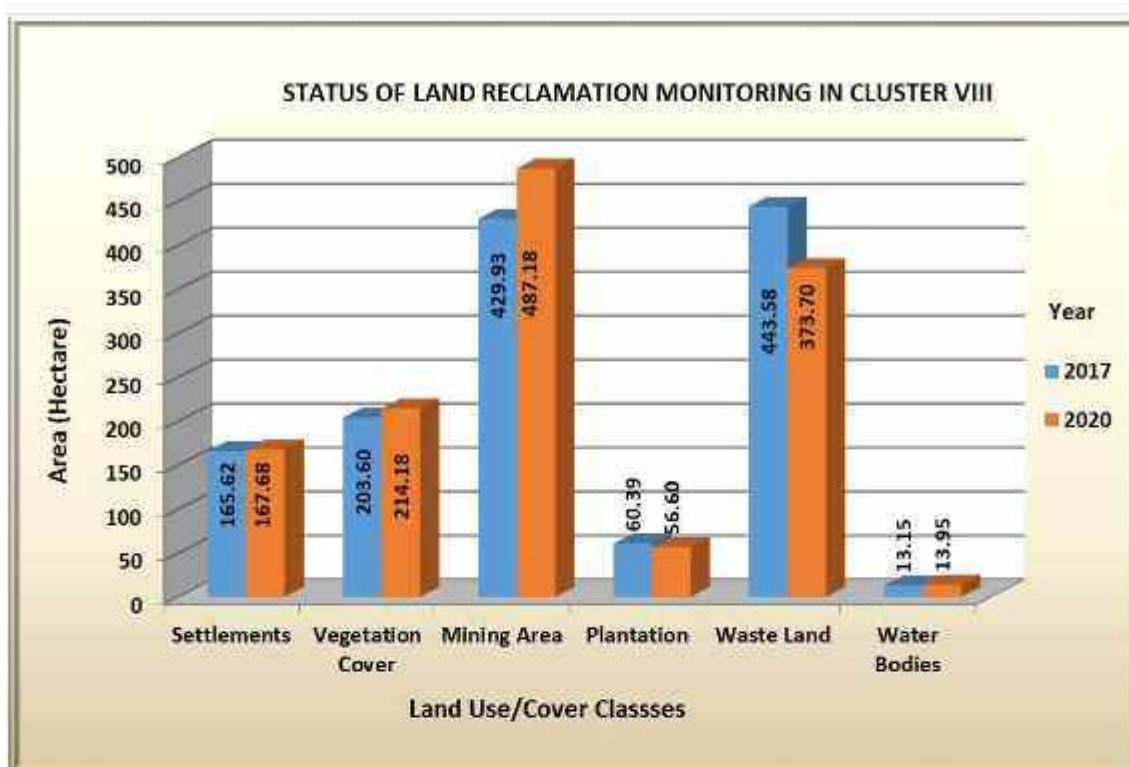


Fig. 5: Land Reclamation Status of Cluster VIII

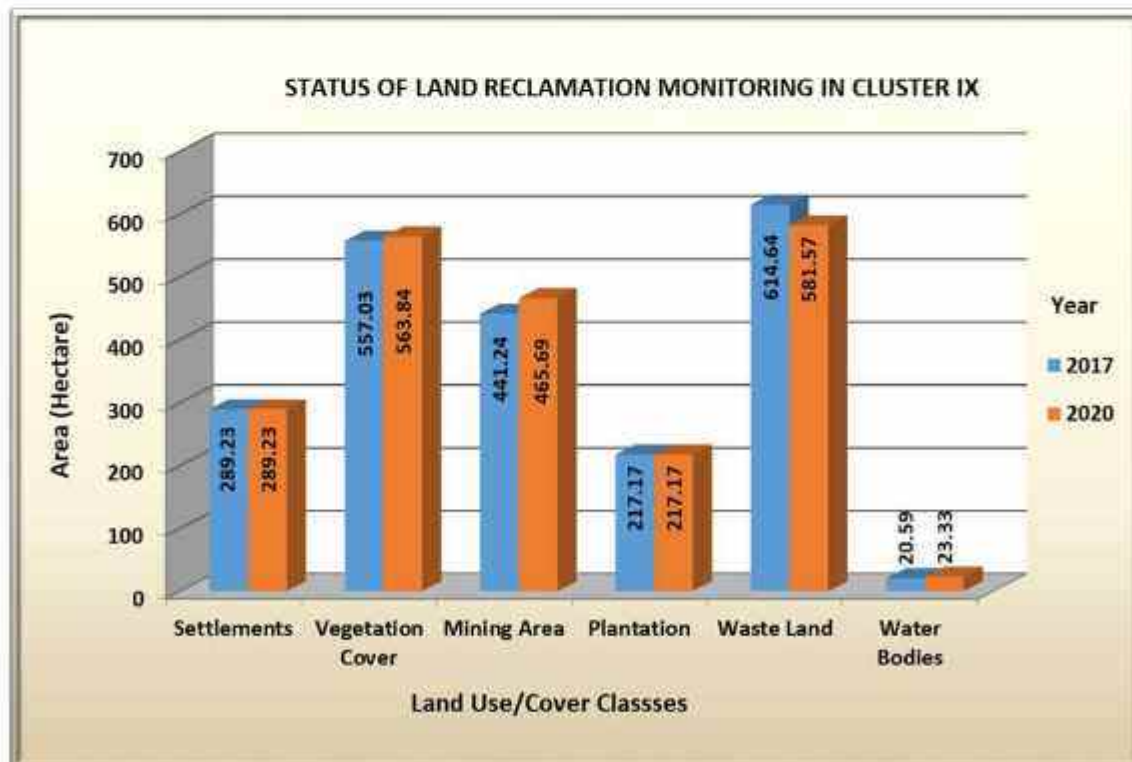


Fig. 6: Land Reclamation Status of Cluster IX

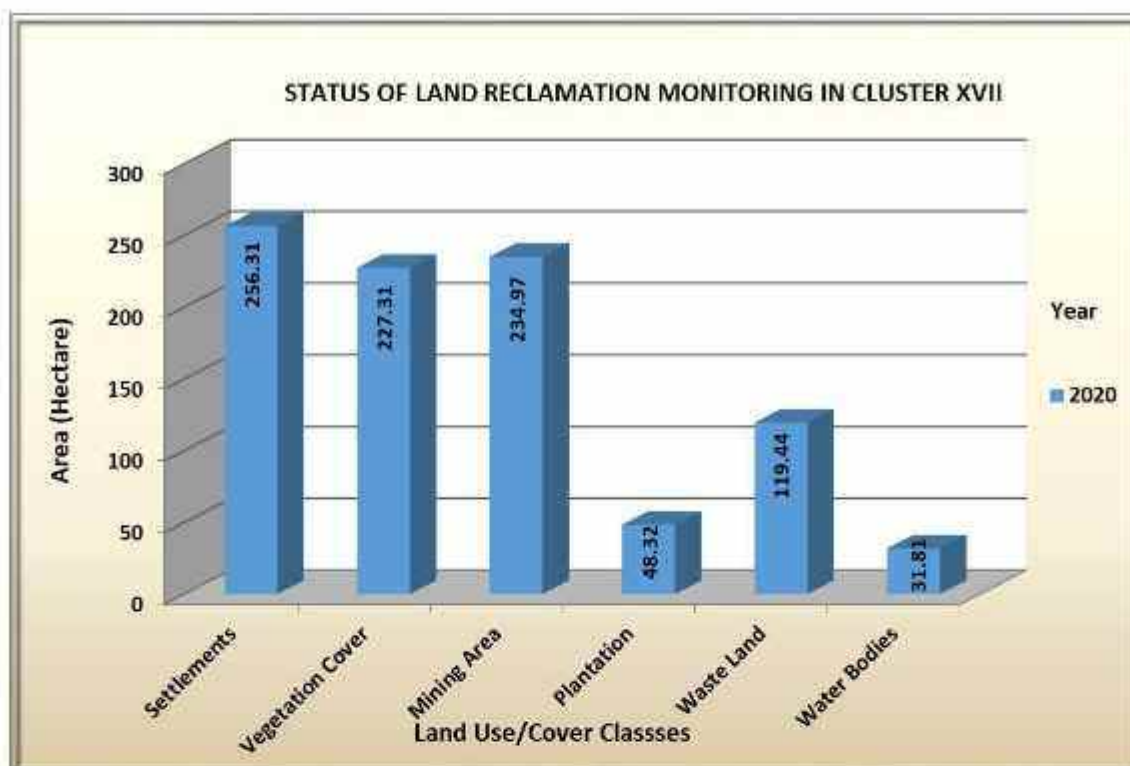


Fig. 7: Land Reclamation Status of Cluster XVII



Photo 1: Plantation on OB dump, Cluster III



Photo 2: Eco Restoration Site, Cluster V



Photo 3: Plantation on OB Dump, Cluster V



Photo 4: Plantation on OB Dump, Cluster VIII



Photo 5: Gokul Eco Cultural Park, Cluster IX



Photo 6: Plantation in Cluster XVII



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

Revenue Expenditure on Environment Management (Cluster-III)

Sl. No.	Element	Annually Recurring Cost (Rs. in Lakhs) as per EIA/EMP	Actual cost incurred (Lakhs)	Remarks
			FY 2022-23	
1.	Pollution control	20.00	24.13	Water Sprinkling on haul roads, railway siding and public roads.
2.	Pollution monitoring	5.00	45.94	As per information provided by Env department, HQ; Being done by CMPDIL RI-II, Dhanbad
3.	Occupational health	5.00	10.03	Expenditure incurred on purchase of florescent jackets, rubber and leather gloves ear plugs, Safety helmets, goggles, medical kits etc. for persons engaged in mining activities.
4.	Green belt & biological reclamation	10.00	45.13 (05 nos. of Manpower with EMS@ Rs. 2735.19)	Manpower Cost incurred on biological reclamation of OB dumps
			16.47	Expenditure on maintenance work of OB plantation on 32.5 Ha by DFO, Dhanbad.
5.	Corporate Social Responsibility	138.45		Being dealt at HQ level. Cluster-III is contributor for the same.
6.	Corpus fund for mine-closure	130.00	318.43	Deposited in Escrow account.
7.	Water cess and consent to operate	6.00	NIL	
8.	Others (Lump sum)	5.00	1.58	Landscaping at Maheshpur Eco-Park
9.	Mine Reclamation	25.00	215*	* 50% of cost deposited in escrow amount with interest for FY 2022-23. Reimbursement is subjected to Third party audit of the claim as per approved Mine Closure Plan.
Total #		344.45	461.71	

Cost of CSR expenditure done at corporate level, mine reclamation is not included.

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	
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	Advance work for bamboo gabion plantation in Maheshpur, Jogidih, Govindpur Colliery	2021-22	17.29	By DFO, Dhanbad
		Completion work for bamboo gabion plantation	Completion work for bamboo gabion plantation in Maheshpur, Jogidih, Govindpur Colliery (1978 Nos.)	2022-23	11.50789	
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	Construction of Toe wall around OB dump	Maheshpur Colliery	2020-21	9.61268	As per details provided by Area Survey Deptt.
		Construction of Rain Water Harvesting Arrangement	New Akashkinaree Colliery	2021-22	8.40	
		Construction of Toe wall around OB dump	Maheshpur Colliery	2022-23	7.77941	
		Construction of Toe wall around OB dump	New Akashkinaree Colliery	2022-23	7.90340	
		Development of Eco-park	New Akashkinaree Colliery	2022-23	13.30	
		Purchase of 05 nos. PM10 Online analyzer	Cluster-III	2021-22	62.00	PO by HQ MM deptt.



Annexure- XVI

BHARAT COKING COAL LIMITED

*A Mini Ratana Company
(A Subsidiary of Coal India Ltd.)*

Office of the General Manager

Govindpur Area No.III

PO- Sonardih, DHANBAD – 828125

Contact No: 0326-2392162 email- cgm.govindpur@bcccl.gov.in

Ref: BCCL: AR.III:GM:20: 18

Dated: 13.04.2020

To
Panchayat Sachivalay,
Tundoo Panchayat,
Kalludih Panchayat,
Akashkinaree Panchayat,
Bahiyardih Panchayat,
Jamua Panchayat

Sub: Copy of Environmental Clearance granted to Cluster-III group of Mines, BCCL by Ministry of Environment & Forest

Dear Sir

Kindly find herewith the attached copy of Environmental Clearance granted to Cluster-III group of Mines, BCCL by Ministry of Environment & Forest.

This is for your kind information.

Encl: As above

Yours faithfully

13/04/2020

Addl. General Manager/ Nodal Officer (Env)
Govindpur Area

Copy to:

1. General Manager, Govindpur Area- for kind information
2. HoD (Env), Koyla Bhawan, BCCL- for kind information



Scanned with
CamScanner

